

## **Pooled overexpression screening identifies PIPPI as a novel microprotein involved in the ER stress response**

Lorenzo Lafranchi<sup>1,2</sup>, Glancis Luzeena Raja<sup>1,2</sup>, Alberto M. Arenas<sup>1,2</sup>, Anna Spinner<sup>1,2</sup>, Kovi R. Shrung<sup>4</sup>, Maximilian Hornisch<sup>3</sup>, Dörte Schlesinger<sup>1,2</sup>, Carmen Navarro Luzon<sup>1,2</sup>, Linus Brinkensträhle<sup>1,2</sup>, Rui Shao<sup>1,2</sup>, Ilaria Piazza<sup>3</sup>, Janne Lehtiö<sup>4</sup>, Rui M.M. Branca<sup>4</sup>, Simon J. Elsässer<sup>1,2</sup>

<sup>1</sup>Science for Life Laboratory, Karolinska Institutet, Department of Medical Biochemistry and Biophysics, Division of Genome Biology

<sup>2</sup>Ming Wai Lau Centre for Reparative Medicine, Stockholm node, Karolinska Institutet, Stockholm 17165, Sweden

<sup>3</sup>Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC Berlin), Berlin, Germany

<sup>4</sup>Science for Life Laboratory, Karolinska Institutet, Department of Oncology-Pathology, Stockholm, Sweden.

