

Profiling the activity of the para-caspase MALT1 in B-cell acute lymphoblastic leukemia for potential targeted therapeutic application

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SUPPLEMENTARY APPENDIX

Profiling the Activity of the Para-Caspase MALT1 in B-Cell Acute Lymphoblastic Leukemia for Potential Targeted Therapeutic Application.

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SUPPLEMENTARY METHODS

1. MTS

Cells were incubated with MI-2 (0-8 $\mu\text{mol/L}$) for 48 hours or with Z-VRPR-fmk for 96 hours in 96-well plates. Patient derived cells were incubated at a concentration of 500,000 cells/well whereas cell line samples were incubated at a concentration of 75,000 cells/well. At the end of the incubation period, MTS was added and incubated for 4 hours at 37°C then the absorbance was measured using a 96-well plate reader at 490nm.

2. Primary and secondary antibodies

Anti-MALT1(D-1) (sc-515389), anti-RBCK1 (E2) (sc-365523), anti-cylindromatosis1(H-6) (sc137139), MCPIP (H-6) (sc-515275) and β -Actin (C4) (sc-47778) all from Santa Cruz Biotechnology. Anti-c-PARP (Asp214) (#9541), Anti-RelB (C1E4) (#4922), and anti-Myc (D84C12) (#5605) were purchased from Cell Signaling Technology. Secondary antibodies used were: IRDye goat anti-rabbit (cat#926-68071) and IRDye goat anti-mouse (cat#926-32210), both from LI-COR Biosciences.

3. RNA sequencing

Polyadenylated RNA was enriched by two rounds of oligo(dT) selection (Invitrogen), followed by library construction and paired-end sequencing of 50bp reads on Illumina HiSeq-2000. We used MapSplice 2 to map RNA-seq reads to human genome hg19, Samtools package (DHIGroup) to remove duplicate reads and create mpileup files, and VarScan package (Genome Institute, Washington University) for INDEL and single-nucleotide variant callings. Variants were annotated using ANNOVAR.

SUPPLEMENTARY LEGENDS

Supplementary Figure S1. MALT1 proteolytic activity in B-ALL cell lines remains absent following pre-BCR crosslinking with anti-IgM or proteasomal inhibition with MG-132.

(A) Immunoblot of protein lysates of MALT1 dependent (2F7, TOM-1, SUP-B15 and RS4;11) or independent (RAJI) B-ALL cell lines that were subjected to coculture with anti-IgM antibodies for 8h. TMD8 was used as a positive control. (B) Immunoblot analysis of the B-ALL cell line RS4;11 after 1 or 2h culture with or without MI-2 and/or MG-132.

B-ALL, B-cell acute lymphoblastic leukemia; BCR, B-cell receptor.

Supplementary Figure S2. MI-2 fails to downregulate Myc in BALL-1 and RAJI. Column analysis showing Myc expression changes in whole cell lysates of BALL-1 and RAJI in triplicate immunoblot assays following 0-2 μ M MI-2 treatment for 8 hours. Changes were not statistically significant compared to baseline when tested using ANOVA.

ANOVA, analysis of variance.

Supplementary Figure S3. Effects of MALT1 inhibition on mRNA and protein levels of MYC, VPREB1, and BCL6. Changes in mRNA level (log2) of (A) MYC, (B) VPREB1, and (C) BCL6 following an 8h treatment with 2 μ M of MI-2. Red lines define the three cell lines with available Myc protein western blot data, and less pronounced mRNA changes following MI-2 treatment. (D), analysis of relative change in mean fluorescence intensity (MFI) of VPREB1 in the indicated cell lines following a 48h treatment with 0-1 μ M of MI-2. (E) Relative changes in the expression of Bcl6 relative to β -Actin when measured by western blot in the indicated cell lines following an 8h treatment with MI-2.

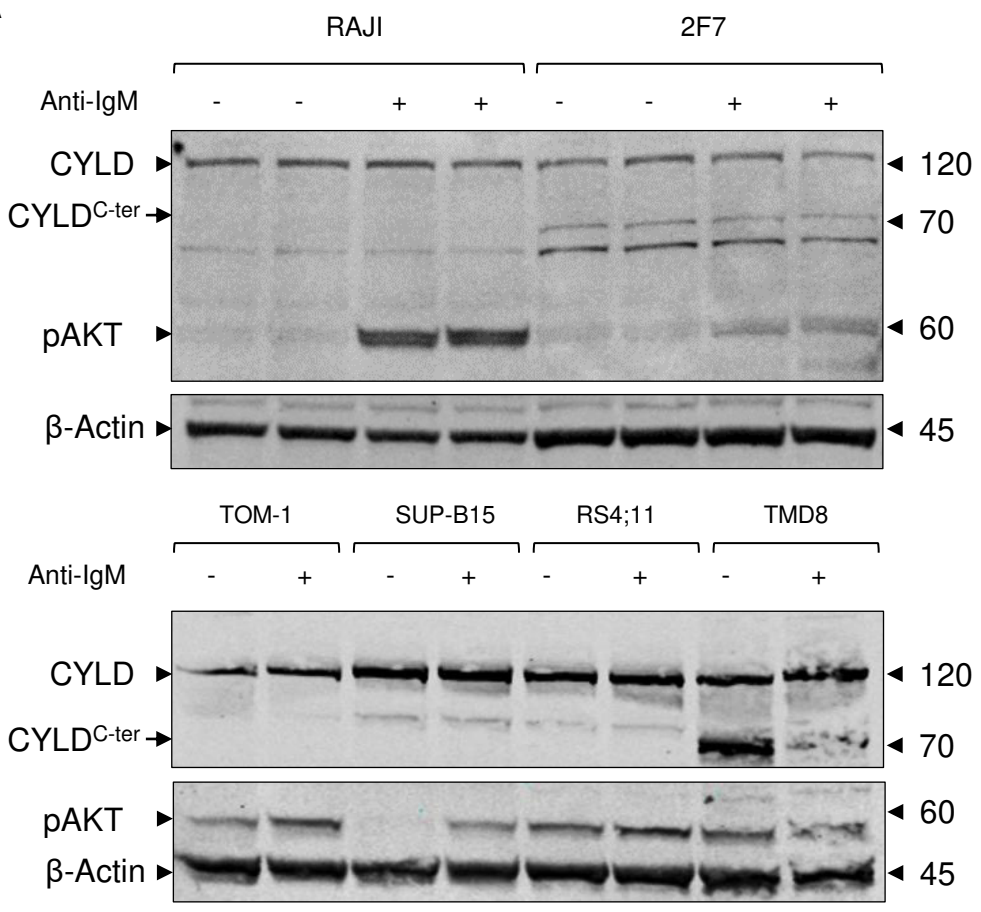
Supplementary Table S1. List of cell lines used according to lineage, level of maturation and Philadelphia chromosome status. ABC-DLBCL, activated B-cell like diffuse large B-cell lymphoma; AML, acute myeloblastic leukemia; B-ALL, B-cell acute lymphoblastic leukemia; MCL, mantle cell lymphoma; T-ALL, T-cell acute lymphoblastic leukemia.

