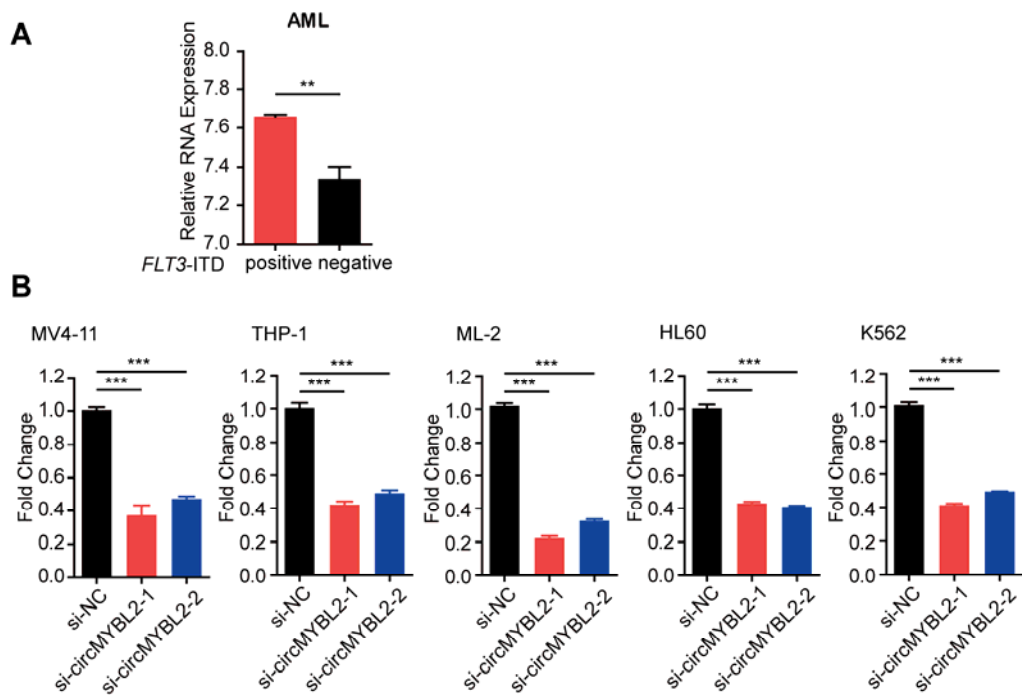
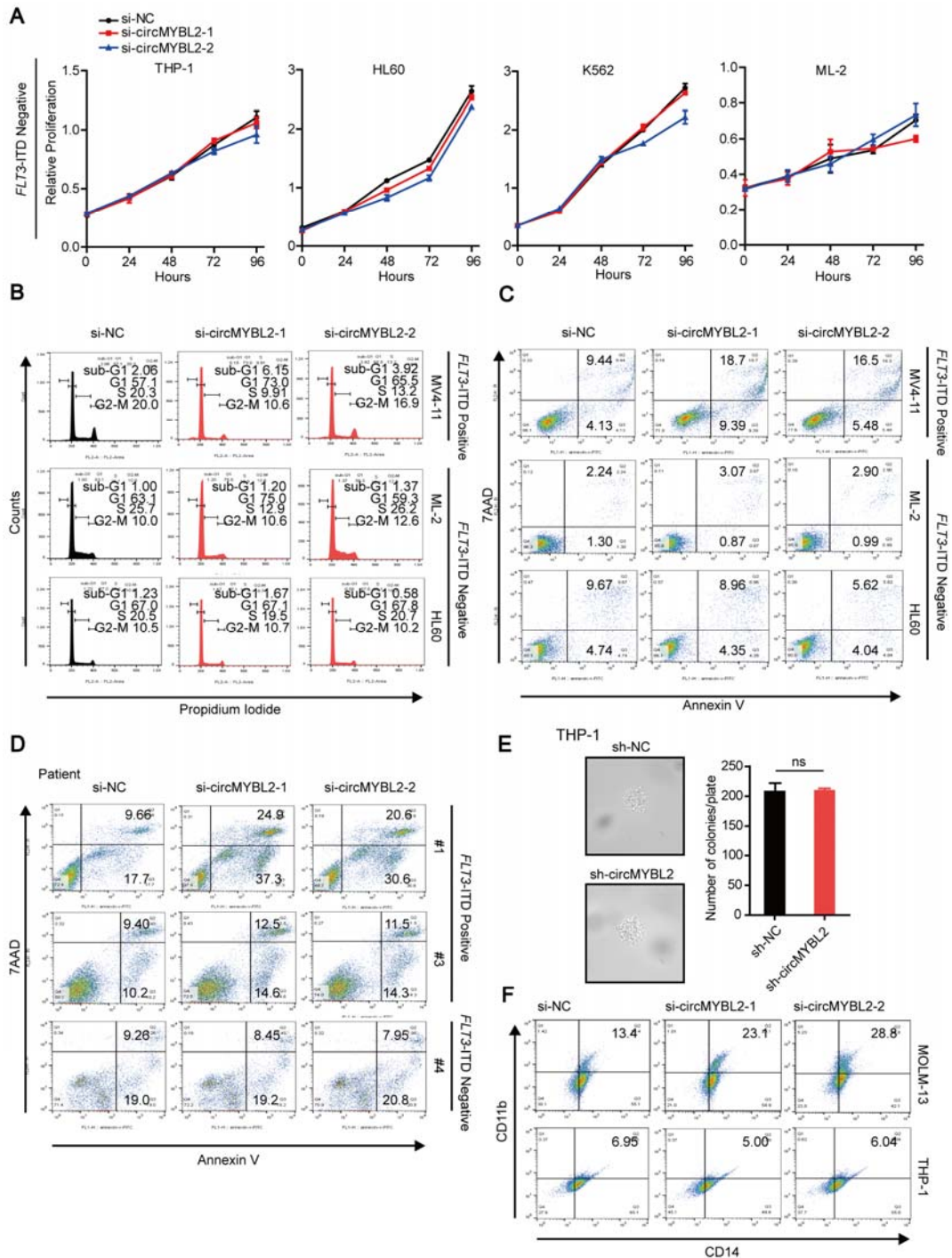


**Supplemental materials for “circMYBL2, a circRNA from *MYBL2*, Regulates *FLT3* Translation by Recruiting PTBP1 to Promote *FLT3*-ITD-positive AML Progression”**

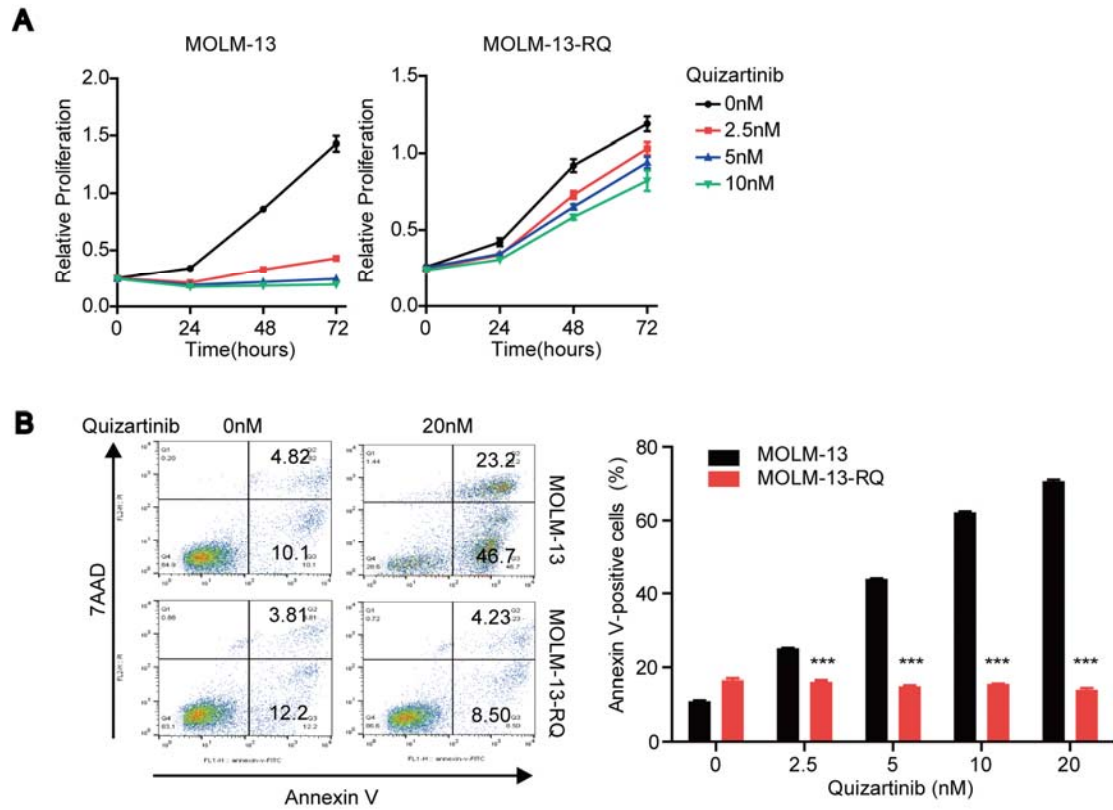
**Supplemental Figures**



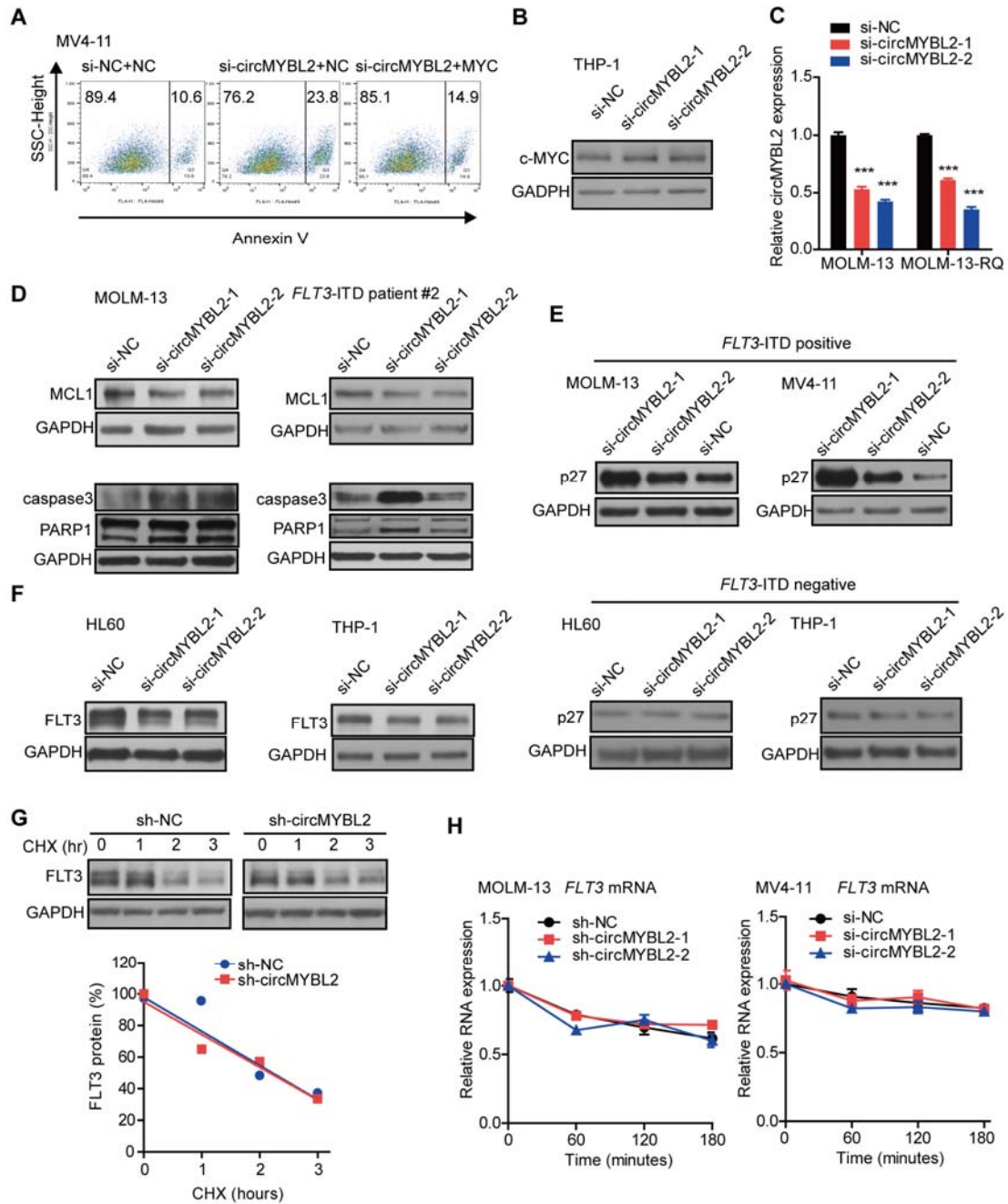
**Supplemental Figure 1. Differential analysis and knockdown efficiency of circMYBL2.** (A) Differential analysis of circMYBL2 between *FLT3*-ITD-positive and -negative AML in GSE94591 data. (B) The efficiency of circMYBL2 knockdown in different cell lines.