### **SUPPLEMENTARY INFORMATION**

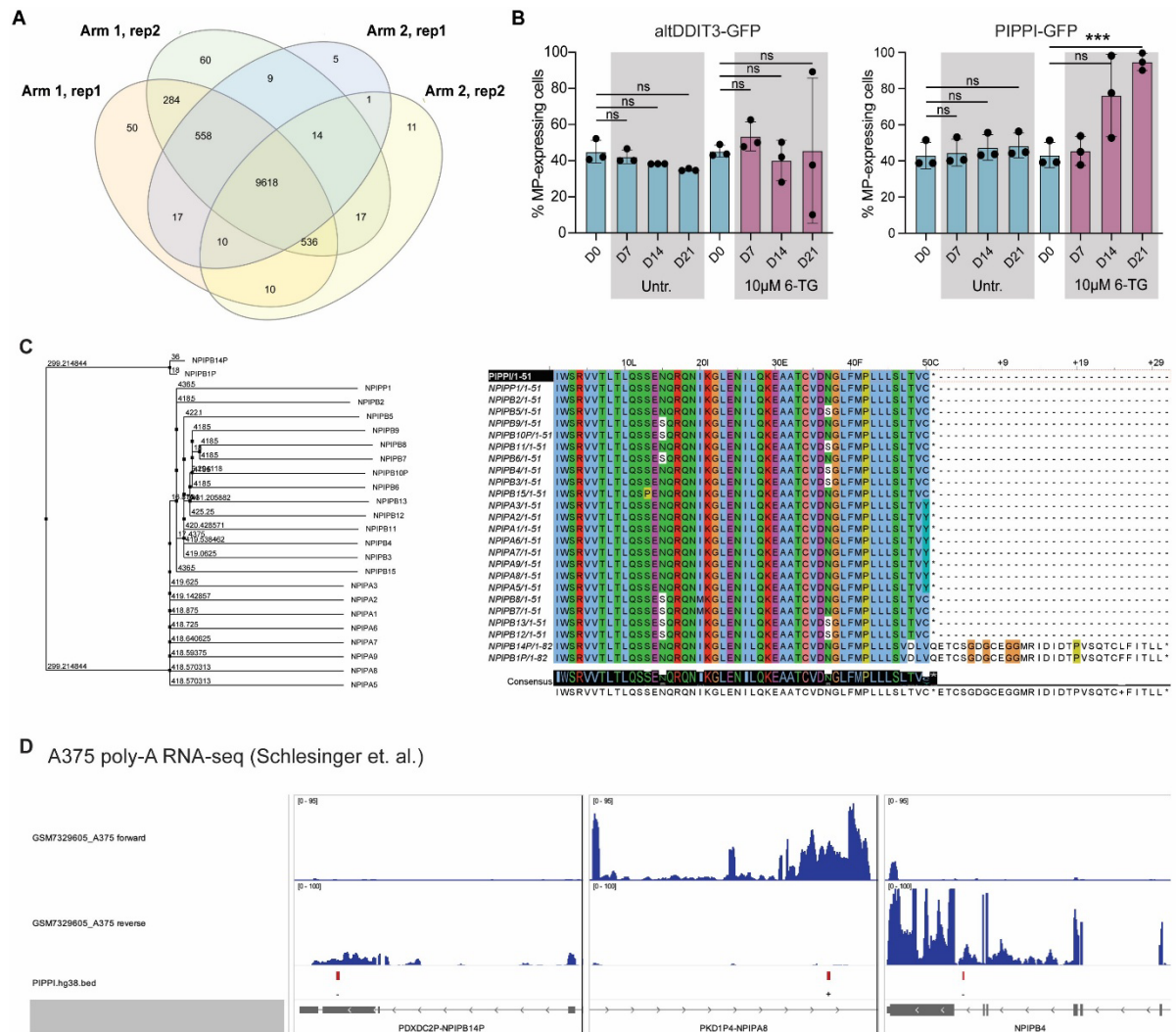
#### **Supplementary Figures 1-4**

#### **Supplementary Tables 1-5**

#### **Supplementary Data**

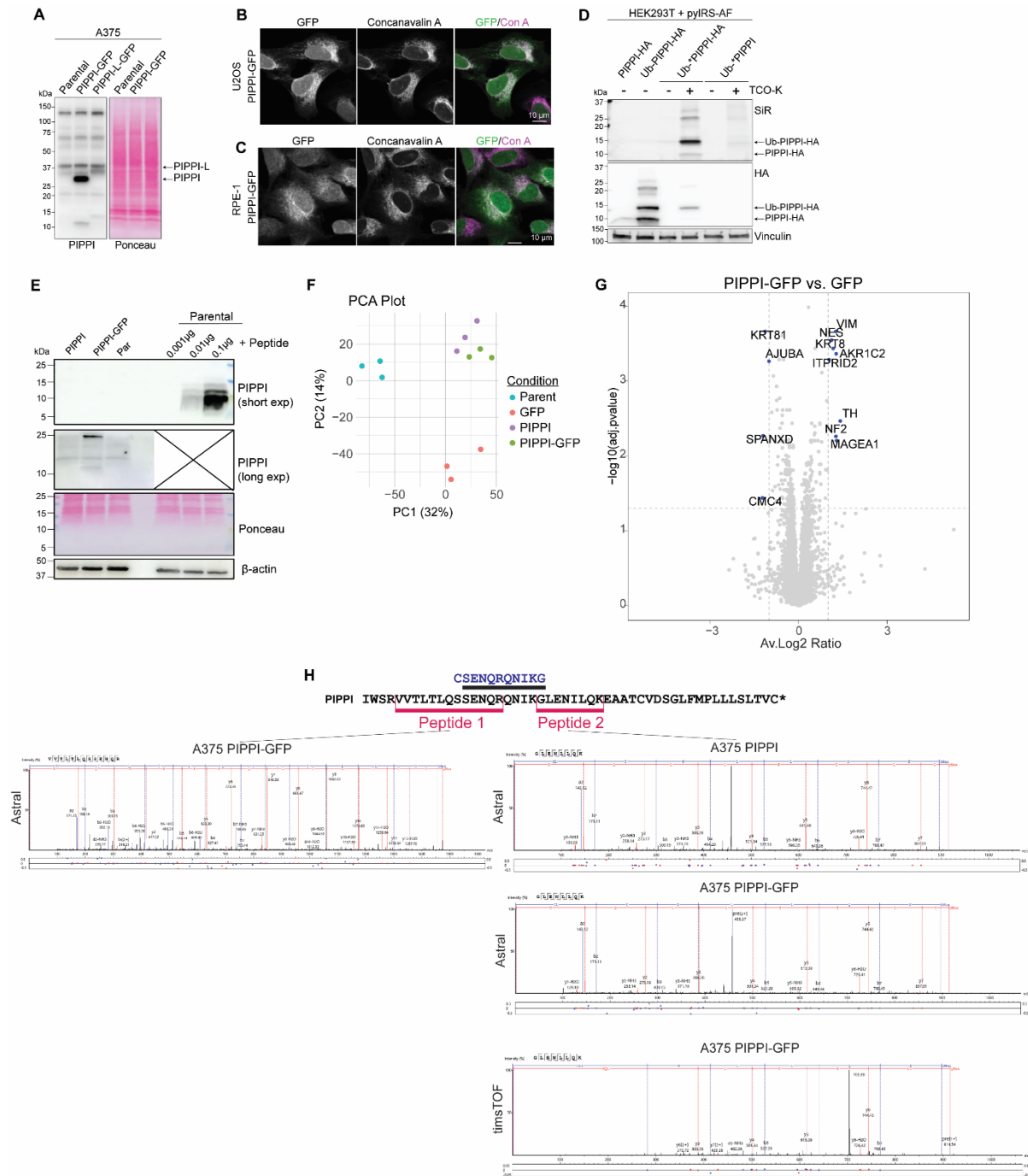
Location and genomic sequence of PIPPI sORFs