Supplementary Table S2. List of down- or up-regulated genes by MI-2 in B-ALL. List of 1036 genes whose expression changed ≥ 2 -fold at $P < 0.05$ (275 down- and 761 up-regulated) following treatment of ALL cell lines (N=12) with 2 μ M of MI-2 for 8h.

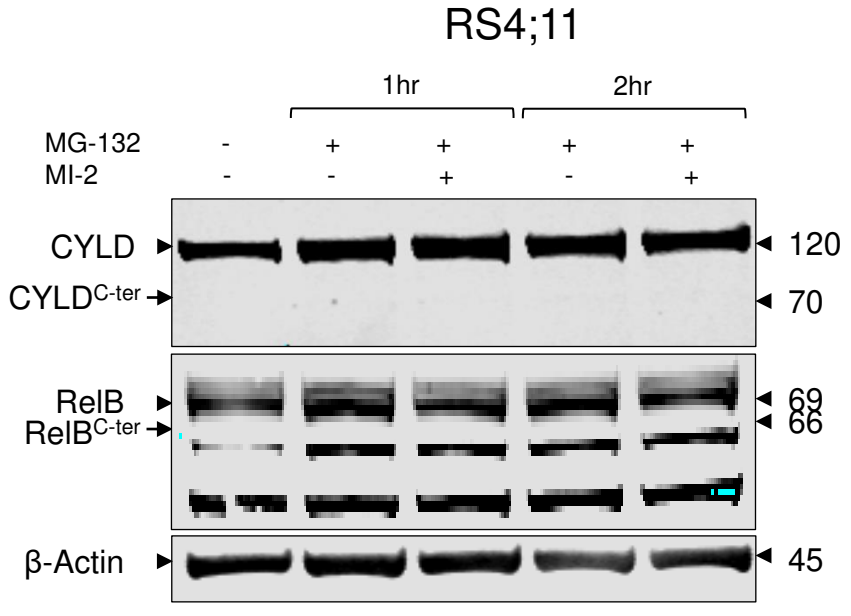
B-ALL, B-cell acute lymphoblastic leukemia.