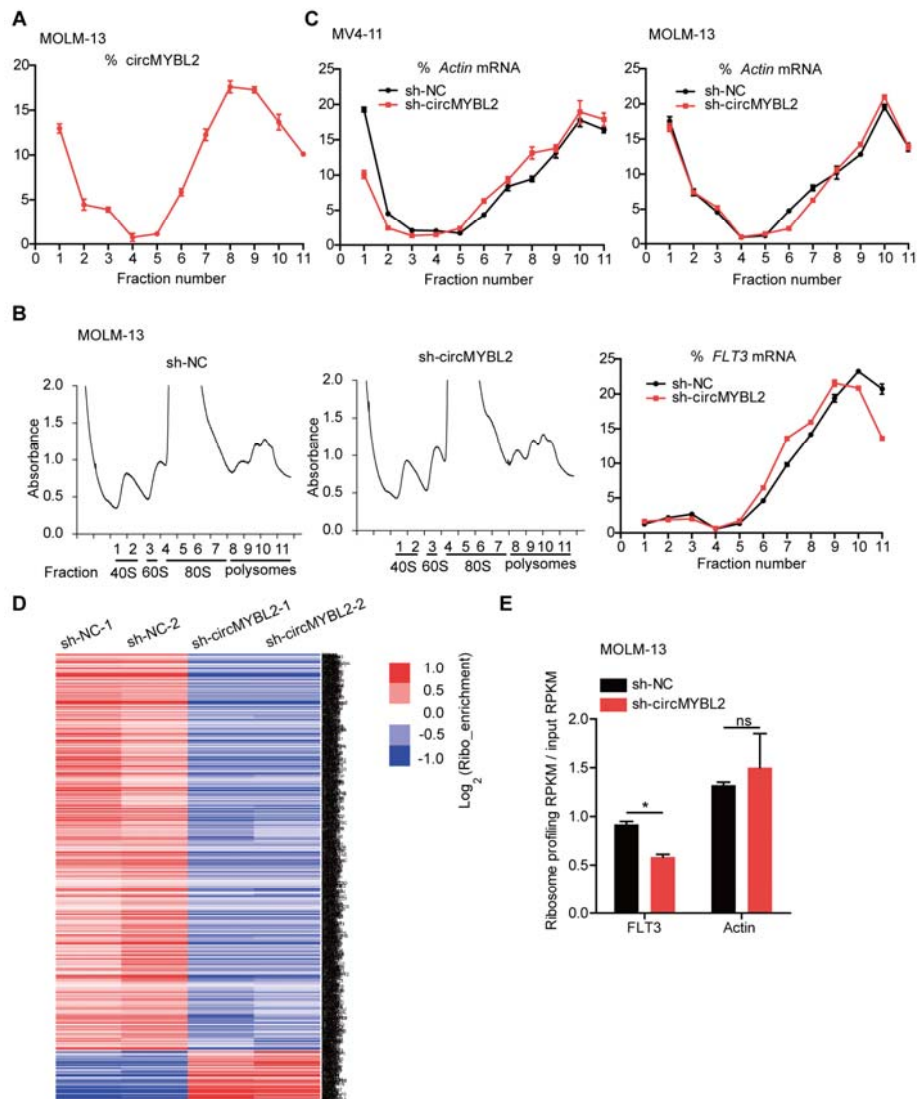
**Supplemental Figure 2. Requirement for circMYBL2 in *FLT3*-ITD AML cells.** (A) Effect of circMYBL2 knockdown on proliferation in *FLT3*-ITD-negative AML cells. (B) Flow cytometric analysis of cell cycle progression in AML cells. (C-D) Flow cytometric analysis of apoptosis in AML cell lines and AML patient cells. Numbers indicate percentage of cells. (E) Effect of circMYBL2 suppression in methylcellulose cultures of *FLT3*-ITD-negative AML THP-1 cells. (F) Flow cytometric analysis of differentiation. Numbers indicate percentage of cells.



**Supplemental Figure 3. MOLM-13-RQ was insensitive to quizartinib compared to parental MOLM-13.** (A) Effect of quizartinib on the proliferation of MOLM-13 or MOLM-13-RQ cells. (B) Flow cytometric analysis of apoptosis. Numbers indicate percentage of cells.



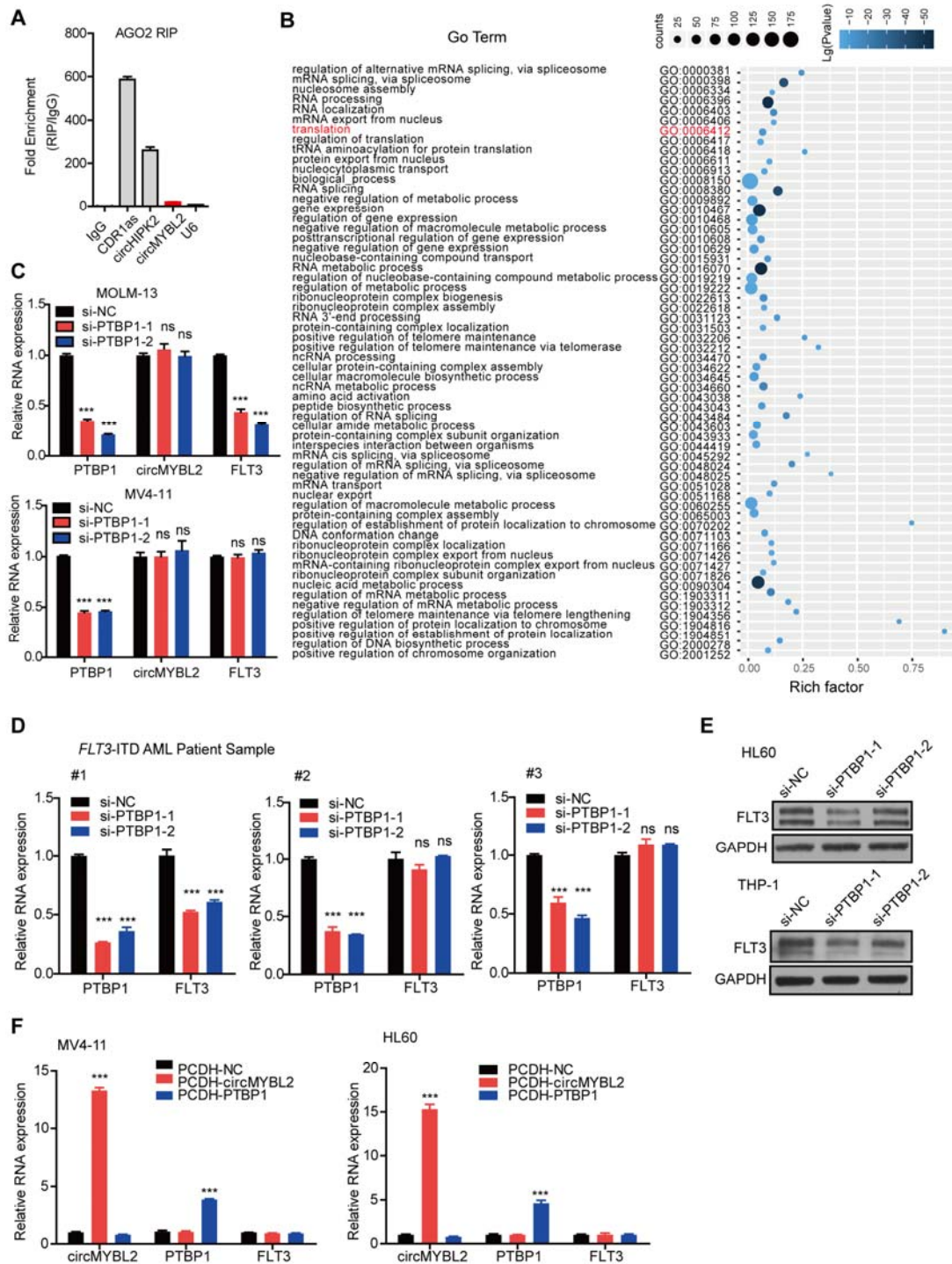
**Supplemental Figure 4. CircMYBL2 regulates *FLT3*-ITD-dependent signaling pathways.** (A) Flow cytometric analysis of apoptosis in MV4-11 upon circMYBL2 knockdown or c-MYC overexpression. (B) Western blot showing no effect of circMYBL2 knockdown on c-MYC in THP-1. (C) QPCR measuring efficiency of circMYBL2 knockdown in MOLM-13 or MOLM-13-RQ. (D) Western blot showing decrease of MCL1 and activation of caspase-3 in MOLM-13 and *FLT3*-ITD AML patient cells upon circMYBL2 knockdown. (E) Upregulation of p27/Kip1 in MOLM-13 and MV4-11, but not HL60 and THP-1, with si-circMYBL2 treatment. (F) CircMYBL2 knockdown also affects wild-type *FLT3*. (G) *FLT3* kinase levels were assessed upon circMYBL2 knockdown by western blot after CHX treatment. The relative intensity of the *FLT3* band was normalized to GAPDH. (H) mRNA stability of *FLT3* in MOLM-13 or MV4-11 cells upon circMYBL2 knockdown.



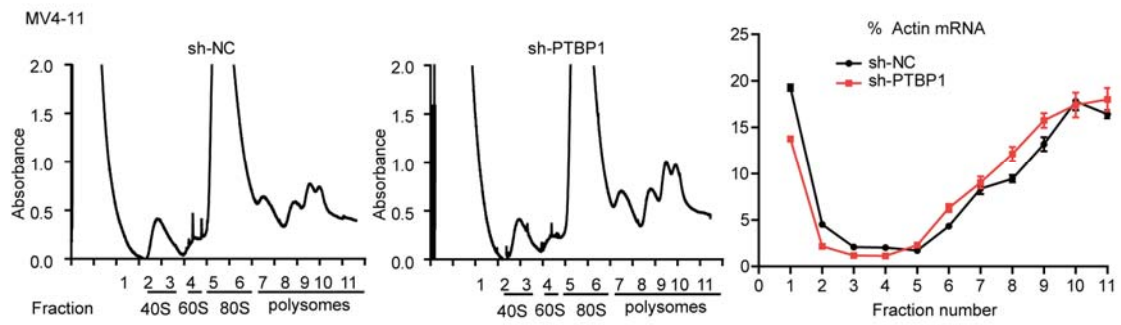
**Supplemental Figure 5. CircMYBL2 modulates the translation of FLT3 kinase.**

(A) Polysomes were fractionated using sucrose gradients, and relative levels of circMYBL2 were analyzed by qRT-PCR in gradient fractions. (B) Polysomes in cytoplasmic extracts of MOLM-13 cells upon circMYBL2 knockdown or control were fractionated through sucrose gradients, and the relative levels of *FLT3* mRNA were analyzed by qRT-PCR in gradient fractions. (C) Relative levels of Actin were analyzed by qRT-PCR in gradient fractions of MV4-11 or MOLM-13 cell lysates as a control. (D) RNAs with changed efficiency of ribosome occupancy measured via ribosome profiling in MOLM-13 upon circMYBL2 knockdown. (E) Ribosome profiling measuring translational efficiency of *FLT3* mRNA upon circMYBL2 suppression, Actin as a control. Error bars represent the mean  $\pm$  standard error of the mean.

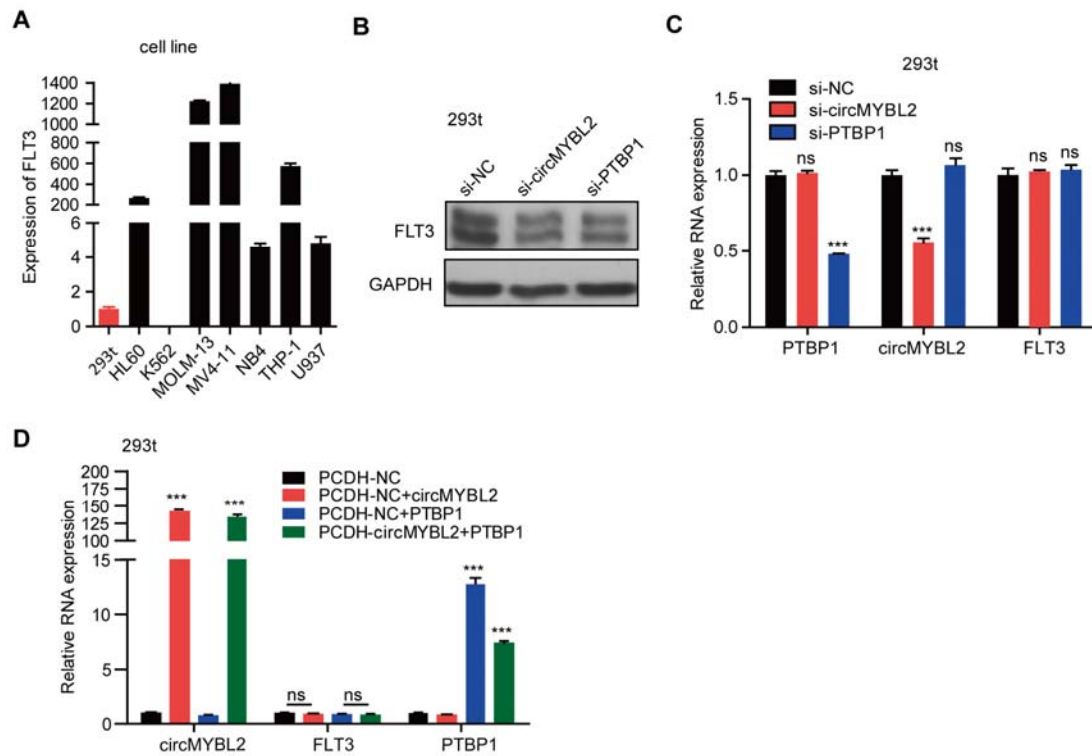




**Supplemental Figure 6. CircMYBL2 interacts with PTBP1 to affect the FLT3 protein.** (A) RNA immunoprecipitation (RIP) of AGO2. Analysis of precipitated RNAs (CDR1as, circHIPK2, positive controls; U6, negative control). (B) GO analysis annotates the biological process and clusters the modules of genes. The top 60 cluster ranked by p value was shown. (C-D) QPCR measuring mRNA expression of *FLT3* upon PTBP1 knockdown in MOLM-13, MV4-11 and AML patient cells. (E) Effect of PTBP1 knockdown on wild-type FLT3. (F) QPCR measuring upregulation of FLT3 protein upon overexpression of either circMYBL2 or PTBP1 in AML cell line MV4-11 and HL60.