## Supplementary Figures



Supplementary Figure 1

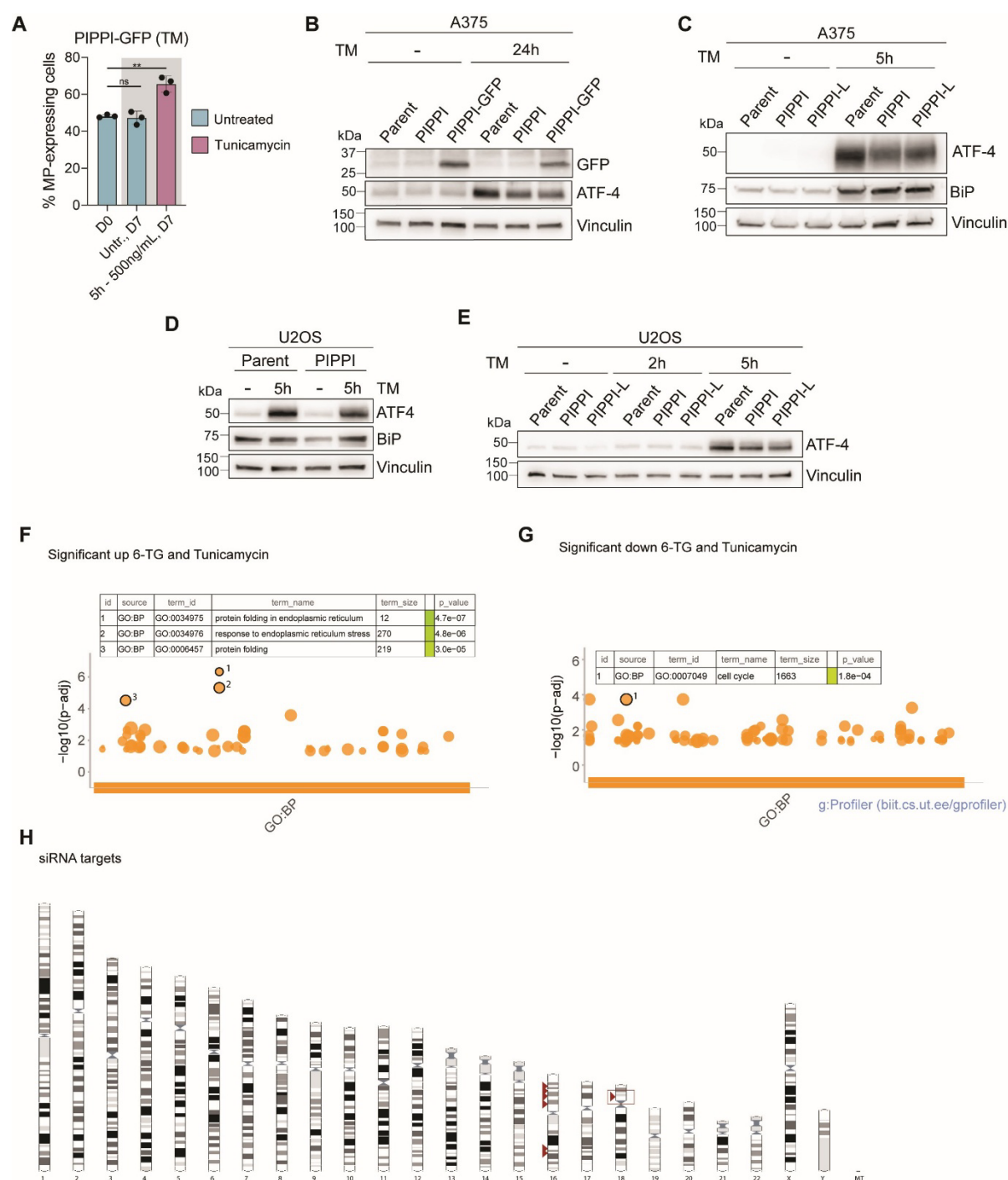
**Supplementary Figure 1: A)** Venn diagram of sORF sequences mapped in the two arms of the A375 screens at timepoint T0 (5 days after lentiviral transduction). **B)** Results of the growth competition assays comparing the growth of altDDIT3-GFP or PIPPI-GFP to A375 parental cells. Where indicated, cells were continuously treated with 10  $\mu$ M 6-thioguanine (6-TG), which was renewed every 2-3 days until the end of the assay. Height of the bars represents the fraction of microprotein-expressing cells present in the total cell population. Values were averaged based on 3 independent biological replicates (black circles). p-values were calculated using unpaired Student's t-test (ns =  $p > 0.05$ , \*\*\* =  $p < 0.001$ ). **C)** Left: Phylogenetic tree of the 24 NPIP family members that the PIPPI sORF overlaps with. Right: Sequence alignment highlighting amino acid variations and the frameshift mutation leading to the elongation of PIPPI-L in the sORFs within the NPIP14P (chr16) and NPIP1P (chr18) loci. **D)** Genome Browser views with poly-A RNA-seq coverage tracks, and location of PIPPI sORFs within NPIP transcripts. The later introns of many NPIP transcripts show RNA-seq coverage whereas earlier introns are quantitatively spliced out showing no coverage.