Supplementary Figure S1

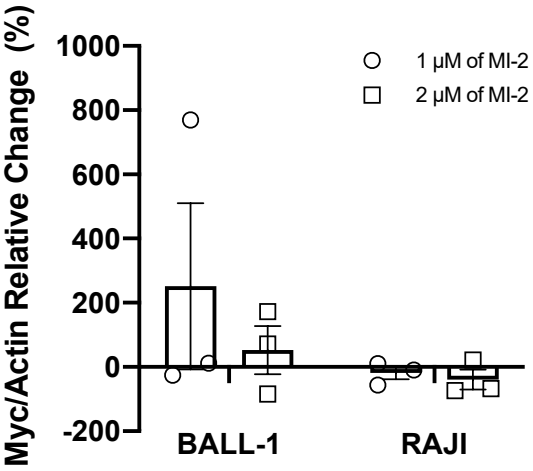
A



B

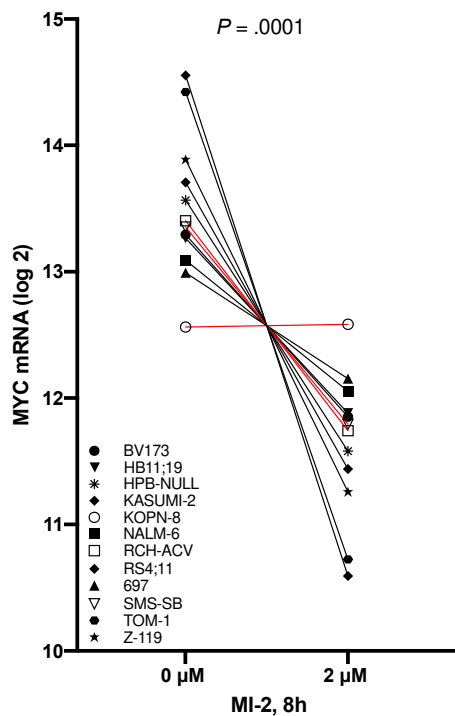


Supplementary Figure S2

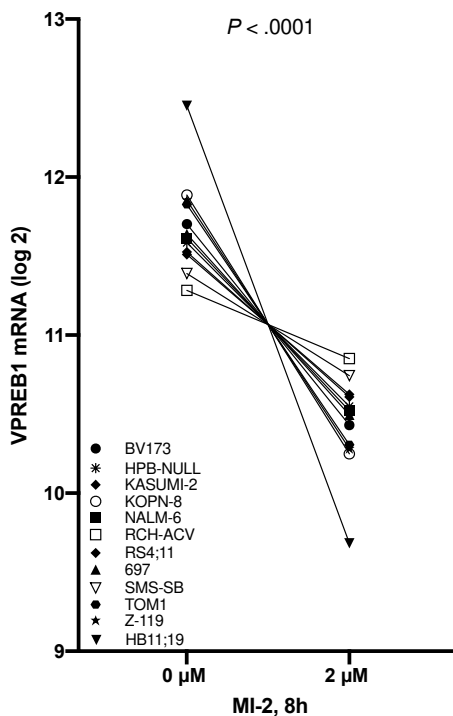


Supplementary Figure S3

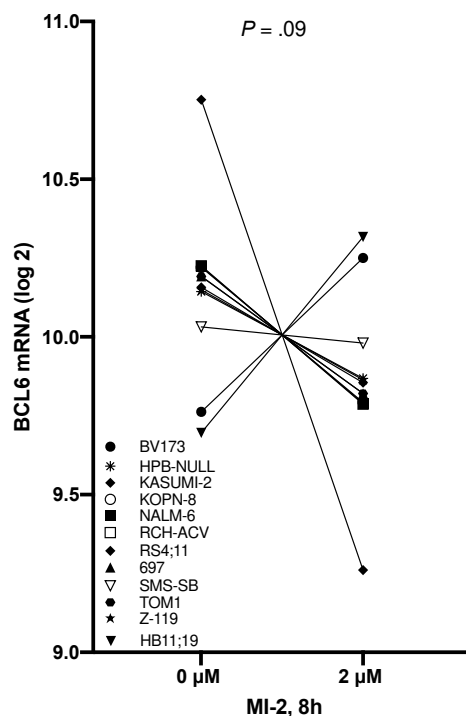
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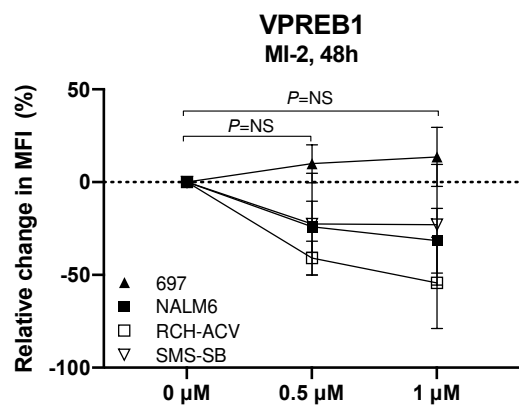
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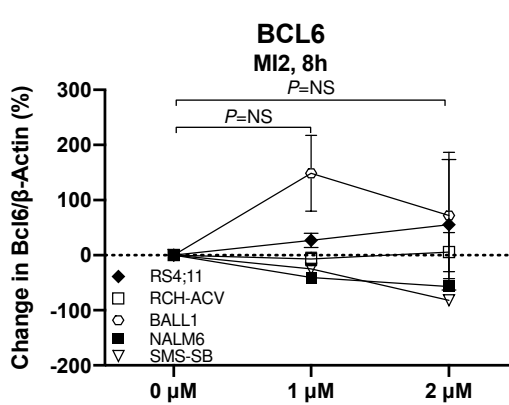
C



D



E



Supplementary Table S1

B-ALL Cell line	Lineage	Level of maturation	Philadelphia chromosome
REH	B-ALL	Pro-B	Negative
SUP-B15	B-ALL	Pro-B	Positive
SEMK2	B-ALL	Pro-B	Negative
BV-173	B-ALL	Pro-B	Positive
TOM-1	B-ALL	Pro-B	Positive
Z-119	B-ALL	Pro-B	Positive
RS4;11	B-ALL	Pro-B	Negative
HB11;19	B-ALL	Pre-B	Negative
RCH-ACV	B-ALL	Pre-B	Negative
NALM-6	B-ALL	Pre-B	Negative
697	B-ALL	Pre-B	Negative
HPB-NULL	B-ALL	Pre-B	Negative
SMS-SB	B-ALL	Pre-B	Negative
KOPN-8	B-ALL	Pre-B	Negative
RAJI	B-ALL	Mature	Negative
RAMOS	B-ALL	Mature	Negative
TANOUE	B-ALL	Mature	Negative
GA-10	B-ALL	Mature	Negative
2F7	B-ALL	Mature	Negative
BALL-1	B-ALL	Mature	Negative
Non B-ALL cell lines			
JURKAT	T-ALL	-	-
LOUCY	T-ALL	-	-
MOLT-4	T-ALL	-	-
CCRF-CEM	T-ALL	-	-
JVM2	MCL	-	-
K562	AML	-	-
TMD8	ABC-DLBC	-	-

Supplementary Table S2

Down-regulated genes (N=275)	Fold change (log2)
GJA5	-3.948
VPREB3	-2.098
AHNAK2	-2.046
CD248	-2.043
SPIB	-2.004
MYC	-1.870
RASD2	-1.858
MYBPH	-1.826
ANGPTL2	-1.814
AP003774.6	-1.812
PTPN6	-1.804
CD180	-1.794
CD1A	-1.786
LINC00940	-1.779
KIAA1462	-1.776
RP11-253E3.3	-1.768
PRICKLE1	-1.767
MARS2	-1.750
HIC1	-1.744
AP003774.4	-1.740
TRIB1	-1.737
IKZF3	-1.724
TMEM229B	-1.712
NRARP	-1.689
GNAZ	-1.684
TSSK5P	-1.664
LLNLR-268E12.1	-1.659
RP1-47M23.3	-1.659
DUSP2	-1.647
CD1C	-1.645
TLR10	-1.644
CH507-42P11.8	-1.643
RASL10B	-1.623
MFSD2A	-1.617
CYTH4	-1.616
TIFAB	-1.582
ALDH1B1	-1.560
RP11-330H6.6	-1.559
LFNG	-1.537
SIT1	-1.522
PLD6	-1.520
CTD-2562J17.6	-1.519
ALG1L9P	-1.514
RGS19	-1.514
RTN4RL1	-1.509