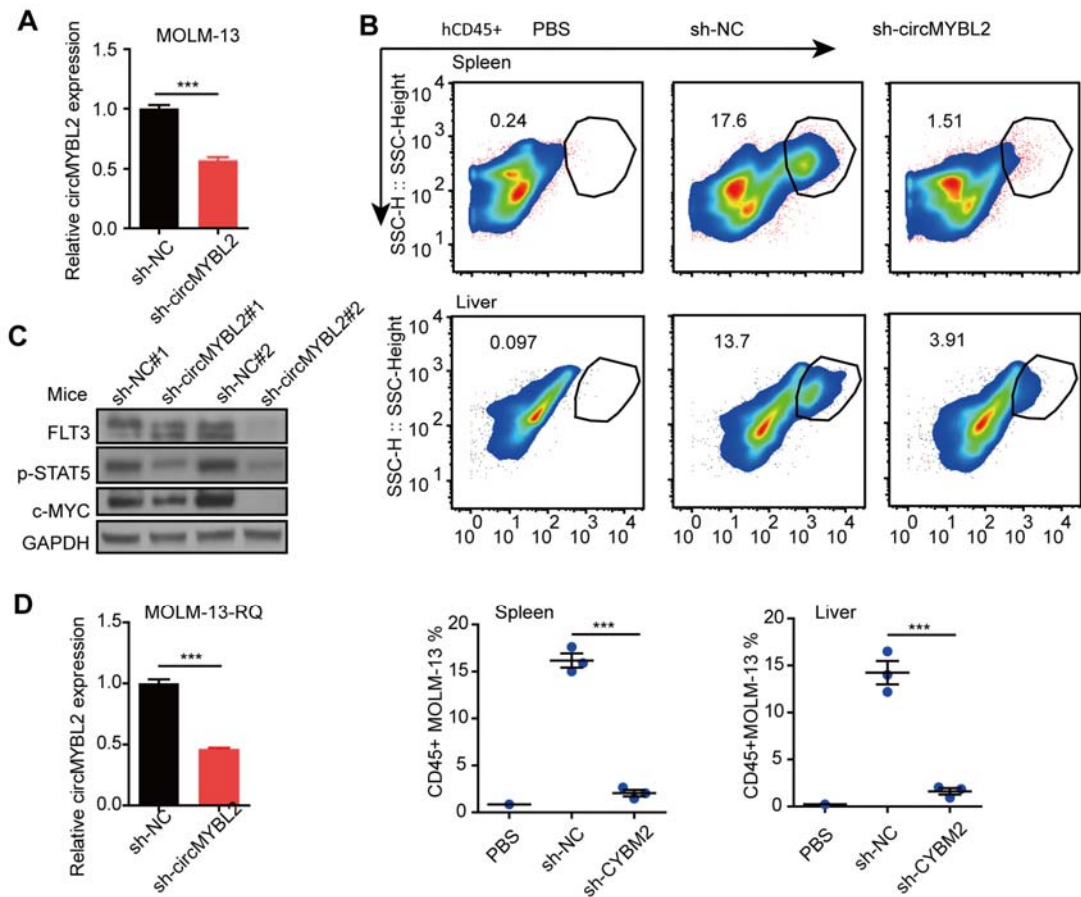


**Supplemental Figure 7.** Relative levels of Actin were analyzed by qRT-PCR in gradient fractions of MV4-11 lysate as a control in polysome profiling assay.



**Supplemental Figure 8. CircMYBL2 recruits PTBP1 to promote FLT3/FLT3-ITD protein translation.** (A) QPCR measuring *FLT3* expression level in 293t cells. (B) Western blot showing downregulation of FLT3 protein upon circMYBL2 or PTBP1 knockdown in 293t. (C) QPCR measuring mRNA expression of *FLT3* upon circMYBL2 or PTBP1 knockdown in 293t cells. (D) QPCR measuring mRNA expression of *FLT3* upon overexpression of either circMYBL2 or PTBP1 in 293t cells.





**Supplemental Figure 9. CircMYBL2 knockdown impairs infiltration of FLT3-ITD AML cells *in vivo*.** (A) Efficiency of circMYBL2 knockdown in sh-circMYBL2 MOLM-13 compared to sh-NC one. (B) Flow cytometry showing decreased levels of hCD45+ cells in the spleen and liver in circMYBL2-knockdown mice. (C) Western blot showing protein levels of FLT3, p-STAT5, and c-MYC in the MOLM-13-infiltrated Lymph nodes from mice. (D) Efficiency of circMYBL2 knockdown in sh-circMYBL2 MOLM-13-RQ compared to sh-NC one.

## Supplemental Tables

**Supplemental Table 1. AML patient samples used in this study**

Characteristics	<i>FLT3</i> -ITD-positive	<i>FLT3</i> -ITD-negative
	AML(n=6)	AML(n=45)
<b>Age at diagnosis, y</b>	45 (29-70)	30 (5-72)
<b>Sex</b>		
<b>Male</b>	2	30
<b>Female</b>	4	15
<b>FAB</b>		
<b>M1</b>	0	1
<b>M2</b>	0	8
<b>M3</b>	1	17
<b>M4</b>	1	2
<b>M5</b>	3	6
<b>M6</b>	0	0
<b>M7</b>	0	0
<b>N/A</b>	1	11

**Supplemental Table 2. The 373 circRNAs differentially expressed in *FLT3-ITD* positive AML compared with the negative.**

circRNA ID	Parental Gene	Poor vs Better	P Value	circRNA ID	Parental Gene	Poor vs Better	P Value
hsa_circ_0002346	CRIM1	0.173750848	0.002565538	hsa_circ_0005571	IFI30	1.286575043	0.000694958
hsa_circ_0005579	CRIM1	0.31303713	0.007051797	hsa_circ_0007772	RPS6KC1	1.288516655	0.002417079
hsa_circ_0081672	POLR2J	0.321556965	0.003934131	hsa_circ_0047073	ESCO1	1.295498216	0.005779615
hsa_circ_0001212	GUSBP11	0.332645522	0.007731131	hsa_circ_0004896	EXOSC1	1.295925936	0.002037588
hsa_circ_0080638	GATSL1	0.339221561	0.006068839	hsa_circ_0025767	TMTC1	1.300532268	0.000266337
hsa_circ_0074269	ANKHD1-EIF4EBP3	0.34713632	0.000157645	hsa_circ_0027470	NUP107	1.305417363	0.00601696
hsa_circ_0005243	TMEM184B	0.387382529	0.00826799	hsa_circ_0007905	STX6	1.307164086	0.004012138
hsa_circ_0005572	KIAA1797	0.38949266	0.002240966	hsa_circ_0003572	RFWD2	1.308169159	0.007897198
hsa_circ_0002891	PDIA3	0.394636836	0.003562792	hsa_circ_0085567	FAM49B	1.322341543	0.006410063
hsa_circ_0021727	CD44	0.401910946	0.00044973	hsa_circ_0005385	PHKB	1.325084265	0.00288686
hsa_circ_0005442	CRIM1	0.403752282	0.000873358	hsa_circ_0015358	RFWD2	1.330557613	0.003250819
hsa_circ_0021728	CD44	0.403949781	1.76432E-05	hsa_circ_0000217	FAM107B	1.331248307	0.005148385
hsa_circ_0040921	ANKRD11	0.414579439	0.003335446	hsa_circ_0008777	AURKA	1.334016361	0.006255584
hsa_circ_0092315	PWP2	0.417300124	0.000404888	hsa_circ_0059181	FKBP1A	1.337421172	0.002886066
hsa_circ_0074930	SLIT3	0.423606588	0.000100453	hsa_circ_0006225	MND1	1.352763423	0.009435071
hsa_circ_0024824	ST3GAL4	0.424235241	5.08053E-05	hsa_circ_0068708	DLG1	1.356496937	0.009807595
hsa_circ_0002504	ENGASE	0.433091445	0.000269707	hsa_circ_0000861	XLOC_012735	1.358820493	0.002487624
hsa_circ_0011938	SCMH1	0.444372137	0.006011991	hsa_circ_0000026	EIF4G3	1.367373839	0.004833824
hsa_circ_0017643	SFMBT2	0.46960568	0.005924796	hsa_circ_0078563	TCP1	1.369887117	0.006546661
hsa_circ_0047145	TMEM241	0.474094356	0.000244299	hsa_circ_0004294	EIF3L	1.370459535	0.006001245
hsa_circ_0086490	MLLT3	0.47583848	5.23952E-05	hsa_circ_0001695	HERPUD2	1.377431042	0.001901685
hsa_circ_0046600	B3GNTL1	0.476873994	0.005304138	hsa_circ_0088058	SUSD1	1.379801321	0.007882692
hsa_circ_0055605	TCONS_00004336	0.479417896	0.003520068	hsa_circ_0082141	SND1	1.387316926	0.005097705
hsa_circ_0043138	TAF15	0.482913762	0.006795836	hsa_circ_0044907	RPS6KB1	1.38751025	0.005574543
hsa_circ_0007769	PHACTR2	0.48617844	0.008044983	hsa_circ_0039697	CNOT1	1.39132836	0.003905485
hsa_circ_0000912	FCHO1	0.486804769	0.008565545	hsa_circ_0045601	<u>HN1</u>	1.394326572	0.008960542
hsa_circ_0054970	SLC1A4	0.490310074	0.00386076	hsa_circ_0040356	PHLPP2	1.398235394	0.008670681
hsa_circ_0054971	SLC1A4	0.493554189	0.009647907	hsa_circ_0004030	CTNNB1	1.398420922	0.004722574
hsa_circ_0001947	AFF2	0.496704156	0.002205922	hsa_circ_0059512	SNX5	1.40825168	0.007717573
hsa_circ_0008078	DOPEY2	0.498538141	0.002710043	hsa_circ_0028048	PRDM4	1.408374223	0.006125273
hsa_circ_0004961	MAD1L1	0.500582852	0.000437332	hsa_circ_0005632	INO80	1.412670393	0.002954707
hsa_circ_0020545	INPP5A	0.501596096	0.007591199	hsa_circ_0008567	ANKLE2	1.415905199	0.005371803
hsa_circ_0056390	SAP130	0.502673533	0.003430013	hsa_circ_0082139	SND1	1.416853507	0.000306942
hsa_circ_0049201	DNMT1	0.507250392	0.004911812	hsa_circ_0003006	<u>FLNB</u>	1.422203682	0.000716646
hsa_circ_0007401	NUP98	0.507294889	0.00276784	hsa_circ_0000191	PSEN2	1.42616932	0.000642085

hsa_circ_0063812	CELSR1	0.511675015	0.003018375	hsa_circ_0001623	BACH2	1.426840789	0.006082843
hsa_circ_0000915	FKBP8	0.512147064	0.007136829	hsa_circ_0001374	CCDC50	1.4355546	0.004954311
hsa_circ_0013204	LOC100131564	0.512832645	0.002977726	hsa_circ_0069618	ATP8A1	1.442486728	0.000359628
hsa_circ_0004946	THAP4	0.517112346	0.008691268	hsa_circ_0000296	PHF21A	1.447531881	0.000895671
hsa_circ_0036941	VPS33B	0.518104036	0.009694038	hsa_circ_0004673	LMBR1	1.450737194	0.004041126
hsa_circ_0005837	UHRF1	0.524386159	0.000119258	hsa_circ_0001222	FBXO7	1.457931858	0.008481479
hsa_circ_0000665	UBE2I	0.533565503	0.001319363	hsa_circ_0007693	ERI3	1.45844554	0.00437303
hsa_circ_0008250	CCDC91	0.538492748	0.009391168	hsa_circ_0003285	N6AMT2	1.458773258	0.001472179
hsa_circ_0030051	ELF1	0.546582608	0.001527344	hsa_circ_0000374	ITFG2	1.463824266	0.00041218
hsa_circ_0005795	LPXN	0.549824603	0.004226478	hsa_circ_0001006	RTN4	1.463987074	0.00017668
hsa_circ_0001538	PAIP2	0.550854257	0.006621992	hsa_circ_0018529	SLC25A16	1.482784983	2.38655E-05
hsa_circ_0007386	CRIM1	0.551035292	0.001490679	hsa_circ_0046965	AFG3L2	1.493137995	0.001064446
hsa_circ_0067301	PLXND1	0.551320293	0.000257538	hsa_circ_0007761	ATXN7	1.494273166	0.005843749
hsa_circ_0053958	CRIM1	0.553033809	0.000465717	hsa_circ_0007934	ZFAT	1.516503752	0.003652007
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hsa_circ_0048104	PTBP1	0.559844894	0.003225403	hsa_circ_0002697	MTHFD1L	1.52669717	2.41338E-06
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hsa_circ_0012651	SSBP3	0.568497774	1.66403E-05	hsa_circ_0007312	SPECC1L	1.539861992	0.000856636
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hsa_circ_0040784	KLHDC4	0.582349324	0.001392211	hsa_circ_0007376	MAP2K2	1.583256136	0.004640394
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hsa_circ_0006209	CTDP1	0.615162347	0.000666771	hsa_circ_0000681	PRKCB	1.632275712	0.004516864
hsa_circ_0070382	AFF1	0.617233744	0.002012582	hsa_circ_0038608	EARS2	1.633285027	8.83287E-05
hsa_circ_0016650	LBR	0.618362202	0.008572679	hsa_circ_0040609	PLCG2	1.645765427	0.006526616
hsa_circ_0087283	TLE4	0.620570034	0.009317869	hsa_circ_0002037	XPO5	1.646858414	0.007967428
hsa_circ_0000332	PC	0.624880956	0.004227776	hsa_circ_0026652	PCBP2	1.657632323	0.003415617
hsa_circ_0036005	SMAD6	0.6299773	0.001495884	hsa_circ_0009098	TPX2	1.668764705	0.004428861
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hsa_circ_0063305	CSNK1E	0.641806424	0.003273204	hsa_circ_0002544	DENND1A	1.695227626	0.000311101
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hsa_circ_0009006	LDB2	0.649193723	0.003491289	hsa_circ_0008678	KIAA1797	1.710062776	0.000343588
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hsa_circ_0068702	DLG1	0.653827787	0.004438186	hsa_circ_0000184	KCTD3	1.719385156	0.000264339
hsa_circ_0015966	RNPEP	0.654515574	0.0080732	hsa_circ_0041829	NEURL4	1.724883841	0.004190962
hsa_circ_0000638	ETFA	0.659048743	0.004820682	hsa_circ_0067029	PDIA5	1.726843359	0.000561219
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hsa_circ_0064379	CAND2	0.674997784	0.007098894	hsa_circ_0007798	MAP3K5	1.801370598	0.007535505
hsa_circ_0072387	HMGCS1	0.676397565	0.002531193	hsa_circ_0000009	SKI	1.81028353	2.37591E-05
hsa_circ_0001174	TCONS_12_00016814	0.678508062	0.009578874	hsa_circ_0004726	ELMOD3	1.811627896	0.004117962
hsa_circ_0002113	IFNGR2	0.681360432	0.000518017	hsa_circ_0003578	CRIM1	1.813922267	0.000226928
hsa_circ_0092135	GAB3	0.681590311	0.005528782	hsa_circ_0058698	DIS3L2	1.817288423	0.002973682
hsa_circ_0004945	SPG7	0.682140423	0.00740769	hsa_circ_0005311	TRIO	1.826718882	0.002348855
hsa_circ_0016123	SOX13	0.682459582	0.006244491	hsa_circ_0077892	TBPL1	1.829545394	6.99173E-05
hsa_circ_0000321	SF1	0.682719842	0.001859028	hsa_circ_0004039	MTR	1.896018693	0.000362914
hsa_circ_0084464	PRKDC	0.68420416	0.000308242	hsa_circ_0066875	TIMMDC1	1.921096284	0.000594826
hsa_circ_0003253	BABAM1	0.685771714	0.007378897	hsa_circ_0058429	SGPP2	1.921497474	0.005771864
hsa_circ_0058518	AGFG1	0.696704797	0.003439091	hsa_circ_0003141	UBAP2	1.929271727	0.000266551
hsa_circ_0048775	LONP1	0.700490759	0.005404096	hsa_circ_0006055	C20orf30	1.957777373	0.000788274
hsa_circ_0000825	CCDC165	0.700640238	0.000758606	hsa_circ_0005139	RDH11	1.964000864	0.001215291