Supplementary Figure 2

**Supplementary Figure 2:** **A)** Immunoblots showing the levels of PIPPI-GFP and PIPPI-L-GFP overexpression in A375 cells. **B-C)** Confocal images of U2OS (B) and RPE-1 (C) cells stably expressing a PIPPI-GFP transgene. Concanavalin A (Con A) staining was included to visualize the endoplasmic reticulum. **D)** Various PIPPI-HA constructs were transiently expressed in HEK293T cells. Where indicated, the pyrrolysine tRNA synthetase (pyIRS) and the non-canonical amino acid TCO\*K were provided to allow suppression of the amber stop codon present in some of the constructs. Lysates were labelled using SiR tetrazine and analysed by SDS-PAGE, followed by immunoblotting. Vinculin was used as a loading control. **E)** Immunoblot titration series of lysates from PIPPI, PIPPI-GFP and parental A375 cells, as well as A375 parental cells spiked with a synthetic PIPPI peptide in increasing concentrations, assessing the sensitivity of the PIPPI antibody. Labels (short exp) and (long exp) represent short and long exposures of the same membrane with the PIPPI rabbit serum antibody.  $\beta$ -actin was used as a loading control. **F)** PCA plot of A375 parental, PIPPI, PIPPI-GFP and GFP

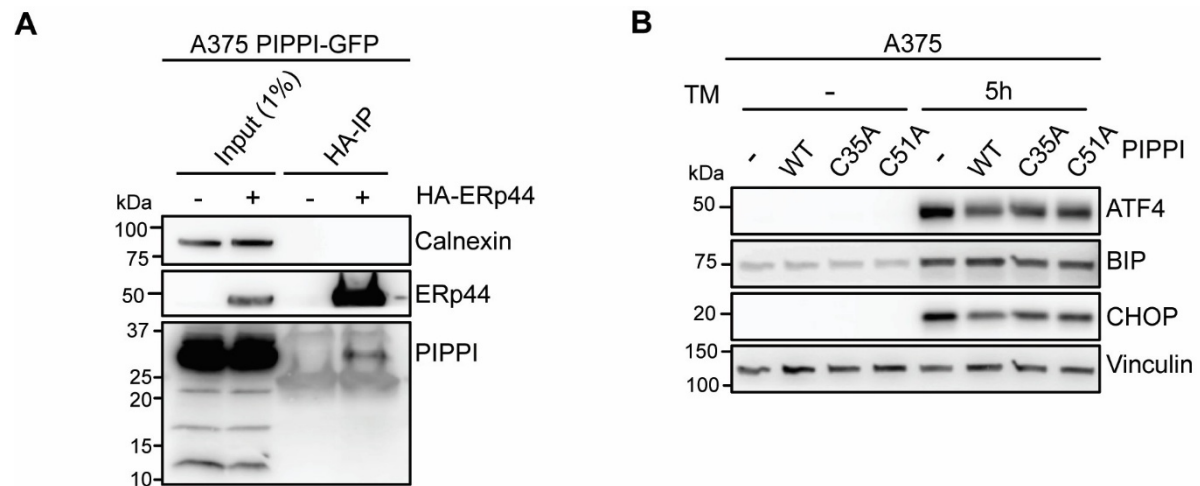
expressing cells, highlighting the similarity in the proteomic profiles of PIPPI (in purple) and PIPPI-GFP (in green) samples. **G**) Volcano plot representing the pairwise comparisons of PIPPI-GFP versus GFP expressing cells. Thresholds are set at  $\text{Log}_2(\text{FC}) = 1$ , and adjusted p-value = 0.05 (dashed lines). **H**) MS2 fragmentation spectra of tryptic peptides (peptide 1, peptide 2-highlighted in red) for A375 PIPPI and PIPPI-GFP overexpressing cells in both Thermo Astral and Bruker timsTOF are presented where the respective peptides were detected. Results for mass spectrometry are from 3 technical replicates.



**Supplementary Figure 3**

**Supplementary Figure 3: A)** Bar chart presenting the results of the growth competition assays performed to assess the ability of PIPPI-GFP-expressing cells to overcome tunicamycin (TM) treatment. Height of the bars represents the fraction of PIPPI-GFP-expressing cells present in the total cell population. Values were averaged based on 3 independent biological replicates (black circles). p-values were calculated using unpaired Student's t-test (ns =  $p > 0.05$ ; \*\* =  $p < 0.01$ ). **B)** Parental, PIPPI- and PIPPI-GFP-expressing A375 cells were treated with 100 ng/mL TM for 24 hours. Lysates were then analysed by immunoblotting. Vinculin was used as a loading control. **C)** Parental, PIPPI- and PIPPI-L-expressing A375 cells were treated for 5h with 500 ng/mL TM. Induction of the UPR was assessed by immunoblotting. Vinculin was used as a loading control. **D)** Parental and PIPPI-