CSPG4	-1.507
EXOSC4	-1.505
AC104024.1	-1.500
SIK1	-1.500
CD3EAP	-1.494
APLN	-1.487
DDN	-1.487
RHOV	-1.482
CD82	-1.472
FFAR1	-1.443
C17orf96	-1.437
SLA	-1.435
SAMHD1	-1.431
SPTLC3	-1.424
LILRB2	-1.421
RIMBP3	-1.416
ALG1L8P	-1.410
RTN4R	-1.396
LYSMD2	-1.396
IRF8	-1.393
SCML4	-1.392
VWA1	-1.391
SH2B2	-1.385
NRXN2	-1.381
ACY3	-1.381
DUSP7	-1.381
F12	-1.378
FBLN1	-1.377
RP11-76C10.4	-1.377
FAM81A	-1.372
RP11-177C12.1	-1.368
HPDL	-1.366
PAQR7	-1.362
CICP22	-1.347
PI16	-1.342
RPS6KA4	-1.338
ID3	-1.325
LCK	-1.325
TEF	-1.317
RRS1	-1.316
PPARGC1B	-1.315
CXCR3	-1.311
ELFN1	-1.308
GS1-393G12.14	-1.306
DENND6B	-1.304
FNDC8	-1.299
ZCCHC24	-1.297
MB	-1.293

RXFP4	-1.291
NAPSB	-1.287
CTC-360G5.9	-1.284
ASB13	-1.282
KLHL14	-1.277
AC006538.1	-1.277
RP11-172H24.4	-1.277
N4BP3	-1.273
RPS15AP11	-1.271
KCNA5	-1.268
AC019117.2	-1.266
CGN	-1.260
KIAA0930	-1.253
C22orf23	-1.253
RAET1E-AS1	-1.244
VPREB1	-1.244
NAT8L	-1.240
MEX3A	-1.237
AP001505.10	-1.235
ABCD2	-1.233
AC007040.11	-1.229
EPHA4	-1.224
SLC2A4	-1.223
ITPKA	-1.220
RAB20	-1.217
ITPRIPL1	-1.215
SDC1	-1.215
CCDC86	-1.215
IGLJ2	-1.213
ZNF296	-1.211
IGLC2	-1.210
PGA5	-1.209
MAP2K6	-1.209
RP3-342P20.2	-1.206
FCRLB	-1.204
RTP5	-1.203
LRTM2	-1.202
RP11-465L8.1	-1.201
USP18	-1.200
CD93	-1.194
RIMBP3B	-1.190
PRKAG2-AS1	-1.183
SMKR1	-1.183
TMEM121	-1.182
SOX18	-1.182
KCNJ2	-1.177
CTB-26E19.1	-1.177
AC011342.1	-1.176

RP11-71G12.1	-1.176
HSPA12B	-1.172
RP11-566E18.1	-1.168
SAMD10	-1.167
AC021106.1	-1.166
BNIP3P41	-1.162
PTPRJ	-1.161
ZNRF3	-1.158
TNRC6C-AS1	-1.158
CBFA2T3	-1.156
AVPR2	-1.155
F2RL3	-1.155
SOWAHD	-1.154
RARA	-1.153
ELFN2	-1.152
PLD4	-1.152
SYNPO2L	-1.151
UNG	-1.150
ENC1	-1.150
C22orf15	-1.149
MYT1	-1.149
RP11-259N19.1	-1.145
SAPCD2	-1.144
RP13-616I3.1	-1.141
LILRA1	-1.139
NTHL1	-1.137
SCUBE1	-1.134
SYNPO	-1.134
CTC-471J1.10	-1.132
NT5M	-1.131
RP5-1039K5.12	-1.129
GJC2	-1.128
HIVEP3	-1.127
PCDHGC3	-1.126
PDLIM2	-1.125
RP11-435O5.4	-1.124
CD38	-1.123
PDGFA	-1.121
LINC00163	-1.119
HSH2D	-1.117
C15orf39	-1.112
FAM78A	-1.110
URB2	-1.107
TCEA3	-1.105
AC020743.3	-1.098
RP11-140I16.3	-1.096
CCDC85B	-1.093
TGM5	-1.092

RP11-21L23.2	-1.091
FXN	-1.091
B4GAT1	-1.091
GLDC	-1.089
KBTBD8	-1.088
FUT7	-1.085
NR1D1	-1.085
TRIM47	-1.084
KLHL33	-1.083
AF064858.8	-1.081
SOX12	-1.081
CD34	-1.080
CXXC5	-1.080
ATP13A2	-1.080
PRDM15	-1.075
TNF	-1.075
SH3BP2	-1.071
UCK2	-1.070
UFSP1	-1.069
PLXNB2	-1.068
GRAP2	-1.066
SAMD11	-1.066
IL6R	-1.065
ITGB7	-1.064
PRKD2	-1.063
RUNX3	-1.063
TFAP4	-1.062
UBL4A	-1.062
RP5-1142A6.10	-1.060
P2RX5	-1.056
LCN8	-1.049
CDH3	-1.049
PKI55	-1.048
TMEM132A	-1.048
AC006946.15	-1.048
EML1	-1.045
PRRT4	-1.044
VASH1	-1.043
KIF26A	-1.043
CTD-2619J13.16	-1.042
C10orf2	-1.041
GNB1L	-1.040
BATF	-1.038
FAM222A	-1.037
KHK	-1.037
PUS7	-1.036
TTC16	-1.033
AC007880.1	-1.031

OPRL1	-1.029
TMC8	-1.028
GRPEL1	-1.028
MYCL	-1.028
PHOSPHO1	-1.027
GJA3	-1.023
UBE2FP3	-1.023
SHANK1	-1.019
MRPL36	-1.019
GALNT6	-1.019
TLL12	-1.018
SLC2A5	-1.018
RP11-767C1.2	-1.018
XKR7	-1.016
SH2D5	-1.015
P2RY11	-1.014
SEMA7A	-1.014
EHD3	-1.014
ADPRHL1	-1.013
GEMIN4	-1.013
RIN1	-1.012
MYBPC2	-1.012
NOP16	-1.011
CEBPA	-1.011
AC018892.9	-1.010
RP11-76C10.3	-1.007
SNHG9	-1.007
RP11-447D11.3	-1.007
AMER1	-1.006
GCNT1	-1.005
RNU6-510P	-1.005
FMNL3	-1.004
TMEM170B	-1.004
DCTPP1	-1.003
RAB3A	-1.003
MYOZ3	-1.001
TP53I11	-1.001
BEND3	-1.001