hsa_circ_0000279	HPS5	0.700805906	4.34812E-05	hsa_circ_0002664	PCCA	1.964994552	0.004080146
hsa_circ_0017441	WDR37	0.70092009	0.000187764	hsa_circ_0008420	PCCA	1.969036892	0.007730748
hsa_circ_0029762	PARP4	0.702208431	0.004106309	hsa_circ_0000540	FBXO34	2.016652728	0.001443648
hsa_circ_0004293	DDX6	0.70305384	0.009129947	hsa_circ_0018814	PPP3CB	2.065447402	0.00018038
hsa_circ_0036399	ETFA	0.705776899	0.003751905	hsa_circ_0002522	NPLOC4	2.082426772	0.005549216
hsa_circ_0038885	NFATC2IP	0.714635008	0.007116669	hsa_circ_0025388	A2ML1	2.087891058	0.009577732
hsa_circ_0065049	ZDHH3	0.715817748	0.003155859	hsa_circ_0013587	LRIG2	2.118278847	0.000834372
hsa_circ_0002321	PPP2R5A	0.723246862	0.001258486	hsa_circ_0080822	PION	2.12098587	0.004654048
hsa_circ_0045606	NUP85	0.726298145	0.002207705	hsa_circ_0002229	LPIN1	2.136690111	0.000574086
hsa_circ_0068629	TFRC	0.727120604	0.000908917	hsa_circ_0070391	KLHL8	2.145248255	0.000675807
hsa_circ_0087063	GRHPR	0.727717135	0.00446881	hsa_circ_0088072	PTBP3	2.22139249	7.06421E-05
hsa_circ_0002755	CLIP2	0.728061481	0.008858404	hsa_circ_0000305	CELF1	2.226877771	0.00136067
hsa_circ_0023202	LRP5	0.729702774	0.006668076	hsa_circ_0008659	PTPN14	2.238423811	0.003643211
hsa_circ_0003557	ARAP1	0.734425862	0.004419498	hsa_circ_0046702	YES1	2.261074675	0.000455443
hsa_circ_0011279	SERINC2	0.745472914	0.002317203	hsa_circ_0041821	NEURL4	2.261157883	0.002985089
hsa_circ_0002094	RBM33	0.748997548	0.004146139	hsa_circ_0008334	GRB10	2.274392673	0.008446395
hsa_circ_0002476	INTS4	0.7503637	0.000541901	hsa_circ_0049657	NFIX	2.276287812	6.05556E-05
hsa_circ_0074146	HSPA9	0.7574538	0.009632353	hsa_circ_0002069	SNX11	2.301585859	0.005702859
hsa_circ_0008926	NUSAP1	0.761784652	0.00287245	hsa_circ_0007875	MTR	2.308564423	0.00261977
hsa_circ_0001563	HNRNPH1	0.762256148	0.007127861	hsa_circ_0068641	TM4SF19-TCTEX1 D2	2.308908482	0.000424183
hsa_circ_0083145	UBE3C	0.76304426	0.009441671	hsa_circ_0079534	MACC1	2.320812506	0.001094722
hsa_circ_0006387	HERC3	0.767256614	0.001149576	hsa_circ_0018736	ASCC1	2.348385069	9.96231E-06
hsa_circ_0003020	TIMM23	0.76783598	0.004679073	hsa_circ_0071185	LRBA	2.353244156	0.005029261
hsa_circ_0028411	<u>C12orf51</u>	0.769022787	0.009461043	hsa_circ_0071196	LRBA	2.408958863	0.005388558
hsa_circ_0014263	ILF2	0.773716371	0.003924549	hsa_circ_0003500	PTBP3	2.442045616	0.008064486
hsa_circ_0005175	HPS4	0.775130619	1.93435E-05	hsa_circ_0000670	C16orf72	2.454828967	0.008830005
hsa_circ_0007613	PRRC2B	0.791580462	0.005254959	hsa_circ_0020926	STIM1	2.509742385	5.42504E-05
hsa_circ_0001360	PHC3	0.792043517	0.002737594	hsa_circ_0070113	FRAS1	2.524481531	0.000387788
hsa_circ_0011450	S100BPB	0.796780422	0.003498052	hsa_circ_0085013	LAPTM4B	2.569627904	0.004538885
hsa_circ_0084727	SLCO5A1	0.806147121	0.009509421	hsa_circ_0004636	LRBA	2.587276284	0.003221041
hsa_circ_0040766	FBXO31	0.806405687	0.003967975	hsa_circ_0000813	RPTOR	2.641508505	0.001889797
hsa_circ_0014877	DCAF8	0.810787284	0.003212024	hsa_circ_0000228	ZEB1	2.67171011	0.007178496
hsa_circ_0043522	WIPF2	0.815870632	0.006986909	hsa_circ_0092364	GTF3C5	2.679020667	0.000401208
hsa_circ_0004722	RFWD2	0.816653837	0.002444952	hsa_circ_0001033	TTC31	2.731038539	5.1448E-05
hsa_circ_0029325	SCARB1	0.818337185	0.003473066	hsa_circ_0002404	ACACA	2.742761144	0.004354313
hsa_circ_0014063	SETDB1	0.819293427	0.009705791	hsa_circ_0071174	LRBA	2.771079351	0.003043664
hsa_circ_0006262	TCONS_12_00002184	0.820285017	0.003337108	hsa_circ_0078383	TIAM2	2.928473103	0.002941969
hsa_circ_0079363	DAGLB	0.838112957	0.006285947	hsa_circ_0000714	AARS	2.951412535	0.000147617

hsa_circ_0004401	EDC3	0.844619694	0.005633338	hsa_circ_0035381	PIGB	2.984251894	0.002284791
hsa_circ_0060744	CSE1L	0.860793476	0.005137773	hsa_circ_0041382	SMG6	3.038041479	0.005575253
hsa_circ_0024037	MRE11A	1.139533638	0.004476213	hsa_circ_0061749	BRWD1	3.048182211	0.002590289
hsa_circ_0028644	VSIG10	1.144789742	0.00519768	hsa_circ_0030777	PCCA	3.217417989	8.75674E-05
hsa_circ_0057037	TLK1	1.149722781	0.000756574	hsa_circ_0041392	SMG6	3.384366323	0.000230851
hsa_circ_0072099	ZFR	1.155956298	0.001581397	hsa_circ_0052318	ZNF418	3.668146245	0.007604701
hsa_circ_0001246	ATXN10	1.160714888	0.001275603	hsa_circ_0001936	BRWD3	3.689173349	0.004472471
hsa_circ_0005252	C14orf118	1.16190218	0.008021227	hsa_circ_0029976	NBEA	3.72890095	1.0157E-05
hsa_circ_0005164	KAT6B	1.167384455	0.008763188	hsa_circ_0087354	UBQLN1	3.762648285	0.002659804
hsa_circ_0065244	SMARCC1	1.174552811	0.003914045	hsa_circ_0019390	C10orf28	3.914307985	7.50796E-05
hsa_circ_0074736	GEMIN5	1.175905958	0.002259347	hsa_circ_0079480	ISPD	3.915385822	0.000634619
hsa_circ_0034557	EIF2AK4	1.184575478	0.006203569	hsa_circ_0030569	ABCC4	3.966357033	0.007509168
hsa_circ_0000508	CUL4A	1.200095791	0.007956054	hsa_circ_0007518	NDUFB2	4.128170944	0.001685757
hsa_circ_0042986	SUZ12	1.203588025	0.008651612	hsa_circ_0008537	GLI3	4.346651214	0.006913173
hsa_circ_0037777	ALG1	1.209380744	0.009173936	hsa_circ_0003239	UBE2G1	4.776238061	0.001000669
hsa_circ_0092297	SMPD4	1.21025212	0.003433775	hsa_circ_0054254	EML4	5.061100909	0.000323844
hsa_circ_0014437	ADAR	1.215492453	0.00447965	hsa_circ_0001644	BCLAF1	5.097446693	7.98613E-05
hsa_circ_0001818	UBR5	1.220055158	0.005833225	hsa_circ_0084984	PTDSS1	5.150143357	1.74637E-06
hsa_circ_0000034	DHDDS	1.224279536	0.00730194	hsa_circ_0000253	BLNK	6.814382734	0.000689672
hsa_circ_0001917	CASK	1.232235829	0.007847749	hsa_circ_0003162	BBS9	7.771234597	0.003200577
hsa_circ_0037858	LITAF	1.233611425	0.004275605	hsa_circ_0020390	DOCK1	7.785532201	0.000265101
hsa_circ_0010039	CASP9	1.236111166	0.008818378	hsa_circ_0006446	LSM14A	8.356403503	5.0447E-05
hsa_circ_0060848	NFATC2	1.23704281	0.002504122	hsa_circ_0015278	KLHL20	8.692303634	0.004865838
hsa_circ_0082326	ZC3HC1	1.238637717	0.009714409	hsa_circ_0061817	C2CD2	9.002002531	4.24047E-06
hsa_circ_0062808	MTMR3	1.240213272	0.004460428	hsa_circ_0041555	UBE2G1	9.012117957	0.0003458
hsa_circ_0079891	ELMO1	1.241540134	0.00614927	hsa_circ_0023685	PAK1	9.558295891	2.08456E-05
hsa_circ_0068606	TFRC	1.245651466	0.0097915	hsa_circ_0003568	IST1	10.86170341	0.000500308
hsa_circ_0006332	MYBL2	1.247856983	0.006521208	hsa_circ_0060828	TMEM189-UBE2V1	12.42474028	0.000234212
hsa_circ_0008614	DHDDS	1.25459237	0.009852745	hsa_circ_0004099	DENND5A	12.95429795	0.004677225
hsa_circ_0008826	DHTKD1	1.254709984	0.001509824	hsa_circ_0000086	ST6GALNAC3	16.98479682	5.98987E-05
hsa_circ_0086483	ACER2	1.262480021	0.004030754	hsa_circ_0078051	AIG1	18.62737921	3.50363E-05
hsa_circ_0032391	PCNX	1.269701548	0.00175285	hsa_circ_0011536	ZMYM4	18.88807983	0.002448269
hsa_circ_0003677	FBXW8	1.272121139	0.009650318	hsa_circ_0011929	CTPS1	22.36633183	0.000779749
hsa_circ_0008950	PKN1	1.273645266	0.002144786	hsa_circ_0049356	CARM1	34.19307152	4.56276E-06
hsa_circ_0028123	ACACB	1.279643042	0.003024823	hsa_circ_0000370	FLI1	45.97041311	4.69948E-06
hsa_circ_0001292	SCAP	1.281771396	5.95627E-06				

**Supplemental Table 3. The 28 circRNAs whose parental genes are reported to have association with leukemia progression.**

circRNA ID	Parental Gene	circRNA ID	Parental Gene	circRNA ID	Parental Gene	circRNA ID	Parental Gene
hsa_circ_0000370	FLI1	hsa_circ_0030569	ABCC4	hsa_circ_0043947	BRCA1	hsa_circ_0020545	INPP5A
hsa_circ_0049356	CARM1	hsa_circ_0035381	PIGB	hsa_circ_0002037	XPO5	hsa_circ_0001947	AFF2
hsa_circ_0023685	PAK1	hsa_circ_0002404	ACACA	hsa_circ_0006332	MYBL2	hsa_circ_0043138	TAF15
hsa_circ_0020390	DOCK1	hsa_circ_0000228	ZEB1	hsa_circ_0042986	SUZ12	hsa_circ_0040921	ANKRD11
hsa_circ_0000253	BLNK	hsa_circ_0008334	GRB10	hsa_circ_0002768	MYLK	hsa_circ_0005442	CRIM1
hsa_circ_0001644	BCLAF1	hsa_circ_0088072	PTBP3	hsa_circ_0031288	PABPN1	hsa_circ_0002891	PDIA3
hsa_circ_0008537	GLI3	hsa_circ_0003578	CRIM1	hsa_circ_0005795	LPXN	hsa_circ_0074269	ANKHD1

**Supplemental Table 4. The sequences of siRNAs and sh-RNAs.**

Name	Sense sequence(5'-3')	Antisense sequence(5'-3')
si-circMYBL2-1	CAUGCUGCGACCCUGAUGCtt	GCAUCAGGGUCGCAGCAUGtt
si-circMYBL2-2	UGCUGCGACCCUGAUGCUUtt	AAGCAUCAGGGUCGCAGCAtt
si-PTBP1-1	GCGUGAAGAUCUGUUCAAtt	UUGAACAGGAUCUUCACGCtt
si-PTBP1-2	GCAUCACGCUCUCGAAGCAtt	UGCUUCGAGAGCGUGAUGCtt
sh-circMYBL2	gatccCATGCTGCGACCCTGATGCcttcgtcag aGCATCAGGGTCGCAGCATGtttttg	aattcaaaaaCATGCTGCGACCCTGATGCtctgac gaagGCATCAGGGTCGCAGCATGg
sh-PTBP1	gatccGCATCACGCTCTCGAAGCActtcgta gaTGCTTCGAGAGCGTGATGCtttttg	aattcaaaaaGCATCACGCTCTCGAAGCAtctgac gaagTGCTTCGAGAGCGTGATGCg