expressing U2OS cells were treated with 500 ng/mL TM for 5 hours. After lysis, the levels of ATF4, BiP and vinculin were assessed by immunoblotting. **E)** Parental, PIPPI- and PIPPI-L-expressing U2OS cells were treated with 200 ng/mL TM for either 2 or 5 hours. The extent of ATF4 induction was then assessed by immunoblotting. Vinculin was used as a loading control. **F)** Top GO (g:Profiler gene ontology) terms associated with significantly upregulated proteins in TM and 6-TG treated A375 cells from whole cell lysate mass spectrometry analysis. Top three pathways are related to protein folding and ER stress. **G)** Top GO terms associated with significantly downregulated proteins in TM and 6-TG treated A375 cells from whole cell lysate mass spectrometry analysis. Top enriched pathway relates to cell cycle. **H)** Schematic representation of the regions targeted by the siRNAs used against PIPPI.



#### Supplementary Figure 4

**Supplementary Figure 4: A)** Lysates from A375 cells either expressing PIPPI-GFP or co-expressing PIPPI-GFP and HA-ERp44 were subjected to immunoprecipitation using HA-beads and analysed by immunoblotting with the antibodies indicated on the right. **B)** Parental, wild type PIPPI-GFP-, C35A PIPPI-GFP-, and C51A PIPPI-GFP-expressing A375 cells were treated with 500 ng/mL TM for 5 hours. After lysis, the level of different proteins involved in the ER stress response were assessed by immunoblotting. Vinculin was used as a loading control.

## Supplementary Tables

**Supplementary Table 1:** sORF library used in this study, including UIDs (unique identifiers) for this study as well as our previous study (Schlesinger et al., 2025), original sequence as well as library sequence.

**Supplementary Table 2:** Table listing the genomic regions encoding for PIPPI, including chromosome number, start and end location, overlapping NPIP gene as well as the corresponding PIPPI isoform.

**Supplementary Table 3:** Results from total proteome DIA mass spectrometry experiment in parental A375, PIPPI, PIPPI-GFP and GFP overexpressing A375 cells.

**Supplementary Table 4:** Results from whole proteome mass spectrometry analysis performed in A375 parental, PIPPI and PIPPI-GFP cells treated with vehicle (DMSO), 6-thioguanine or tunicamycin.

**Supplementary Table 5:** Results from GFP-Trap IP-MS experiments performed in PIPPI-GFP U2OS and PIPPI-GFP A375 cell lines.

## Supplementary Data – Location and genomic sequences of PIPPI sORFs

Ensembl release 110 - July 2023

Exons	All exons
HSP	Location of selected alignment
Markup	loaded

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 228620 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 228561  
 228560 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 228501  
 228500 GACAGACACAGTGGCATGTGGAGACAACAGTGTGTGCCAATGACTTTCCCTTTACCTCCA 228441  
 228440 GCTGTCGGCAGTACTCAGTGGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC 228381  
 228380 CTGGAGGATGGAAAGGTGCAAAAATCTATC 228351

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1698748	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	1698807
1698808	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	1698867
1698868	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTGGAACCTCTGTTTTCTTAG	1698927
1698928	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	1698987
1698988	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAGTGGGCTTTTC</b>	1699047
1699048	<b>ATGCCTCTCTTACTGTCTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	1699107
1699108	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	1699167
1699168	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	1699227
1699228	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTCCA	1699287
1699288	GCTGTCGGCAGTACTCAGTGGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC	1699347
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74390669	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	74390728
74390729	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	74390788
74390789	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTGGAACCTCTGTTTTCTTAG	74390848
74390849	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTCTGAGAATCAGAGACAGAACATA</b>	74390908
74390909	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	74390968
74390969	<b>ATGCCTCTCTTACTGTCTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	74391028
74391029	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCCTCTT	74391088
74391089	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	74391148
74391149	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACTCCCCA	74391208
74391209	GCTGTCGGCAGTACTCAGTGGAAGGGTGATATCATGACACTGATACTGCTATTTTGAAAC	74391268
74391269	CTGGAGGATGGAAAGGTGCAAAAATCTATC	74391298

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14725161	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	14725220
14725221	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	14725280
14725281	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTGGAACCTCTGTTTTCTTAG	14725340
14725341	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTCTGAGAATCAGAGACAGAACATA</b>	14725400
14725401	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	14725460
14725461	<b>ATGCCTCTCTTACTGTCTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	14725520
14725521	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCCTCTT	14725580
14725581	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	14725640
14725641	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCCA	14725700
14725701	GCTGTCGGCAGTACTCAGTGGAAGGGTGATATTATGACACTGACACTGCTATTTTGAAAC	14725760
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14764281	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	14764340
14764341	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	14764400
14764401	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTGGAACCTCTGTTTTCTTAG	14764460
14764461	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTCTGAGAATCAGAGACAGAACATA</b>	14764520
14764521	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	14764580
14764581	<b>ATGCCTCTCTTACTGTCTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	14764640
14764641	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	14764700
14764701	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	14764760
14764761	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCCA	14764820
14764821	GCTGTCGGCAGTACTCAGTGGAAGGGTGATATTATGACACTGACACTGCTATTTTGAAAC	14764880
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14950833	CTGTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	14950892