Up-regulated genes (N=761)	Fold change (log2)
JUN	5.031
RP11-443P15.2	4.337
OSGIN1	4.319
HMOX1	4.084
LUCAT1	3.914
MIR616	3.640
HSPA6	3.315
SLC7A11-AS1	3.307

ATF3	3.163
HSPA1A	3.157
RHOB	2.970
DDIT3	2.945
RGS1	2.907
SLC7A11	2.903
HSPA1B	2.860
AC058791.1	2.793
RP11-178L8.3	2.786
AC016831.6	2.766
MIR210HG	2.723
CHAC1	2.692
LINC-PINT	2.676
NEAT1	2.667
PPP1R15A	2.561
CXCL8	2.497
EGF	2.475
DLGAP1-AS2	2.404
SNORD14E	2.393
RP11-138A9.1	2.327
DLGAP1-AS1	2.323
SNORA63	2.323
EID3	2.319
KLF2	2.259
DNAJB4	2.256
MPZ	2.251
NQO1	2.156
RP11-452J6.2	2.146
ANKRD37	2.143
SDAD1P1	2.133
DUSP10	2.122
AC103591.4	2.121
CARS-AS1	2.117
RP11-121L10.2	2.117
TSC22D3	2.113
ADM	2.096
CREBRF	2.082
PIGHP1	2.067
MT1X	2.065
RP11-138A9.2	2.054
TMEM88	2.054
KLF6	2.041
TEX19	2.027
BHLHE40	2.004
CYP4F11	1.998
MICD	1.994
MIR22HG	1.980
AC016831.7	1.964

TRGV9	1.954
SNORA81	1.949
ARRDC3	1.904
RP11-13N13.6	1.901
RNU6-216P	1.898
RP11-888D10.4	1.890
SNORA46	1.857
LINC01354	1.856
AC018766.6	1.850
RP11-13N13.5	1.847
KLHL24	1.833
RAP1AP	1.831
INHBE	1.823
AC055733.4	1.819
RP11-325K4.2	1.818
GPNMB	1.810
AC008982.2	1.808
RP11-417F21.1	1.798
RP11-173M1.5	1.798
RP13-580F15.2	1.798
RNU6-584P	1.797
SLC12A8	1.784
LSMEM1	1.777
AC078852.1	1.774
RP11-43P8.2	1.773
RP11-46F15.2	1.773
TCP11L2	1.753
RP13-991F5.2	1.748
GABARAPL1	1.745
DEDD2	1.742
RP5-1157M23.2	1.742
RP1-168P16.3	1.741
AMBP	1.739
CTD-2529O21.1	1.739
RPSAP36	1.737
AC093732.1	1.736
MAP1A	1.735
SESN2	1.733
RP11-603J24.7	1.730
RP11-155O18.6	1.725
BRSK2	1.711
HCG27	1.709
RHEBL1	1.708
RP11-563N6.6	1.705
CTA-276O3.4	1.702
RP4-756G23.5	1.702
Y_RNA	1.701
RP11-638I2.9	1.699

RP11-106D4.2	1.689
RP11-220I1.4	1.687
GDAP1L1	1.687
RP3-449M8.6	1.681
RP4-758J24.6	1.678
RP11-23N2.4	1.675
RP11-20I23.2	1.671
CTD-2521M24.5	1.668
RP11-211N11.5	1.664
RP1-34B20.21	1.663
CLIP4	1.651
RP11-498C9.12	1.649
AC068580.6	1.644
SLC26A5	1.644
JUND	1.639
HBP1	1.636
MXD1	1.635
MAFF	1.629
LRRC70	1.629
CTD-2363C16.2	1.629
CTD-2184C24.2	1.620
CTD-3252C9.4	1.620
PNRC1	1.613
RP11-335G20.7	1.609
RP11-810P12.7	1.605
RP11-631M21.7	1.600
OSCAR	1.599
CTA-228A9.4	1.596
MIR193BHG	1.586
RP11-364L4.1	1.578
RP11-102M11.2	1.574
RP11-141B14.1	1.572
RP11-1017G21.6	1.571
SYTL1	1.570
CD69	1.569
HSPA1L	1.569
CTB-50L17.5	1.566
RPL5P30	1.562
CTB-193M12.3	1.560
RP13-20L14.10	1.559
LINC00942	1.557
BEST1	1.554
CHMP4BP1	1.553
CCL3L3	1.552
RP11-1023L17.2	1.550
RP11-293M10.6	1.546
VEGFA	1.540
AC007386.4	1.539

KIZ-AS1	1.539
UBC	1.536
VASN	1.535
RP11-173A16.1	1.535
RP11-1017G21.5	1.534
DDIT4	1.527
ASNS	1.523
AC004837.5	1.519
RNU6-548P	1.517
RHOA-IT1	1.515
DDX50P1	1.515
LA16c-390E6.3	1.514
TMEM150B	1.513
MAFG	1.511
CCDC17	1.508
LCN12	1.499
CCNG2	1.498
RP4-724E16.2	1.496
FLCN	1.492
LIN37	1.491
SUMO2P19	1.490
RP11-174G6.5	1.489
FOS	1.488
RP11-485G7.5	1.487
CTD-2410N18.4	1.486
SLC25A39P1	1.486
SLC2A3	1.485
SLC6A9	1.484
PMAIP1	1.478
CCPG1	1.478
CTD-2587H24.1	1.477
OSER1-AS1	1.475
ADM2	1.473
GLYCTK-AS1	1.471
UNKL	1.470
ANXA1	1.469
RP3-416J7.4	1.467
RP11-737O24.3	1.463
RP1-27K12.4	1.461
Metazoa_SRP	1.461
RP11-96K19.5	1.460
TM6SF1	1.458
RP11-564A8.8	1.456
RAD17P2	1.451
GP6	1.449
XXbac-B444P24.14	1.449
RP11-564A8.4	1.445
PTOV1-AS1	1.444