**Supplemental Table 5. Primers for quantifying target genes and constructing expression vectors.**

Name	Forward Primer	Reverse Primer
qFLT3	TTTACCCCACTTTCCAATCACAT	CGAGTCCGGGTGTATCTGAAC
qcircMYBL2	TGTTAAGACCCTGCCCTTCTC	CAGGACTTGCTGCTGATGTGAC
qGAPDH	GAGAGACCCTCACTGCTG	GATGGTACATGACAAGGTGC
qU6	CGCTTCGGCAGCACATATAC	TTCACGAATTTGCGTGTGTCAT
qActin	CATGTACGTTGCTATCCAGGC	CTCCTTAATGTCACGCACGAT
qPTBP1	ATGGACGGCATTGTCCCAGATATAG	CTAGATGGTGGACTTGGAGAAGGAGA
qMTOC1	CTTAGGGGCCATCAATTTCA	GCAGCTAGGACTGGGAGAGA
qMALAT1	GCTTGAGAAGATGAGGGTGTTT	TCCAAAAGCCTTCTGCCTTA
Intron-1	GGAGGCAGGG TATCTCCATG	CTAGGTAATAGGAAACAAAATCCAAACA TGATCT
Intron-2	GTAAGTAGTCAACAAAATTCATCAATA TTATTTCTCTCT	ACAAAAAGAGTTTTAAAAATGTTAAAAT TGAATACAGAT
Intron-3	GCGGCCGCAATGGTC ACTTAAAAAA TTTGTAGTCA GCc	GCGGCCGCCCTCAGGTGATCTGCCACet
8-9 exons of MYBL2	ATCATGTTTGGATTTTGTTCCTATTACC TAGGACCCTGATGCTTGGTGTGACC	GAGAGAAATAATATTGATGAATTTTGTG ACTACTTACGCAGCATGTTTCTGGTGCAG G



**Supplemental Table 6. The genes whose translational efficiency were changed upon circMYBL2 knockdown.**

Gene	Ribosome/Input		sh-circMYBL2 2 vs sh-NC	P Value	Gene	Ribosome/Input		sh-circMYBL2 vs sh-NC	P Value
	sh-NC (mean)	sh-circMYBL2 (mean)				sh-NC (mean)	sh-circMYBL2 (mean)		
TBC1D20	0.894635065	0	0	1.96E-07	SGO1	4.73427373	0	0	0.039818335
PDLIM5	1.565919483	0	0	1.35E-06	LIN52	0.506360909	0	0	0.040407187
GOLGA8R	0.18987169	0	0	4.56E-06	NUBPL	0.198238227	0	0	0.040450678
GPATCH2	0.255451448	0	0	7.52E-06	RSAD2	3.268535086	0	0	0.041040444
ZNF717	0.324151168	0	0	9.63E-06	C8orf37	0.601953808	0	0	0.041290385
GOLGA1	0.198992394	0	0	1.02E-05	PRDM11	1.769000895	0	0	0.041407969
BTBD6	8.137741579	0	0	1.02E-05	ARMC10	0.522515368	0	0	0.041425353
GAS2L1	25.769515	0	0	1.02E-05	ZNF517	2.23327381	0	0	0.04165966
CDCA3	4.685366364	0	0	1.02E-05	ZNF17	0.286617266	0	0	0.041795784
FBXO6	4.685366364	0	0	1.02E-05	CYB561D1	1.609790124	0	0	0.042124852
PPP1R3G	1.840679643	0	0	1.02E-05	SPIRE1	1.950137474	0	0	0.042724835
AATK	12.8847575	0	0	1.02E-05	NEIL3	1.298505249	0	0	0.042853388
BIRC2	0.302881449	0	0	1.35E-05	RUSC1	10.57657539	0	0	0.04300495
LGALS3	0.277391101	0	0	1.82E-05	RGS12	0.57944931	0	0	0.043075108
SPOUT1	0.835960732	0	0	2.24E-05	ZNF641	0.392869547	0	0	0.043084232
NME4	5.869480504	0	0	2.87E-05	XIAP	0.682150815	0	0	0.043433139
CYP4V2	0.199960987	0	0	3.72E-05	TSR2	0.317907128	0	0	0.04344394
RNF31	1.049025502	0	0	3.98E-05	SLC2A4RG	6.256987898	0	0	0.043781611
KLHL29	2.832057657	0	0	6.09E-05	STK17A	0.547988455	0	0	0.043837672
SLC12A2	2.466076355	0	0	6.35E-05	GOLGA8N	0.037960956	0	0	0.043930776
NIPAL3	0.827346577	0	0	6.48E-05	TMEM121B	3.701863111	0	0	0.04414685
KATNB1	0.22832637	0	0	8.09E-05	FAM89A	0.899586289	0	0	0.044262387
POLR2J	0.184418805	0	0	8.71E-05	EXO5	0.337395243	0	0	0.044441326
SCLT1	0.20984172	0	0	9.61E-05	KCNA3	7.441378345	0	0	0.044513873
ZNF2	0.833630924	0	0	0.00010588	TNFSF4	2.480459448	0	0	0.044513873
TBXAS1	0.411976189	0	0	0.000105897	PCCA	0.425793477	0	0	0.044670941
DUSP5	3.581158937	0	0	0.000112995	C5orf42	2.03056755	0	0	0.044883845
TRIM66	0.20499541	0	0	0.000115178	PMFBP1	0.54007258	0	0	0.044979187
GNA11	4.155436949	0	0	0.000119631	ZNF430	0.135214474	0	0	0.045076515
ARID3B	0.665935409	0	0	0.000119631	PCSK7	0.310560519	0	0	0.045130541
RMDN2	0.341801067	0	0	0.000124169	GSTZ1	0.601126122	0	0	0.045499538
ACOT8	1.069570704	0	0	0.000125928	WDR35	0.276413968	0	0	0.04569864
CD55	0.212471742	0	0	0.000136816	TLDC1	1.106844617	0	0	0.045708662
ZNF33B	0.094429183	0	0	0.000136988	ANKRD39	2.213689235	0	0	0.045708662
TAF4B	0.594170636	0	0	0.000139969	PRELID3B	0.529280628	0	0	0.045880615
PARPB	1.55869679	0	0	0.000142354	PSMC6	0.220939918	0	0	0.046371867
CSTB	0.147073169	0	0	0.000156353	ZFP36L1	1.431655729	0	0	0.046437081
PPP1R26	1.267627653	0	0	0.000174386	ZSCAN32	0.675159343	0	0	0.046512535
PDCD5	0.233413908	0	0	0.000192643	MKS1	0.483187888	0	0	0.046654109
RAB3IP	1.150726248	0	0	0.000215171	KYNU	0.674305113	0	0	0.046660129
PRKAR1B	2.970389716	0	0	0.000302288	CTTN	0.411415183	0	0	0.046786324
VEGFA	0.062088889	0	0	0.00031941	ERICH1	0.048747197	0	0	0.046884795
TRIM9	2.610557608	0	0	0.000320662	INPP5F	0.398608562	0	0	0.046908779
ANKRA2	0.405940174	0	0	0.000358303	KATNB1	3.683966418	0	0	0.047175917
LIG4	0.459491546	0	0	0.000359353	ALKBH4	2.009436228	0	0	0.047175917
SMIM29	1.690346817	0	0	0.000383129	TYW1	0.181572559	0	0	0.047418986
FBXO43	1.027694043	0	0	0.000391696	SLC25A43	0.260312887	0	0	0.047487383
NMNAT1	0.816909527	0	0	0.000392789	COPS9	1.034613803	0	0	0.047497622
TRIP4	0.239966024	0	0	0.000406758	DHRS13	7.378191422	0	0	0.047596432
MRPS33	0.225142487	0	0	0.000426273	UIMC1	0.573857829	0	0	0.047614752
RPS15A	0.006578013	0	0	0.000437566	CEBPZOS	0.603146298	0	0	0.047688773
PRIM1	3.532561732	0	0	0.000446187	SCARB2	0.671021815	0	0	0.047721449
KATNAL2	0.196444118	0	0	0.00046523	TM7SF2	0.763584166	0	0	0.047724469
GALNT11	0.387681958	0	0	0.000483147	ALOX5	0.651604784	0	0	0.047869697

FOXRED1	1.258342448	0	0	0.000488032	PGRMC1	1.943654043	0	0	0.047911998
LPAR6	0.528909979	0	0	0.000503889	ZNF70	0.379982868	0	0	0.048021559
SAV1	0.909513629	0	0	0.000571451	ARID5B	2.092233256	0	0	0.048154164
PEX6	0.511402001	0	0	0.000608192	CDK14	0.39852062	0	0	0.048154165
VPS8	0.446067201	0	0	0.000631425	CREBZF	0.474656372	0	0	0.048537413
UBR3	0.720229771	0	0	0.000651218	SLC38A9	0.297941713	0	0	0.048541307
RAP2C	0.652858175	0	0	0.000655122	NSUN3	0.312012126	0	0	0.048557844
STARD4	1.392458867	0	0	0.00068738	8-Mar	1.180309575	0	0	0.048868436
SMIM14	0.588049677	0	0	0.000705601	SPRTN	1.730791255	0	0	0.049443259
GFER	2.030381376	0	0	0.000717837	STARD3NL	0.57269999	0	0	0.04947275
MAPK3	4.286585965	0	0	0.000743732	COO10B	0.136250372	0	0	0.049856227
TMEM167A	0.288529431	0	0	0.000750897	NPC2	0.598510874	0	0	0.049882465
PADI2	2.515791047	0	0	0.000759514	EEF1AKMT2	0.497525497	0	0	0.049939614
EMP1	3.328220168	0	0	0.000844237	NXT2	4.664165965	0.129090382	0.027677056	0.020722856
KYAT1	3.328220168	0	0	0.000844237	USP33	0.889955019	0.030486661	0.034256407	0.003844061
FOXA1	9.984660504	0	0	0.000844237	MPHOSPH9	0.874520667	0.030391908	0.034752647	0.011192438
TMEM143	14.26380072	0	0	0.000844237	SP3	0.949792993	0.033035799	0.034782104	0.015894988
SAT1	0.031814857	0	0	0.000851175	ZFX	0.794987342	0.029038148	0.036526554	0.006313763
ZNF490	0.270045424	0	0	0.00086104	MXD1	1.182923196	0.048589299	0.041075616	0.013361269
DTD2	0.186914962	0	0	0.0008647	HSDL2	0.99568883	0.043899423	0.0440895	0.018463111
STAM	0.440303359	0	0	0.000871065	POP1	1.169834611	0.052928803	0.045244689	0.005001058
SEC61G	0.073527062	0	0	0.000872442	RNPEPL1	10.17811468	0.477004703	0.046865723	0.006670449
C18orf54	2.165648615	0	0	0.000985549	RNF138	0.846499253	0.040533042	0.04788314	0.023687868
SUGP1	0.492652741	0	0	0.000986831	DCTN1	0.631883128	0.031216589	0.049402473	0.047569996
RAD54B	0.881440015	0	0	0.000996683	PPP2R5C	0.757759827	0.040978927	0.054079044	0.031583276
IER3	0.083828187	0	0	0.001006389	KIF15	2.813251078	0.157085886	0.055837848	0.009538481
ZNF107	0.101776257	0	0	0.001085733	C5orf22	1.545417144	0.088494085	0.057262264	0.005754565
ZNF431	0.064366669	0	0	0.001086668	KCTD3	1.880635011	0.108200237	0.057533884	0.005379395
F3	0.848068549	0	0	0.001108422	FCHSD2	1.23275811	0.073385339	0.059529391	0.039943778
C2orf49	0.28425004	0	0	0.001119476	GCNT1	1.060131224	0.063394466	0.059798697	0.018383034
NUBP1	0.690338854	0	0	0.001127477	RRM2	22.26212745	1.334499259	0.059944822	0.020472172
COA5	0.142752046	0	0	0.001164974	STAU2	0.942295589	0.059534834	0.063180635	0.004682995
KCNO3	0.787907526	0	0	0.001221729	GNB5	4.367270675	0.279388469	0.063973243	0.037232255
C1orf35	0.985922144	0	0	0.00122488	DTD1	0.96946963	0.062884864	0.064865223	0.006493389
UPRT	0.616996765	0	0	0.001260017	GALNT7	0.651205198	0.042285822	0.064934712	0.010910892
MAP3K7	0.867829004	0	0	0.001295523	TRIM22	0.266294293	0.017314912	0.065021716	0.026455654
PFKM	3.196039065	0	0	0.00137103	NFATC2IP	0.957554848	0.06238339	0.065148634	0.030836865
PIP5K1A	0.557443846	0	0	0.001401746	CEP295	0.47201733	0.031043163	0.065766998	0.007471735
DDX10	0.114108358	0	0	0.001440099	DSN1	8.482384295	0.558787703	0.065876254	0.026684451
CYP2R1	0.294553953	0	0	0.001455112	TRAK2	0.742091269	0.051331215	0.069171027	0.010249586
NUDT6	0.259340026	0	0	0.001468133	RASAL2	0.871784097	0.060642458	0.069561326	0.047922864
SLC15A2	0.146247217	0	0	0.001541809	EIF1AX	0.247831282	0.017836017	0.071968385	0.00793703
MBOAT1	2.471434603	0	0	0.001546531	SH3BGRL	0.313268242	0.022557316	0.072006393	0.006081538
TM2D3	0.400139913	0	0	0.001553545	N4BP1	1.212896401	0.089711894	0.07396501	0.006574915
DYM	0.85294832	0	0	0.001577372	POLC1	4.110014801	0.315438594	0.076748773	0.015415559
L2HGDH	2.154629276	0	0	0.001583668	FANCC	8.182165351	0.630877188	0.07710394	0.024944325
CREG1	0.957653195	0	0	0.001605862	ENOPH1	0.691229539	0.05365485	0.077622334	0.019979817
MAP3K6	4.489520609	0	0	0.0016199	WDR89	1.278589217	0.099527699	0.07784181	0.048677809
LYRM2	0.265082611	0	0	0.001642097	BRD9	0.5063406	0.039912638	0.078825672	0.041627901
RPP38	0.645222211	0	0	0.00165093	VRK1	0.472636345	0.037322887	0.07896745	0.019955016
TMCO6	1.541349224	0	0	0.00172568	KMT5B	0.333602983	0.026464402	0.079329033	0.02472703
ELOVL6	1.2969753	0	0	0.001792982	C5orf51	0.915135141	0.073523281	0.080341447	0.014379454
CDKN2AIPNL	0.158896784	0	0	0.001841602	SUPV3L1	0.907107171	0.074503592	0.082133175	0.014353442
PLCXD1	4.238947366	0	0	0.001859433	SPTSSA	1.049410827	0.087114445	0.083012718	0.01435866
ORC2	0.630298381	0	0	0.001893387	EDC4	4.900270915	0.422858223	0.086292826	0.013662041
PANK1	0.75658737	0	0	0.001896898	RDX	0.350630773	0.030391908	0.086677811	0.023434314
UOCR10	0.068026178	0	0	0.001932529	KIF16B	0.477517757	0.041566829	0.087047714	0.015908564
CCDC174	0.21363598	0	0	0.001970652	MAP3K5	0.826711657	0.072166763	0.087293753	0.012323689
PRKCE	0.600743439	0	0	0.001972983	ANKS1A	0.957534073	0.084298245	0.08803681	0.014564032
BTBD10	0.310524714	0	0	0.002011379	CGGBP1	1.527611741	0.134877192	0.088292848	0.013295542
PPP1R12A	0.373618377	0	0	0.002087393	TTC17	0.209985665	0.018601619	0.088585185	0.009615525