14950893	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	14950952
14950953	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	14951012
14951013	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	14951072
14951073	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	14951132
14951133	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	14951192
14951193	<b>ATGCCTCTCTTACTGTCTCTTACTGTC</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	14951252
14951253	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	14951312
14951313	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	14951372
14951373	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA	14951432
14951433	GCTGTCGGCAGTACTCAGTGGAAGGTGATATTATGACACTGACACTGCTATTTTGAAAC	14951492
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16349370	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	16349429
16349430	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	16349489
16349490	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	16349549
16349550	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	16349609
16349610	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	16349669
16349670	<b>ATGCCTCTCTTACTGTCTCTTACTGTC</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	16349729
16349730	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	16349789
16349790	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	16349849
16349850	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA	16349909
16349910	GCTGTCGGCAGTACTCAGTGGAAGGTGATATTATGACACTGACACTGCTATTTTGAAAC	16349969
16349970	CTGGAGGATGGAAAGGTGCAAAAATCT	16349996

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16392734	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	16392793
16392794	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	16392853
16392854	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	16392913
16392914	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	16392973
16392974	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	16393033
16393034	<b>ATGCCTCTCTTACTGTCTCTTACTGTC</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	16393093
16393094	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	16393153
16393154	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	16393213
16393214	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA	16393273
16393274	GCTGTCGGCAGTACTCAGTGGAAGGTGATATTATGACACTGACACTGCTATTTTGAAAC	16393333
16393334	CTGGAGGATGGAAAGGTGCAAAAATCT	16393360

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18359370	CTGTCAGAAAACCTCTCCCAGTTCCTTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	18359311
18359310	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	18359251
18359250	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	18359191
18359190	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	18359131
18359130	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	18359071
18359070	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	18359011
18359010	<b>ATGCCTCTCTTACTGTCTCTTACTGTC</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	18358951
18358950	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	18358891
18358890	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA	18358831
18358830	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA	18358771
18358770	GCTGTCGGCAGTACTCAGTGGAAGGTGATATTATGACACTGACACTGCTATTTTGAAAC	18358711
18358710	CTGGAGGATGGAAAGGTGCAAAAATCT	18358684

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18319157	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	18319098
18319097	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	18319038
18319037	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	18318978
18318977	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	18318918

18318917 **AAAGGCCTGAAAAACATTCTCCAAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC** 18318858  
 18318857 **ATGCCCTCTCTTACTGTCTCTTACTGTC**TATTGACCTGGTGCAAGAAACATGCTCTGGTGA 18318798  
 18318797 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 18318738  
 18318737 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 18318678  
 18318677 GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA 18318618  
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15364911 **CCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAA**CTGACTTCTTGAGGTAAGATTGTT 15364852  
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 15364791 GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA 15364732  
 15364731 ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT 15364672  
 15364671 TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG 15364612  
 15364611 **ATTTGGAGCAGGGTGGTCACACTGACCTTGACAGTTCTGAGAATCAGAGACAGAACATA** 15364552  
 15364551 **AAAGGCCTGAAAAACATTCTCCAAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC** 15364492  
 15364491 **ATGCCCTCTCTTACTGTCTCTTACTGTC**TATTGACCTGGTGCAAGAAACATGCTCTGGTGA 15364432  
 15364431 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 15364372  
 15364371 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 15364312  
 15364311 GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA 15364252  
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 298144 TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG 298203  
 298204 **ATTTGGAGCAGGGTGGTCACACTGACCTTGACAGTTCTGAGAATCAGAGACAGAACATA** 298263  
 298264 **AAAGGCCTGAAAAACATTCTCCAAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC** 298323  
 298324 **ATGCCCTCTCTTACTGTCTCTTACTGTC**TATTGACCTGGTGCAAGAAACATGCTCTGGTGA 298383  
 298384 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 298443  
 298444 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 298503  
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 564266 GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA 564325  
 564326 ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT 564385  
 564386 TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG 564445  
 564446 **ATTTGGAGCAGGGTGGTCACACTGACCTTGACAGTTCTGAGAATCAGAGACAGAACATA** 564505  
 564506 **AAAGGCCTGAAAAACATTCTCCAAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC** 564565  
 564566 **ATGCCCTCTCTTACTGTCTCTTACTGTC**TATTGACCTGGTGCAAGAAACATGCTCTGGTGA 564625  
 564626 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 564685  
 564686 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 564745  
 564746 GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCAGTACTTTTCTTTACCCCTA 564805  
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 1022617 TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG 1022558  
 1022557 **ATTTGGAGCAGGGTGGTCACACTGACCTTGACAGTTCTGAGAATCAGAGACAGAACATA** 1022498  
 1022497 **AAAGGCCTGAAAAACATTCTCCAAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC** 1022438  
 1022437 **ATGCCCTCTCTTACTGTCTCTTACTGTC**TATTGACCTGGTGCAAGAAACATGCTCTGGTGA 1022378  
 1022377 TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT 1022318  
 1022317 TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCA 1022258