AC084117.3	1.444
RP11-400N9.1	1.444
MARK2P8	1.443
DNAJB1	1.441
GPR55	1.440
BAG3	1.440
RP11-769O8.1	1.439
RNU6-88P	1.435
RP11-61L19.1	1.435
CEBPB-AS1	1.435
KLHL6-AS1	1.434
RP3-406P24.5	1.432
HNRNPA1P36	1.431
LA16c-358B7.4	1.426
NARF-IT1	1.424
ANTXRLP1	1.421
RP11-134L10.1	1.419
HTR2B	1.417
RP3-522J7.7	1.417
IL23A	1.414
KB-431C1.5	1.413
XXbac-BPG299F13.17	1.413
AC107081.5	1.412
U73166.2	1.407
RN7SL449P	1.407
TAS2R20	1.406
CTC-529I10.2	1.405
RP11-192M23.1	1.404
RP11-107E5.3	1.403
RP3-465N24.5	1.399
AC137932.4	1.397
SH2D6	1.396
RP11-347P5.1	1.395
RND1	1.395
SNORA9	1.394
RP11-275F13.3	1.391
CEBPB	1.388
AC006128.2	1.388
RP4-536B24.4	1.385
RP11-113K21.6	1.385
DLEU2L	1.379
IFIT1P1	1.378
CTD-2363C16.1	1.377
C9orf173-AS1	1.377
RP5-890E16.2	1.376
RP11-348N5.9	1.374
KRT18P63	1.374
RP5-1021I20.5	1.372

RP11-392O17.2	1.368
CTC-559E9.13	1.366
RP11-642A1.1	1.366
TAS2R6P	1.363
RP11-180O5.2	1.362
MIR425	1.362
RP11-467H10.1	1.360
MALAT1	1.359
INHBC	1.356
CTD-2017C7.1	1.356
PANX2	1.355
GUCY2F	1.355
RP11-498C9.4	1.355
CTD-2542C24.5	1.354
AC092652.3	1.352
RNU6-118P	1.352
AL513128.2	1.350
RPL7P17	1.346
RP11-484D2.4	1.345
DTX2P1-UPK3BP1-PMS2P11	1.344
CTB-46B19.2	1.342
JDP2	1.341
AP001442.2	1.341
CLK1	1.340
CTD-2083E4.4	1.339
AL022341.3	1.336
SLAMF7	1.333
LINC01176	1.332
RP11-128N14.4	1.332
RP11-34F20.7	1.328
RP11-327P2.5	1.328
RP11-713N11.6	1.327
MIR99AHG	1.327
RP11-596C23.2	1.327
RP11-299J3.6	1.325
HIPK1-AS1	1.325
RP11-156E8.1	1.325
RP11-50I19.2	1.324
CTD-2047H16.4	1.322
KMT2E-AS1	1.320
RP11-61J19.5	1.319
BBC3	1.319
C11orf65	1.319
RP11-485M7.1	1.318
RPSAP13	1.317
ZNF295-AS1	1.316
AC137932.6	1.316
RP11-313D6.3	1.316

RP13-216E22.5	1.316
AC006042.8	1.316
AP000254.8	1.314
TFE3	1.314
RP1-140A9.1	1.311
RNU4ATAC12P	1.309
SERPINH1P1	1.309
AP000640.10	1.308
RP11-687E1.2	1.308
ACTG1P24	1.306
ATP6V0C	1.305
RP5-915N17.11	1.304
RP11-708J19.1	1.301
Y_RNA	1.299
AC139887.4	1.299
RP11-476H16.1	1.298
GABARAP	1.298
CTD-2623N2.3	1.296
SPATA1	1.294
BTBD8	1.293
SQSTM1	1.293
RP11-135N5.3	1.292
RP11-386I23.1	1.292
NFKBIZ	1.291
LA16c-390E6.4	1.291
FBXW11P1	1.289
RP11-230F18.6	1.288
ZCWPW2	1.285
AC093690.1	1.283
RP11-45A17.2	1.282
OCLM	1.282
AL117339.5	1.281
TMEM14EP	1.281
RP11-394B2.6	1.277
RP4-730K3.3	1.273
RP11-686G8.2	1.271
DUSP1	1.270
ALDOA	1.270
CCDC80	1.270
RP11-437B10.1	1.268
RP11-513G19.1	1.267
PHBP12	1.265
XXbac-BPG299F13.14	1.265
RGS20	1.264
RP11-44D5.1	1.261
RP11-227G15.12	1.261
CAHM	1.260
RNA5SP82	1.259

CFLAR-AS1	1.259
RP11-288H12.3	1.258
RP11-613F22.6	1.258
MIR93	1.254
RP5-966M1.7	1.251
GOLGA8H	1.251
RP4-635E18.7	1.247
SNORA47	1.246
ISG20	1.246
AC002059.10	1.245
CBSL	1.245
UBALD2	1.244
RP11-638I2.10	1.243
TRIM17	1.243
RAB11FIP1P1	1.243
AL109840.2	1.243
SCRG1	1.243
RP11-840I19.3	1.242
TNFSF9	1.242
RP4-569M23.4	1.241
RP5-867C24.4	1.240
SNORA72	1.237
ABCB6	1.237
C19orf73	1.237
RP11-351C21.2	1.236
COL24A1	1.235
HIST1H3E	1.235
NLRP12	1.234
LINC00563	1.232
CTD-2199O4.6	1.232
RP5-864K19.4	1.232
RP11-452J21.2	1.231
CTC-507E2.2	1.231
TMEM79	1.230
CTC-459F4.1	1.230
ZSWIM4	1.230
ZSCAN5D	1.229
PRDX3P1	1.229
MIR3671	1.228
RP3-368A4.6	1.227
RP11-397E7.4	1.224
RP11-1084A12.1	1.224
RP11-242D8.3	1.223
IFRD1	1.223
AC091057.5	1.221
RP1-253P7.4	1.221
RP11-495P10.9	1.220
CTD-2083E4.5	1.220