TOMM7	0.054384822	0	0	0.002120957	CTNNAL1	8.126806443	0.724340475	0.089129781	0.020260977
CHCHD7	0.176541647	0	0	0.002123874	CEP152	0.28162075	0.025218817	0.08954886	0.013960044
CNIH4	0.494180528	0	0	0.002131557	MAN1A2	0.759007104	0.068581623	0.090357024	0.01100236
PRDX4	2.144045746	0	0	0.002137209	SAMD9	0.447287034	0.041173038	0.092050596	0.010888295
SLC8B1	0.640387244	0	0	0.002146698	PHAX	0.763601108	0.071507104	0.093644579	0.010639395
RAB3GAP1	0.325498374	0	0	0.002233619	RGP1	1.12332242	0.105429611	0.093855165	0.01575607
NXPE3	1.732382023	0	0	0.002272943	SLC35A2	4.268577537	0.411730375	0.096456108	0.043733543
BTN2A2	0.810430332	0	0	0.002277159	NPRL2	0.990091626	0.097058029	0.09802934	0.013974393
CAPN7	0.595453556	0	0	0.002288047	FGL2	0.645845999	0.065471234	0.101372826	0.013318381
HHLA2	2.569648629	0	0	0.002291891	PPIL1	1.2239462	0.124172653	0.101452705	0.02330515
FBXO3	0.499669849	0	0	0.002294786	HIST1H1D	2.660536197	0.271627678	0.102095088	0.015589606
INTS12	0.431854857	0	0	0.002308746	NCS1	6.374260416	0.651906428	0.102271697	0.044826196
FCHSD1	1.201358693	0	0	0.002460103	ANKRD12	0.333155997	0.034614501	0.103898778	0.023761854
ATG12	0.248949388	0	0	0.002500328	GLRX5	1.026821022	0.108500376	0.105666298	0.020686562
COG2	0.684831826	0	0	0.002530905	SKA1	5.595002567	0.592642207	0.105923492	0.016746789
GPX7	0.698393997	0	0	0.002578354	FAM53B	2.621134175	0.279388469	0.106590678	0.01445894
TMCO4	1.21227913	0	0	0.00261359	RNF115	0.34040931	0.036589697	0.107487357	0.044733932
KIAA1191	0.754075472	0	0	0.002855208	RHOT1	0.363806721	0.039192771	0.107729651	0.037753702
ATOX1	0.348152315	0	0	0.002911484	UBL4A	5.299126358	0.575211554	0.108548375	0.017280187
FAM160B1	0.871681876	0	0	0.002954711	REL	1.058497506	0.117108939	0.110636953	0.040069384
SUV39H2	0.688241666	0	0	0.003023185	CDC6	3.43519422	0.380195637	0.110676606	0.01765646
IPO4	20.4042879	0	0	0.00310018	PAPD5	0.735775631	0.081488303	0.110751566	0.032162157
MAIP1	2.447071436	0	0	0.003169411	ZC3H14	0.387530158	0.043125012	0.111281693	0.017477878
LNX2	1.251736527	0	0	0.003175612	NUDT3	1.728549085	0.196116697	0.113457407	0.024790252
CLCN5	1.66525221	0	0	0.003181842	DEPDC1B	16.7290207	1.908018813	0.114054424	0.017277869
ZDHHC4	0.849045292	0	0	0.003224641	GPATCH2L	0.540495344	0.061787443	0.114316328	0.000330331
IOSEC2	1.869282449	0	0	0.003240597	RNF139	0.945855428	0.108953721	0.115190671	0.023782508
ZNF589	0.21150738	0	0	0.003269004	STX12	1.672096767	0.192681703	0.115233584	0.02569212
MTFMT	0.932034497	0	0	0.003319468	SLC27A2	0.917716887	0.106578708	0.116134627	0.016829927
TMEM14B	0.075414013	0	0	0.00332656	MBLAC2	0.951747918	0.110805625	0.116423291	0.027078361
MAPRE2	2.466022649	0	0	0.003392411	PPFIA1	0.283330964	0.033260532	0.117391095	0.020448322
CNOT4	0.485323399	0	0	0.003412658	ATP6V0A2	0.718987364	0.084754899	0.11788093	0.024853137
HIST1H4K	2.658414028	0	0	0.003453974	KIF18A	1.329416345	0.157719297	0.118638	0.019576883
ASPHD2	1.284715491	0	0	0.003471925	CUL9	0.54884384	0.065518234	0.119375001	0.01802825
PTCD1	2.424883031	0	0	0.003500975	SLC25A30	0.791247268	0.094937829	0.119985032	0.018169446
ZNF266	0.505596527	0	0	0.0035173	C17orf80	0.676848411	0.081318889	0.120143429	0.038193904
ZSCAN30	0.116255086	0	0	0.003550636	OTULIN	1.373949366	0.165272052	0.120289769	0.020689742
PIK3R3	1.681817092	0	0	0.00359096	ZWILCH	2.953546901	0.356020857	0.120540106	0.034208321
ATP23	0.382970041	0	0	0.003611259	CCDC88B	0.614093356	0.074220846	0.12086248	0.023625409
FAM120B	0.119952384	0	0	0.003622175	VAT1L	5.106090523	0.617595563	0.120952725	0.037019985
GMFB	1.658879443	0	0	0.003694052	COX6B1	0.296910531	0.036050125	0.121417468	0.024980286
LRRC28	0.353214838	0	0	0.003781906	NFIX	2.926414709	0.355585324	0.121508863	0.031459833
FAR2	2.235529998	0	0	0.003821829	AIMP2	0.761261004	0.094024966	0.123512127	0.04201254
DHRS7B	2.434243776	0	0	0.003821829	RNF213	0.50200889	0.062185033	0.123872374	0.020027879
TMEM187	4.56420708	0	0	0.003821829	FOXN2	1.622881912	0.202455412	0.124750551	0.032824941
PMAIP1	0.220700578	0	0	0.003936124	FYCO1	0.47757643	0.060455001	0.12658707	0.021961814
SUMO2	0.260885178	0	0	0.003984124	LEMD3	1.259927115	0.159650554	0.126714119	0.047658145
FAM109A	9.661515008	0	0	0.004007179	GGA3	1.320115982	0.167513429	0.126892963	0.047751217
NFE4	0.11358403	0	0	0.004014034	SERINC5	0.920669573	0.118708302	0.128936923	0.032486404
CLN5	0.486835827	0	0	0.004077806	PHF6	1.389434439	0.182981798	0.131695165	0.000553378
ERCC6L	9.050705978	0	0	0.004110498	UGCG	2.032117091	0.268827393	0.132289322	0.042747154
TET1	0.963585329	0	0	0.004150631	GUF1	1.144682789	0.152196053	0.132959152	0.027010311
SMYD2	0.894793868	0	0	0.004185431	ZSCAN29	0.608037276	0.080898419	0.133048453	0.031114233
PNPLA2	2.537822943	0	0	0.004257002	TK1	121.4002138	16.17564764	0.133242332	0.025565805
IGF2BP3	0.218259129	0	0	0.004418945	SPATA13	2.588610367	0.346145006	0.133718465	0.023252963
MPPE1	0.642103633	0	0	0.004432782	RSPRY1	0.949109069	0.127650443	0.13449502	0.038610618
ZBED6CL	1.37660634	0	0	0.004459401	H2AFV	1.450546536	0.196357358	0.135367845	0.023807363
SDHAF3	0.381145691	0	0	0.004484744	8-Sep	3.121850947	0.425156366	0.136187273	0.029761101
SUPT4H1	0.310032428	0	0	0.004500195	HEATR5B	0.479851294	0.065518234	0.136538621	0.024107201
ZNF286B	0.282998417	0	0	0.004574313	RAD51C	0.542317856	0.074080276	0.136599367	0.046648744
LUC7L	0.219238646	0	0	0.004627073	ATXN7L1	0.413715769	0.056852305	0.137418753	0.030599226

FAM172A	0.345704038	0	0	0.004629973	GINS3	11.99297273	1.654449865	0.137951607	0.040418376
TMEM8A	9.611800317	0	0	0.00472644	JAML	0.604368716	0.083577747	0.138289334	0.027840738
PALB2	0.775669504	0	0	0.004729519	ZCCHC17	0.312233369	0.044147162	0.141391556	0.046598574
DCAKD	1.949018602	0	0	0.004819058	SPC24	7.813409502	1.107637864	0.141761143	0.007786305
ZNF518B	1.380803034	0	0	0.00484205	ARID4B	0.302984298	0.043053809	0.142099143	0.02823419
MRPL55	3.369389923	0	0	0.004864299	GABPB1	0.753879687	0.108050789	0.143326304	0.029996498
ERAP2	1.21930009	0	0	0.004876192	HDAC7	2.197684954	0.315438594	0.143532217	0.028435096
C19orf47	0.734710232	0	0	0.004903551	PATL1	1.716159234	0.246716208	0.143760674	0.037327042
SLC35G1	0.545349611	0	0	0.004935427	CDC42SE2	1.415724641	0.203670055	0.143862761	0.00861479
GBGT1	1.229957988	0	0	0.005005141	NAA35	0.789308589	0.113870118	0.144265652	0.027493089
IFI35	2.514048217	0	0	0.005021772	VTHB	0.997264118	0.144067719	0.144462953	0.03034819
RHNO1	1.498736631	0	0	0.005032638	BCAT2	4.161691845	0.601759779	0.144594987	0.045666105
NAXD	0.443910001	0	0	0.005086981	FBXO11	0.408343097	0.059174562	0.14491383	0.029523824
PTDSS2	2.240276202	0	0	0.005350292	CBLL1	0.587531302	0.085589465	0.145676434	0.029537702
TTC27	0.84685233	0	0	0.005391739	GINS2	45.43239319	6.642065489	0.14619669	0.035061384
RWDD2A	1.196148465	0	0	0.005395705	PPA2	0.675613211	0.099275091	0.146940719	0.028577555
GATAD1	0.543703848	0	0	0.005395705	TMED7	3.777682864	0.555903599	0.14715465	0.031695639
TRAF4	4.345900388	0	0	0.00553028	HEATR3	0.810189823	0.119799037	0.147865394	0.032415404
NDUFC2	1.133441177	0	0	0.005573839	TCF19	10.75495614	1.601767223	0.148932939	6.52E-05
PRR5L	1.950266295	0	0	0.005607784	INPPL1	4.085046015	0.615974577	0.150787672	0.031859357
ZNF92	0.1162836	0	0	0.005684656	FAU	0.638022152	0.096528942	0.151294029	0.011214577
POFUT2	0.279382594	0	0	0.005718303	ARID4A	0.29548227	0.045010801	0.152329955	0.049586214
DKK2	0.295820028	0	0	0.005760622	RAD51D	0.791427444	0.120723413	0.152538826	0.033216909
TOM1	0.450354185	0	0	0.005772018	ASPM	5.706311472	0.873689027	0.153109243	0.032974663
ZNF783	0.28969202	0	0	0.005777314	ZBTB41	0.586323775	0.090125313	0.153712534	0.032992884
PRRG4	1.338860618	0	0	0.005784056	GPR180	1.788764613	0.27545342	0.153990871	0.046215773
FSD1L	0.309134589	0	0	0.005835635	PIP4P2	0.78975534	0.122232455	0.154772559	0.047997668
MYO6	0.175611947	0	0	0.005897717	MRPL44	2.994312826	0.463806945	0.154895955	0.037173342
ZNF804A	0.144877277	0	0	0.006004363	GLT8D1	1.325066189	0.206954421	0.156184214	0.039001116
ANKRD26	0.248577916	0	0	0.006075553	MSANTD4	0.719787437	0.112721573	0.156603974	0.045810596
PIDD1	6.803159271	0	0	0.006152337	STARD9	0.504327438	0.079018961	0.15668186	0.040499245
SPATA5L1	1.170232966	0	0	0.00626733	TYMS	7.041168985	1.10335489	0.156700527	0.04698476
SEMA4B	3.989116901	0	0	0.006353396	BIN2	0.28641019	0.04492915	0.156869942	0.03982608
KIAA1841	1.59564676	0	0	0.006353396	MED25	2.417874208	0.379751317	0.157059997	0.033559267
DTNB	0.436064439	0	0	0.006476235	BCAP29	0.683513405	0.107753129	0.157645963	0.046399833
NSDHL	0.508231548	0	0	0.006503797	TMEM248	1.027365508	0.162159404	0.157840031	0.034288201
FAAH	0.741653312	0	0	0.006738902	PHTF2	1.296078733	0.204787359	0.158005339	0.033690162
PTPN22	0.414980787	0	0	0.006812136	STAM2	0.929404477	0.147046563	0.158215897	0.038260768
NFS1	1.741765591	0	0	0.006979089	PRKACB	1.402228514	0.222044587	0.158351214	0.047593987
PRDM2	0.627957402	0	0	0.006996708	PAFAH1B2	0.843473129	0.133800635	0.158630584	0.046632127
TIGD6	0.676176555	0	0	0.007080923	AFTPH	0.856774232	0.136192151	0.158959205	0.034553539
TIAM2	0.381888701	0	0	0.00712145	NR2C1	0.229778952	0.036727123	0.159836759	0.037336437
TIMM9	0.195660229	0	0	0.007148595	IFNGR2	0.928516164	0.149577001	0.161092512	0.038145684
UCHL3	0.850839306	0	0	0.007169587	ATP6AP2	1.218634661	0.196390221	0.161155945	0.041041134
MIF4GD	3.944218629	0	0	0.007221827	ATP8B4	0.221579159	0.035786263	0.161505546	0.040876053
ZNF527	0.177207032	0	0	0.007221876	NIPA1	1.292014583	0.209132511	0.161865442	0.009143112
NSRP1	0.049430377	0	0	0.00723003	PDK2	3.980010869	0.651906428	0.163795138	0.040211105
GSTCD	2.490806664	0	0	0.007242155	KDELC2	23.16570414	3.847316622	0.166078121	0.037531299
MITD1	0.045578301	0	0	0.007300089	RB1	0.874972932	0.145315304	0.166079771	0.037002581
FAM3C	0.293536932	0	0	0.007324774	POU2F2	0.803006116	0.133507821	0.16626003	0.043899972
SMIM12	0.427369049	0	0	0.007357194	PNPLA6	7.768612642	1.296609469	0.166903607	0.046629647
ZNF768	1.689097534	0	0	0.007360206	UBE2Z	1.407404638	0.235984227	0.167673333	0.041520051
ABCC5	0.231446972	0	0	0.007405126	ARHGAP19	3.040345425	0.511299159	0.168171404	0.038645037
CGREF1	1.383158292	0	0	0.007423892	RNF26	8.756653289	1.476014553	0.168559209	0.041634612
SPRYD4	0.166994917	0	0	0.007503441	ADH5	1.190942083	0.2018807	0.169513449	0.045504816
GJA3	3.148694893	0	0	0.007611844	ORC5	1.195698441	0.203191614	0.169935501	0.042394101
IGF1	7.871737232	0	0	0.007611844	SMARCAD1	0.769554811	0.133610199	0.17362012	0.041539222
LHPP	4.723042339	0	0	0.007611844	CIAO1	0.77865585	0.136207959	0.174927035	0.049733518
GPRC5C	4.723042339	0	0	0.007611844	C5orf24	1.082234996	0.189875659	0.175447717	0.043947792
HELO	0.234664562	0	0	0.007620412	MCM9	0.541158632	0.095168822	0.175861229	0.042649137
GDAP1	0.547222089	0	0	0.007744154	SPC25	6.348623282	1.121393084	0.176635632	0.028924231