1022257	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCCCA	1022198
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2008500	CTGTCAGAAAACCTCTCCAGTTCCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	2008559
2008560	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	2008619
2008620	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	2008679
2008680	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	2008739
2008740	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	2008799
2008800	<b>AAAGGCCTGGAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	2008859
2008860	<b>ATGCCTCTCTTACTGTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	2008919
2008920	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	2008979
2008980	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	2009039
2009040	GACAGACACAGTGGCATGTGGAGACAACAGTGGTGTCCCAATGACTTTTCTTTACCCCTA	2009099
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2009160	CTGGAGGATGGAAAGGTGCAAAAATCT	2009186

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2053776	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	2053835
2053836	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	2053895
2053896	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	2053955
2053956	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>	2054015
2054016	<b>AAAGGCCTGGAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	2054075
2054076	<b>ATGCCTCTCTTACTGTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	2054135
2054136	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	2054195
2054196	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	2054255
2054256	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTA	2054315
2054316	GCTGTCTGGCAGTACTCAGTGAAGGGTGATATTATGACACTGACACTGCTATTTTGAAAC	2054375
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28657306	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGTTTCTTTGTCAAGAAGGGAA	28657365
28657366	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	28657425
28657426	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	28657485
28657486	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAGTCAGAGACAGAACATG</b>	28657545
28657546	<b>AAAGGCCTGGAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	28657605
28657606	<b>ATGCCTCTCTTACTGTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	28657665
28657666	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	28657725
28657726	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	28657785
28657786	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCTCA	28657845
28657846	GCTGTCTGGCAGTACTCAGTGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC	28657905
28657906	CTGGAGGATGGAAAGGTGCAAAAATCTATC	28657935

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28457868	CCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAACTGACTTCTTGAGGTGAGATTGTT	28457809
28457808	CTGTCAGAAAACCTCTCCAGTTCCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	28457749
28457748	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	28457689
28457688	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	28457629
28457628	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	28457569
28457568	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAGTCAGAGACAGAACATG</b>	28457509
28457508	<b>AAAGGCCTGGAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	28457449
28457448	<b>ATGCCTCTCTTACTGTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	28457389
28457388	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	28457329
28457328	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	28457269
28457268	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCCCA	28457209
28457208	GCTGTCTGGCAGTACTCAGTGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC	28457149
28457148	CTGGAGGATGGAAAGGTGCAAAAATCTATC	28457119



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30226645	CCTGGGAGTGAAAAGAAATATTACAGCCGTGCCTAAGTGACTTCTTGAGGTGAGATTGTT	30226586
30226585	CTGTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	30226526
30226525	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	30226466
30226465	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	30226406
30226405	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	30226346
30226345	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAAGATTCTGAGAGTCAGAGACAGAACATA</b>	30226286
30226285	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAGTGGGCTTTTC</b>	30226226
30226225	<b>ATGCCTCTCTTACTGTCTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	30226166
30226165	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	30226106
30226105	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	30226046
30226045	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTCTTTACCCTCCA	30225986
30225985	GCTGTCGGCAGTACTCAGTGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC	30225926
30225925	CTGGAGGATGGAAAGGTGCAAAAATCTATC	30225896

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29486675	CCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAAGTGACTTCTTGAGGTGAGATTGTT	29486616
29486615	CTGTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	29486556
29486555	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	29486496
29486495	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	29486436
29486435	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	29486376
29486375	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAAGATTCTGAGAGTCAGAGACAGAACATA</b>	29486316
29486315	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAGTGGGCTTTTC</b>	29486256
29486255	<b>ATGCCTCTCTTACTGTCTCTTACTGTCTGT</b> TGACCTGGTGCAAGAAACATGCTCTGGTGA	29486196
29486195	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	29486136
29486135	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	29486076
29486075	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTCTTTACCCTCCA	29486016
29486015	GCTGTCGGCAGTACTCAGTGAAGGGTGATATTATGACACTGATACTGCTATTTTGAAAC	29485956
29485955	CTGGAGGATGGAAAGGTGCAAAAATCTATC	29485926