AC010149.4	1.220
RPA4	1.219
EIF4EP1	1.219
ATP5HP4	1.219
EEF1A1P3	1.218
AC068580.5	1.218
RP11-463O12.5	1.217
RP11-348N5.7	1.216
HRK	1.215
RP3-508I15.22	1.215
SETP5	1.215
RP11-383C5.5	1.214
DOCK3	1.213
STC2	1.213
AL035696.4	1.211
RP11-82O19.2	1.210
RP11-798M19.6	1.210
AC016727.3	1.209
RP11-690I21.1	1.209
MIR6775	1.209
RP11-166B2.8	1.208
MTND1P23	1.206
LL0XNC01-36H8.1	1.206
RSL24D1P8	1.206
TAS2R31	1.206
GOLGA6L5P	1.205
TNFAIP3	1.205
RP11-471B22.2	1.204
ACTG1P17	1.203
ISCA1P4	1.203
RP11-242D8.2	1.201
PCK2	1.201
RGS2	1.200
ABTB1	1.200
RP11-30L15.4	1.199
AC012513.4	1.198
CTD-2033C11.1	1.198
SH3GL1P1	1.197
RGS17P1	1.197
RP11-616K22.1	1.197
DENND5B-AS1	1.196
GLYCTK	1.196
CTD-2256P15.1	1.196
AC091132.1	1.191
RP11-397P13.6	1.190
PLA2G6	1.189
MIR553	1.188
RP11-44N11.1	1.187

RP11-421E14.2	1.186
GCLM	1.186
LINC00106	1.185
RP11-707G18.1	1.181
KDM6B	1.180
RP11-493E3.1	1.179
GPAT3	1.178
DARS-AS1	1.178
AJ011931.1	1.177
VLDLR-AS1	1.177
RP11-640N20.4	1.177
RP11-210K20.2	1.176
RBM5-AS1	1.175
FAM157C	1.174
RP11-354A14.1	1.174
RP11-454F8.2	1.174
SLC35G2	1.173
GGACT	1.170
MTCYBP18	1.168
CTA-363E19.2	1.163
RPS16P5	1.163
FAM84B	1.161
AC144530.1	1.161
METTL20	1.161
RP11-417L19.5	1.160
RP11-325K4.3	1.159
GPR18	1.158
RP4-530I15.9	1.157
CH507-513H4.3	1.157
H1FX-AS1	1.156
AC097382.5	1.156
RP11-96C23.9	1.155
CTC-436K13.6	1.154
ZBED2	1.154
MAP1LC3B2	1.154
AC100830.5	1.152
RP11-277A4.4	1.152
LINC01004	1.152
CRELD1	1.152
GEM	1.150
TRGV2	1.148
HLA-J	1.146
NOXRED1	1.146
FAM229A	1.145
RP4-536B24.2	1.145
CTD-2024I7.13	1.144
KCP	1.143
FOXP1-IT1	1.143

RP11-31F15.2	1.143
POU5F2	1.143
SLAMF6	1.142
CATSPER3	1.142
LCTL	1.139
MBNL2	1.136
AC006946.12	1.136
CTD-2349P21.3	1.135
RP5-1099D15.1	1.135
CTD-2184D3.5	1.135
ADGRG2	1.135
RP11-473O4.3	1.134
MUC6	1.133
CTD-2371O3.3	1.133
CTC-241N9.1	1.132
RP11-297N6.4	1.132
AC012358.4	1.131
RN7SL809P	1.131
RP4-584D14.6	1.131
RP4-569M23.5	1.130
RP11-157K17.5	1.130
TAS2R15P	1.129
TLR6	1.128
CENPUP2	1.127
ROCK1P1	1.127
TXNIP	1.127
RP3-415N12.1	1.126
RP11-91P24.1	1.125
RP11-114F3.5	1.125
UBE2Q2P1	1.125
PRR26	1.124
DGCR12	1.123
RP5-1092A3.4	1.123
RP11-304F15.3	1.123
RNA5SP108	1.122
RP5-991G20.2	1.122
SEPSECS-AS1	1.122
KIAA1683	1.121
RP11-214K3.23	1.121
TMTC1	1.121
CTD-2373H9.3	1.121
RP11-796E2.4	1.120
ATF5	1.119
LINC00174	1.118
DNM1P46	1.117
RP11-84A19.4	1.115
ST3GAL3	1.115
RP11-428C19.4	1.115

RP11-485G7.6	1.114
RP11-351A11.1	1.112
RP11-977B10.2	1.111
AC062029.1	1.109
RP11-568G11.4	1.108
RP11-357N13.6	1.108
RP11-505P4.6	1.107
CTC-453G23.8	1.106
FBXO48	1.106
CTC-325J23.2	1.105
AC015971.2	1.105
SPDYE16	1.104
OLMALINC	1.104
CDC42-IT1	1.103
HHIP-AS1	1.103
MME-AS1	1.102
CALML6	1.101
RP11-338I21.1	1.101
AL109628.2	1.099
OSER1	1.097
RP11-214K3.20	1.097
EXTL3-AS1	1.097
ALKBH6	1.097
TRGV7	1.096
RNU6-100P	1.095
RP11-575L7.8	1.095
LINC01480	1.093
PRADC1P1	1.093
MIR3153	1.092
GCNT7	1.090
RP11-530C5.2	1.090
RPS15AP10	1.089
RP11-79N23.1	1.089
SLFN14	1.088
RP11-143J12.3	1.088
RP1-179N16.6	1.087
NDUFA4L2	1.087
AC004834.1	1.087
RP3-508I15.20	1.087
RP11-74J13.8	1.086
ARHGEF10	1.085
CTB-52I2.4	1.084
HIF1A-AS2	1.084
RP11-778D9.12	1.083
GPR61	1.082
SLC30A1	1.082
GADD45G	1.082
RP11-326C3.16	1.082