AC069544.2	5.551010672	0	0	0.007798112	MAP3K4	0.807411192	0.143254572	0.177424556	0.047863724
APOBEC3G	0.593539078	0	0	0.007806725	TCIRG1	8.137741579	1.44868095	0.178020024	0.043856109
PIGH	1.655318098	0	0	0.007826272	ELK4	1.033286025	0.185124799	0.179161234	0.009271862
HIST2H2BF	1.885850837	0	0	0.007948368	NUSAP1	2.874561127	0.519022967	0.18055729	0.001629989
JAK2	0.405760741	0	0	0.007951488	U2SURP	0.587653158	0.106506919	0.181241124	0.013489481
FRA10AC1	0.07302702	0	0	0.007986145	MRPS23	0.34909807	0.06375613	0.182631001	0.046848083
PPM1H	2.258526074	0	0	0.008023719	IMP3	4.24715856	0.777149851	0.182981125	0.012357405
ABHD5	0.747889508	0	0	0.008067193	LEPROT	1.38779714	0.253989517	0.183016314	0.047296477
TPRKB	0.562026997	0	0	0.008082094	OSGIN2	1.497939903	0.277326852	0.185138837	0.048347966
MAPK7	6.421559465	0	0	0.008172087	AGK	0.692712187	0.128665742	0.185741993	0.049960225
ZSCAN26	0.160697505	0	0	0.008201176	RSRC1	0.498059487	0.092811669	0.186346554	0.025759664
BBS10	0.39889283	0	0	0.008263173	LATS2	1.50031324	0.282919552	0.188573655	0.013882655
ATP5J2	0.649194456	0	0	0.008274581	MAPK11PIL	1.783075615	0.347019954	0.194618754	0.035116569
MRGBP	0.357237742	0	0	0.008307667	UBXN7	1.409837687	0.279800476	0.1984629	0.029894396
ZNF322	0.430199719	0	0	0.008405309	PURA	1.328214579	0.272135163	0.204887951	0.009459548
ZNF275	2.420417364	0	0	0.008446802	HIST1H2BC	3.33945113	0.689690668	0.206528151	0.032619381
HPCAL1	1.181505728	0	0	0.008452349	ZBTB44	0.711549384	0.149725806	0.210422227	0.033677573
CHTF18	8.548180556	0	0	0.008489844	MCM4	9.154073013	1.927158061	0.210524655	0.015863857
C3orf58	1.270404677	0	0	0.008532005	ARFGEF1	0.692348909	0.148265338	0.214148294	0.023619467
NEPRO	0.655804256	0	0	0.008741545	SHCBP1	12.12604415	2.605388573	0.214858905	0.049737347
CCDC134	0.823516158	0	0	0.008806459	PSMC3	1.276369679	0.277258473	0.217224271	0.043650064
OGG1	0.380879558	0	0	0.008855559	ZHX1	0.513390953	0.111879071	0.217921781	0.006483832
ZBTB22	0.680038634	0	0	0.008882814	ZFP91	1.813458084	0.402497312	0.22195016	0.033492127
SPIN3	0.46909685	0	0	0.008884016	LMO4	1.809443074	0.402826608	0.222624637	0.028071891
RNF7	0.455455934	0	0	0.008929029	TEX15	1.43930724	0.32150887	0.223377512	0.016937354
CHCHD5	2.233038738	0	0	0.009007689	DCK	1.509493099	0.339362849	0.224819079	0.024821311
COMMD6	0.147046465	0	0	0.009099288	KCTD12	3.909493368	0.89511417	0.228959122	0.022552081
MPEG1	1.253524856	0	0	0.009197053	IL6R	2.279741365	0.526664203	0.231019277	0.010319685
SNRPF	0.12355334	0	0	0.009211057	RAB21	0.834609476	0.193467558	0.231806088	0.041579585
MPST	2.341936594	0	0	0.009248842	HIST1H2AJ	9.030359162	2.099536932	0.232497611	0.032555372
MANSC1	3.250722577	0	0	0.009260895	CDC45	24.22681623	5.684966529	0.234655948	0.046331284
ZNF786	0.531269197	0	0	0.009637328	MAT2A	0.247132522	0.058304393	0.235923595	0.01681557
RPS27	0.028945177	0	0	0.009886984	DTL	9.80507964	2.313914107	0.235991363	0.035477043
DPCD	1.760712209	0	0	0.010061638	CNOT9	1.564480003	0.371282124	0.237319827	0.002535424
SAMSN1	0.223735067	0	0	0.010108496	CTDSPL2	1.291734603	0.308100314	0.23851673	0.01392732
TATDN1	0.026902112	0	0	0.010194235	ATP5J	0.470635707	0.1123613	0.238743679	0.047981513
ENDOD1	5.180802052	0	0	0.010208737	ATAD5	3.862821509	0.932241407	0.24133691	0.003659245
ULK1	3.700572894	0	0	0.010208737	SLC44A1	1.488637978	0.363712984	0.244326014	0.026482802
ALKBH8	0.38087292	0	0	0.010366984	CREB3L2	1.176130517	0.288860389	0.245602325	0.020291189
DNAJB9	0.655562863	0	0	0.010596683	CCNC	1.06734331	0.26278593	0.246205628	0.022231933
C11orf68	5.462442754	0	0	0.010699467	ZNF652	0.802182659	0.197602475	0.246331023	0.041445888
GPR157	1.170523447	0	0	0.010699467	AP3B1	0.64285436	0.159126387	0.247531007	0.02942729
ZBTB20	0.294319136	0	0	0.010815054	URI1	0.527542828	0.133169879	0.252434252	0.029467717
DCAF5	0.26701741	0	0	0.011001091	HMMR	6.894215721	1.754679953	0.254514803	0.006439281
ALDH3B1	2.336784842	0	0	0.011109846	ZWINT	7.344428752	1.874831268	0.255272579	0.0213428
C14orf93	0.573085104	0	0	0.011202461	IMPAD1	2.466070895	0.630870642	0.255820156	0.021828593
PCNX2	0.176164256	0	0	0.011205473	STK4	0.686917702	0.176906399	0.257536527	0.020224349
ZBTB5	1.065784189	0	0	0.011326121	ENPP2	0.620491746	0.16079897	0.259147637	0.027228459
PDCD2L	1.856815709	0	0	0.011354904	NCOA3	0.630581594	0.16548339	0.262429782	0.007510242
S100BPB	0.45373801	0	0	0.011559873	STX6	0.769459464	0.203199619	0.264080993	0.048672708
MTX1	0.333136594	0	0	0.011585498	BNIP3L	1.034126493	0.279236514	0.270021623	0.028782708
PEX3	1.336250432	0	0	0.01168331	ZBTB33	1.430671985	0.387798797	0.271060593	0.004464171
TMEM256	0.272169504	0	0	0.011804517	CAND1	1.623426174	0.440532514	0.271359746	0.044436946
ZNF134	0.259359895	0	0	0.011829475	EML4	1.096106021	0.298788671	0.272591032	0.033271669
PEX12	0.501942315	0	0	0.011881101	PTBP3	1.026385134	0.284689115	0.277370653	0.016740658
TRAPPC3	1.394949306	0	0	0.011971318	OPA1	0.98389607	0.273465051	0.277940993	0.004995713
C21orf59	1.343101545	0	0	0.011979406	TMEM154	0.426452397	0.119872612	0.281092598	0.029647298
NUDT1	2.642925407	0	0	0.012050261	CCR2	2.694263232	0.758988911	0.281705552	0.027693094
IPPK	1.345155872	0	0	0.012270488	TMEM123	0.746088668	0.211855466	0.28395481	0.036897211
CD2BP2	2.395954415	0	0	0.012274653	WDFY2	0.609253518	0.173339591	0.284511432	0.047992798
NPTN	1.250300385	0	0	0.012313881	PPP2CA	1.840763226	0.524553393	0.284965163	0.032640005