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790104	CCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAAGTGACTTCTTGAGGTAAGATTGTT	790163
790164	CTGTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	790223
790224	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	790283
790284	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	790343
790344	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	790403
790404	<b>ATTTGGAGCAGGATGGTCACACTGACCTTGCAAGATTCTGAGAATCAGAGACAGAACATA</b>	790463
790464	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	790523
790524	<b>ATGCCTCTCTTACTGTCTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	790583
790584	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	790643
790644	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	790703
790704	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAAAGACTTTTCTTTACCCCTTA	790763
790764	GCTGTCGGCAGTACTCAGTGAAGGGTGATATTATGACACTGACACTGCTATTTTGAAAC	790823
790824	CTGGAGGATGGAAAGGTGCAAAAATCT	790850

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718959	CCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAAGTGACTTCTTGAGGTAAGATTGTT	718900
718899	CTGTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTCCAGA	718840
718839	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA	718780
718779	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	718720
718719	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAACCTCTGTTTTCTTAG	718660
718659	<b>ATTTGGAGCAGGATGGTCACACTGACCTTGCAAGATTCTGAGAATCAGAGACAGAACATA</b>	718600
718599	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	718540
718539	<b>ATGCCTCTCTTACTGTCTCTTACTGTCT</b> TATTGACCTGGTGCAAGAAACATGCTCTGGTGA	718480
718479	TGGCTGTGAGGGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTT	718420
718419	TATTACTCTGTTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTGCA	718360
718359	GACAGACACAGTGGCATGTGGAGACAACAGTGTGTCCCAAAGACTTTTCTTTACCCCTTA	718300
718299	GCTGTCGGCAGTACTCAGTGAAGGGTGATATTATGACACTGACACTGCTATTTTGAAAC	718240
718239	CTGGAGGATGGAAAGGTGCAAAAATCT	718213

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69977564	TACCTGGGAGTGAAAAGAAATATTACAGCCATGCCTAAGTGACTTCTTGAGGTAAGATTG	69977505
69977504	TTCTGTTCAGAAAACCCCTCTCCCAGTTCCCTGCAGCTCTTCAGGAATCCACATCTCTGCA	69977445
69977444	GAGCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTATCAAGAAGGG	69977385

69977384	AAACAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT	69977325
69977324	TGCAAGCTGTGTGACCCCGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG	69977265
69977264	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCCGAGAATCAGAGACAGAACATA</b>	69977205
69977204	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>	69977145
69977144	<b>ATGCCTCTCTTACTGTCTGTT</b> GACCTGGTGCAAGAAACATGCTCTGGTGATGGCTGTGAG	69977085
69977084	GGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCCTCTTTATTACTCTG	69977025
69977024	TTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCAGACAGACACA	69976965
69976964	GTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACTCCCCAGCTGTGGCA	69976905
69976904	GTACTCAGTGGAAAGGTGATATTATGACACTGATACTGCTATTTTGAAACCTGGAGGATG	69976845
69976844	GAAAGGTGCAAAAATCTATCA	69976824

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11620752	CCTGGGAGTGAAAAGAAATATTACAGCCATGCCCAA	CTGACTTCTTGAGGTAAGATTGTT	11620693
11620692	CTGTCAGAAAACCTCTCCCAGTTCCTTGCAGCTCTTCAGGAATCCACATCTCTCCAGA		11620633
11620632	GCTCTTTGTTCTCATGGGTGGCACCTCCAGAGTGAAGAAGATCCTTTGTCAAGAAGGGAA		11620573
11620572	ACAGAGGGGAAATGAGAGGGTCCTGCAGGCAGAGCTGGAATCAACTTCCACTCTGCCTCT		11620513
11620512	TGCAAGCTGTGTGACCCTGGGCACAATTTCTCCTTCTCTGGAAACCTCTGTTTTCTTAG		11620453
11620452	<b>ATTTGGAGCAGGGTGGTCACACTGACCTTGCAGAGTTCTGAGAATCAGAGACAGAACATA</b>		11620393
11620392	<b>AAAGGCCTGGAAAACATTCTCCAAAAGAAGCTGCAACATGTGTGGACAATGGGCTTTTC</b>		11620333
11620332	<b>ATGCCTCTCTTACTGTCTGTT</b> GACCTGGTGCAAGAAACATGCTCTGGTGATGGCTGTGAG		11620273
11620272	GGAGGAATGAGGATAGACATAGACACTCCTGTGTCTCAAACATGCTTCTTTATTACTCTG		11620213
11620212	CTATGACTCTGTCTTCCCTGGGGCAGGACCCAGCCTGCCTACATTTGCAGACAGACACA		11620153
11620152	GTGGCATGTGGAGACAACAGTGTGTCCCAATGACTTTTCTTTACCCCCAGCTGTGGCA		11620093
11620092	GTACTCAGTGGAAAGGTGATATTATGACACTGATACTGCTATTTTGAAACCTGGAGGATG		11620033
11620032	GAAAGGTGCAAAAATCTATCA		11620012