ZNF793	1.080
USP3-AS1	1.079
CBLN3	1.079
CH17-262A2.1	1.078
UXT-AS1	1.078
BACH1-IT2	1.077
OPTN	1.077
LINC00854	1.076
RP11-85K15.3	1.076
RP11-17G12.2	1.076
XKR3	1.075
YPEL5	1.075
ASPN	1.075
POU5F1P3	1.072
XXcos-LUCA16.1	1.072
EVI2A	1.072
CTD-2313J17.1	1.071
RP11-180M15.7	1.069
RP13-753N3.1	1.069
GGTA2P	1.068
ST6GALNAC4P1	1.067
LIMS1-AS1	1.067
YPEL2	1.066
ZBTB40-IT1	1.066
RP11-575L7.4	1.066
N4BP2L2-IT2	1.066
RN7SL535P	1.065
ASMTL-AS1	1.064
AC005551.1	1.064
HNRNPA3P11	1.063
AC005519.4	1.062
ZC3H6	1.062
RP11-379C10.4	1.062
RP11-767N6.2	1.060
RP11-45A17.4	1.060
HCG2040054	1.060
RP11-164P12.3	1.059
TMEM156	1.059
PET100	1.058
RP11-154D6.1	1.058
AL390957.1	1.058
KIAA0196-AS1	1.057
AK8	1.056
RP11-173A6.2	1.055
RP11-84G21.1	1.055
RP11-118E18.4	1.054
RP11-245D16.4	1.054
LRRC63	1.054

RP11-21M24.3	1.053
RP11-752G15.8	1.052
RHBDL2	1.051
ATP10B	1.051
IRF9	1.050
RP11-197M22.2	1.050
RNASEK	1.050
CTD-2284J15.1	1.048
ENTPD3	1.047
ETF1P2	1.047
RP11-284M14.1	1.047
MTND5P11	1.046
CTD-2522E6.4	1.046
RP1-225E12.2	1.046
RP11-365F18.3	1.046
LIMD1-AS1	1.046
GAPDHP22	1.045
RGS13	1.045
RP11-197N18.8	1.044
GPT2	1.044
IL21R-AS1	1.044
RP11-61K9.3	1.044
HERPUD1	1.043
ADIRF-AS1	1.043
RP1-283E3.8	1.042
RP11-455I9.1	1.042
AC009120.11	1.042
SLC25A34	1.042
LLNLR-246C6.1	1.041
RP11-715F3.2	1.041
VAC14-AS1	1.040
RP11-188C12.2	1.040
SCGB2B2	1.040
RP11-798G7.5	1.040
ACTG1P14	1.040
Y_RNA	1.039
RP11-609N14.4	1.039
ZFAND2A	1.039
RP11-261P9.4	1.038
IGHV7-81	1.038
ZNF674	1.037
GOLGA8VP	1.036
RP11-855A2.2	1.036
RP11-347I19.8	1.036
PLCD1	1.036
RP11-394B2.5	1.036
HMGB1P31	1.036
RP11-485M7.2	1.035

SRP72P2	1.035
RTEL1-TNFRSF6B	1.033
CTC-203F4.2	1.033
RP11-75A9.3	1.033
ST3GAL1P1	1.033
AC137932.5	1.032
RP11-603J24.5	1.031
AL139424.2	1.031
NIPSNAP3B	1.031
RP13-487P22.1	1.031
CTD-2342J14.6	1.030
STYK1	1.030
RP11-544A12.8	1.030
RP11-334C17.3	1.029
TCAF2	1.029
AC009303.1	1.028
CTA-984G1.5	1.027
RP11-546B15.1	1.026
ZNF441	1.024
RP1-228P16.1	1.024
RP11-823P9.3	1.023
AC069257.6	1.023
RP11-863K10.4	1.022
AC004623.3	1.021
RP11-92K15.3	1.021
RP11-58A17.3	1.021
YPEL3	1.021
CYP51A1-AS1	1.020
CARS	1.020
KDM3A	1.020
AC093110.3	1.020
TUBB3	1.020
CTC-265F19.1	1.020
RP11-2B6.3	1.019
IRF2BP2	1.019
ARIH2OS	1.019
NFKB2	1.018
CTA-972D3.2	1.018
KB-1410C5.5	1.017
RP1-86C11.7	1.017
SNX16	1.016
AC005387.2	1.016
AL021918.4	1.016
LINC00921	1.014
PROC	1.014
NTAN1P2	1.014
HIST2H4A	1.014
FLJ35934	1.013

ST8SIA1	1.013
CTB-50L17.9	1.012
CITF22-92A6.1	1.012
RP11-627K11.3	1.012
RIMKLBP2	1.011
RP11-513M16.7	1.011
RNU5A-1	1.010
RP11-102M11.1	1.010
SLC3A2	1.010
TP53INP1	1.010
RP11-440L14.1	1.010
AC093901.1	1.009
TPPP	1.009
RP13-870H17.3	1.008
RP11-714G18.1	1.008
B4GALNT1	1.008
RP11-752G15.10	1.007
RP1-30M3.6	1.007
RN7SL280P	1.006
HSD17B7P2	1.006
RP11-474P2.2	1.006
RPL7AP10	1.006
ULBP2	1.006
ACKR4	1.005
FER1L5	1.005
RP1-47A17.1	1.005
MORF4L2-AS1	1.004
RP11-267M23.6	1.004
RNU6ATAC16P	1.003
AF011889.5	1.002
CSNK1G2-AS1	1.001
CTC-524C5.2	1.001
CALCRL	1.001