ZNF337	0.174649554	0	0	0.012341574	HIST1H2AE	3.769716804	1.082845648	0.28724854	0.002803916
POLR2M	0.785578541	0	0	0.012356086	NIP7	0.987340496	0.28677148	0.290448413	0.005141454
MAN2C1	0.851639619	0	0	0.012529338	TBC1D5	0.935446529	0.272711483	0.291530809	0.021320637
LYRM7	0.920645717	0	0	0.012594883	SEL1L3	1.441406874	0.424691939	0.294637098	0.03163562
MRPL46	1.471532338	0	0	0.012797809	FBXL20	1.147876064	0.340717143	0.296823981	0.043055708
SYT11	1.487229229	0	0	0.012804583	ENG	7.313864947	2.175153597	0.297401389	0.028161603
LMTK3	6.44465999	0	0	0.012804583	BDP1	0.337876343	0.101165104	0.299414582	0.037077933
TMEM106C	2.900096996	0	0	0.012804583	E2F8	15.63458422	4.703472963	0.300837739	0.04729932
NCK1	0.347502353	0	0	0.012829884	DBI	0.133835842	0.040663612	0.303832003	0.039929137
PIGA	1.110716407	0	0	0.01286847	ORC1	14.80900594	4.51995622	0.30521672	0.027196298
GRIN2D	1.43884437	0	0	0.012910317	MKI67	7.081167407	2.190631252	0.309360184	0.040934374
PARP3	0.362832106	0	0	0.012948822	WIPI2	1.449414706	0.450755518	0.310991406	0.000476708
FPGT	0.428573297	0	0	0.0129919	TSN	1.634251349	0.508600782	0.311213316	0.02107987
SNUPN	0.349005433	0	0	0.013007509	TTBK2	1.054670091	0.329993259	0.312887662	0.030365834
BTG3	1.675379028	0	0	0.013066905	TP53	3.84195241	1.20279987	0.313069955	0.007503024
RPAIN	0.127957674	0	0	0.0131108	ATG2B	0.838230426	0.264229683	0.315223207	0.015495062
NAPG	0.541867826	0	0	0.013187156	KNL1	5.577144853	1.769203724	0.317223915	0.017065458
DHRS11	2.707858131	0	0	0.013196633	GPD1L	5.418092397	1.735464131	0.320309069	0.021713866
USP45	0.224394955	0	0	0.013373673	DDX3Y	0.368497381	0.119480523	0.324237102	0.035540123
FAM8A1	1.179153846	0	0	0.013449881	ABCB10	8.402995859	2.729861272	0.324867621	0.004989901
AGL	0.809623913	0	0	0.013485446	SDHB	0.612715367	0.199925093	0.326293584	0.027794918
CALCOCO1	0.27533219	0	0	0.013587363	E2F3	0.741945001	0.243289129	0.327907229	0.045407804
ZDHHC18	4.241986067	0	0	0.013626269	LAMP2	0.930821378	0.306837946	0.329642135	0.018859692
ALPK1	0.127274092	0	0	0.01367534	RBM25	0.155052762	0.051227961	0.330390509	0.00325899
MORN2	0.977400881	0	0	0.013720113	RLIM	0.52295817	0.173178683	0.331152075	0.019664577
ZNF791	0.148464576	0	0	0.013850908	GALNT1	0.730882664	0.242335031	0.331564891	0.00771686
MEAF6	0.616260284	0	0	0.013866799	MESD	0.79931852	0.266308322	0.333169213	0.033772723
AP3S1	0.122363384	0	0	0.014050855	TMEM14C	0.273813836	0.091481866	0.334102423	0.047696724
RABGGTA	3.422030641	0	0	0.01418135	NEK4	1.674904074	0.559637886	0.334131306	0.02789627
CWF19L2	0.116655252	0	0	0.014236053	AGTPBP1	0.784123425	0.262442018	0.334694781	0.041879342
SPRED1	0.635293955	0	0	0.01432779	NNT	2.465794039	0.825764924	0.334888036	0.034405317
ZSWIM4	1.697105202	0	0	0.014370119	PPP4R2	0.881215764	0.296350027	0.336296783	0.03413315
A2M	1.697105202	0	0	0.014370119	OPN3	2.666701634	0.89935006	0.33725185	0.049590008
ERCC6	0.567714568	0	0	0.014423939	ERNA1	2.969285257	1.002641053	0.337670842	0.037028549
NAGLU	3.271015799	0	0	0.014527447	PTPRJ	1.595961975	0.54056125	0.338705595	0.021213773
RHOA	0.17901445	0	0	0.01464498	POLE3	1.343661394	0.456276664	0.339577118	0.029059357
CHMP3	1.058313587	0	0	0.014723303	FANCI	2.922293723	0.995092177	0.340517508	0.008757095
KRIT1	0.379351367	0	0	0.01476493	PLEKHA2	0.963380269	0.3289729	0.341477722	0.037868959
PAPLN	0.762411616	0	0	0.014812036	FBXO45	1.673417013	0.572126801	0.34189135	3.24E-05
ALDOC	12.47426799	0	0	0.014845078	SPCS3	3.67502773	1.260274989	0.342929382	0.031001094
NUS1	0.316067534	0	0	0.014860302	PPP4R3B	0.731448846	0.251158542	0.343371301	0.039030572
UMAD1	0.357341917	0	0	0.014878482	BMP1	3.194115648	1.100356945	0.344495023	0.017928682
TMEM170A	1.333121354	0	0	0.014919945	HIST1H2BL	9.0623078	3.136555012	0.346109962	0.027509604
ARHGAP44	0.491638829	0	0	0.014941143	PPA1	0.86965961	0.304141591	0.349724866	0.015839774
PWWP2A	0.789680292	0	0	0.014983345	NDRG1	0.874576441	0.310314942	0.354817404	0.049000797
NARS2	1.096828015	0	0	0.015148202	AREL1	1.286807842	0.458745731	0.356499017	0.049321027
SEZ6L2	0.804285753	0	0	0.015263892	MLLT10	0.43664873	0.155938109	0.357124843	0.02059904
TYW5	0.106965488	0	0	0.015303725	GPR85	2.189170573	0.799892415	0.365386062	0.01018386
GMCL1	1.072977352	0	0	0.015380179	SHMT1	15.6179651	5.712801734	0.365783999	0.016094977
ABHD17A	0.426499162	0	0	0.015451376	PCYT2	3.368073691	1.233119695	0.366120165	0.024347105
BLOC1S5	1.180148162	0	0	0.015469235	MRPS30	1.64806608	0.611847727	0.371251939	0.042789658
JKAMP	0.536686585	0	0	0.015552537	RNF38	1.065138148	0.398506417	0.374135898	0.01303926
TUBA1A	0.977038793	0	0	0.015690892	TRIP12	0.83178538	0.3149906	0.378692157	0.019372554
CCDC50	0.819399519	0	0	0.015692752	UBE2V2	0.737425569	0.280592547	0.380502872	0.029522258
ANAPC16	0.274191871	0	0	0.015748569	STAU1	1.362898494	0.521409847	0.382574234	0.040760547
SEPSECS	0.421178569	0	0	0.015789093	RUNX1	2.374964693	0.910867082	0.383528683	0.021598335
SMAD3	0.700868792	0	0	0.015922935	ATP6V1C1	1.119849437	0.429646741	0.383664738	0.007205555
GPR65	0.271125095	0	0	0.015967897	PAICS	1.10898296	0.426678288	0.38474738	0.02070861
OTUD7B	0.595204169	0	0	0.016025187	CPPED1	1.62799027	0.629087109	0.386419453	0.026578305
SS18L1	1.198239303	0	0	0.016064167	PPP1CB	1.402917545	0.542779222	0.386893174	0.026577422
UROD	0.495337609	0	0	0.016097351	ATP6V1A	0.952617115	0.370232346	0.38864759	0.016712925

POC5	0.336870673	0	0	0.016123376	TPX2	4.642905809	1.806257916	0.389036089	0.031835101
GAREM1	1.97856438	0	0	0.016222776	PSME3	1.699277149	0.66515551	0.391434387	0.008638401
FAM120AOS	0.388077681	0	0	0.016251804	KDM3A	0.334353399	0.131522118	0.393362587	0.009372876
SIGIRR	6.892665586	0	0	0.016316666	TRIM26	1.83741485	0.72649412	0.395389272	0.02176697
CRY1	1.448597553	0	0	0.016351094	PLAGL2	1.683323207	0.666148042	0.395733891	0.005682844
TRMT1L	0.693284398	0	0	0.016390938	NISCH	1.164205879	0.461046639	0.396018133	0.008205652
AHI1	0.2301842	0	0	0.016449699	KPNA4	0.796212789	0.317863661	0.399219487	0.01961316
ZNF224	0.105917795	0	0	0.01647492	RNF114	0.975786918	0.39298523	0.402736727	0.008867449
PAPD7	2.190375352	0	0	0.016570241	WDR43	0.494014199	0.199797266	0.404436282	0.048235872
HHEX	1.588147623	0	0	0.016584053	PTCD3	0.426335772	0.173284195	0.406450048	0.026993093
ZNF362	1.450338127	0	0	0.016609492	NCALD	0.869533177	0.355017396	0.408285049	0.032030808
C17orf97	0.668223602	0	0	0.016638672	CAPG	1.255429891	0.513445848	0.408980104	0.024898203
COX20	0.112701861	0	0	0.01676477	BAZ2B	0.217070981	0.089036454	0.410172072	0.035533966
ZNF33A	0.11513187	0	0	0.016776576	UNG	5.624021561	2.319376865	0.412405401	0.02415065
TMEM177	2.570997789	0	0	0.016781051	NETO2	2.261963726	0.936771843	0.414140966	0.030601483
UBE2D4	0.552790516	0	0	0.016838377	ATAD2	2.832617489	1.176453971	0.415323981	0.031595923
GAPT	1.093315273	0	0	0.017053449	CLN8	1.486368826	0.619557026	0.416825902	0.011568563
CNTLN	0.536442878	0	0	0.017113104	DYRK1A	1.047271924	0.438129944	0.418353566	0.033557771
SPG7	0.752498839	0	0	0.017403091	HMGB1	0.401303444	0.168873325	0.42081205	0.044916063
ZNF76	0.432926158	0	0	0.017436916	DNAJC10	0.687592979	0.289509576	0.421047894	0.018912219
FAM217B	1.307193623	0	0	0.017448139	IREB2	0.814314061	0.343863391	0.422273675	0.046965591
SLC4A1AP	0.506067563	0	0	0.017531672	ANP32E	0.869610749	0.371862273	0.427619223	0.037340984
POLR2I	0.99541869	0	0	0.017565972	PSMB1	1.758741339	0.754043678	0.428740521	0.030207629
NAT1	1.869372822	0	0	0.017591732	APPL1	0.767115345	0.330727937	0.431131953	0.04510942
STMP1	0.567093743	0	0	0.017598296	SERINC1	0.666750717	0.28969702	0.434490751	0.029553299
AKR7A3	0.899432614	0	0	0.017628787	ZFP36	1.240405928	0.539562273	0.434988467	0.026727102
RNF2	1.530198221	0	0	0.017662788	EPB41	1.134256077	0.500417129	0.441185319	0.017160913
CCDC15	1.351674811	0	0	0.018043623	FAM208B	0.776466041	0.342979555	0.44171868	0.004185561
ZNF546	0.349928288	0	0	0.018543347	PRDX6	1.907122615	0.84540018	0.443285698	0.027150277
ZDHHC21	0.144674562	0	0	0.01855584	TMPO	2.933481603	1.306481283	0.445368835	0.03138992
DPH6	0.131382353	0	0	0.018698402	RPS23	0.169541819	0.075719994	0.446615439	0.043837709
CBWD1	0.075587151	0	0	0.018894276	TGOLN2	0.840261301	0.382942126	0.455741715	0.033976158
EMP2	22.53806004	0	0	0.018971679	NACA	0.046214061	0.021108475	0.456754385	0.043504859
PRADC1	12.87889145	0	0	0.018971679	TMEM245	2.347156098	1.085676947	0.462549955	0.031024945
MMP15	15.02537336	0	0	0.018971679	TMOD3	1.284460881	0.605408844	0.471333034	0.022923052
RARG	1.502537336	0	0	0.018971679	CPSF7	3.075247279	1.45321163	0.472551147	0.007346798
PXMP2	15.02537336	0	0	0.018971679	VPS41	0.805556964	0.382180501	0.474430137	0.028807335
TIMM22	1.959831308	0	0	0.018971679	PIP4K2B	2.614406287	1.242786646	0.475360946	0.027454791
PDHX	0.413340986	0	0	0.019002611	CYP1B1	1.175288029	0.561264965	0.477555247	0.026875758
ERI2	0.459091287	0	0	0.019029499	ZNF292	0.380999303	0.182783151	0.479746681	0.039593094
TEC	0.070126282	0	0	0.019078023	SEC23B	1.172952643	0.56711823	0.483496272	0.041935774
SLC2A13	1.282329959	0	0	0.019112234	UBE2W	0.26535053	0.128733919	0.485146644	0.032149949
RIPK2	1.130572345	0	0	0.019120797	RIF1	0.956007391	0.469094328	0.49068065	0.036994921
PRKX	0.628013979	0	0	0.019229862	ZBED1	3.007646092	1.486922123	0.494380681	0.043989679
UGGT2	0.118972863	0	0	0.019443581	MDN1	0.53158179	0.263259595	0.495238174	0.020727461
MED26	1.143923164	0	0	0.019522063	LRPPRC	0.726995159	0.360702076	0.496154715	0.042522384
UBE2E2	0.801817001	0	0	0.019541848	RNMT	0.72549479	0.360767053	0.497270357	0.03128782
POMGNT1	0.658029591	0	0	0.019586675	BCL2	0.788530911	0.394021989	0.49969124	0.032201259
PPM1E	2.194243904	0	0	0.019605683	ERAP1	1.31913799	0.660292879	0.500548755	0.003917717
DHX40	0.489994999	0	0	0.019608806	SKAP2	1.374831204	0.696219459	0.506403591	0.035211574
ERCC8	0.389917538	0	0	0.019906274	MED13	1.248908261	0.633143675	0.506957712	0.037229979
SLC25A17	1.249646519	0	0	0.019980354	MRPS22	0.433344571	0.219746923	0.507095133	0.014084646
GID4	0.880886961	0	0	0.019993946	SNX27	1.376722761	0.702152359	0.510017252	0.014580961
ZNF114	0.869427936	0	0	0.020009271	NUDT21	2.459793512	1.256989373	0.511014183	0.010331238
ZNF747	1.548634636	0	0	0.020096118	FEM1B	1.212660425	0.620337458	0.511550839	0.027524181
SPPL2A	0.74358749	0	0	0.020153218	DACH1	1.261807405	0.648489352	0.513936873	0.043924632
PPT2	1.936552909	0	0	0.020173909	STRAP	0.635306132	0.32740397	0.515348355	0.043636993
TGM5	0.237131391	0	0	0.020189579	DNAJA2	0.26115751	0.134952541	0.516747694	0.023354322
RNF103	0.728017814	0	0	0.020206497	FAM107B	0.411898711	0.213565595	0.518490564	0.034065838
SCMH1	0.692890506	0	0	0.020241129	HIST1H1B	7.84348031	4.105365332	0.523411186	0.020623305
C1orf109	1.373885949	0	0	0.020304628	GNB4	1.56177853	0.822735286	0.526793825	0.04910172

REXO2	0.632539397	0	0	0.020399	SLC6A6	1.326376981	0.699243337	0.527182956	0.012900966
SMDT1	0.679584921	0	0	0.020601127	TIAL1	0.923458897	0.491588731	0.532334176	0.006312258
PPP1R15A	0.293485804	0	0	0.020655647	PGM2	1.712202643	0.915091137	0.534452529	0.030523133
HIPK2	0.924102175	0	0	0.020702562	MSL2	1.491629575	0.807404649	0.541290319	0.046049751
PHKA1	0.986609377	0	0	0.020756551	AFF3	0.909990398	0.494448905	0.543356178	0.006344607
FLVCR1	0.950983616	0	0	0.020935285	DDX46	0.745437141	0.405677672	0.544214461	0.013885634
HDAC9	0.52083034	0	0	0.021111382	STRN	1.869661867	1.026104329	0.54881813	0.049437036
DTWD2	1.479697725	0	0	0.021143432	ARL6IP1	1.828235539	1.006683581	0.550631229	0.043003873
CHMP6	2.5820346	0	0	0.021183182	UBE2D3	0.326483209	0.180509752	0.55289138	0.021706091
SKA2	0.490515239	0	0	0.021327738	MTDH	0.862939033	0.478057105	0.553987115	0.022479229
LDLRAD3	1.415542863	0	0	0.021355146	XPO4	1.695156914	0.941850511	0.555612583	0.035131479
KPTN	1.656429545	0	0	0.021409207	LRRFIP1	0.444798361	0.248090729	0.557759989	0.034318789
BTRC	0.62402774	0	0	0.021420733	MIOS	0.436120679	0.244984012	0.561734455	0.029927912
WARS2	1.341243999	0	0	0.021433261	VDAC3	1.042068973	0.588155097	0.56441091	0.031996439
GLTP	0.410616777	0	0	0.021451694	TAPBP	3.571990369	2.022995331	0.566349604	0.006060836
GPR137B	0.843718293	0	0	0.021455974	HIST1H2AC	1.926194123	1.091137797	0.566473433	0.001233637
WHAMM	0.285696114	0	0	0.021496339	BTAF1	0.389465866	0.222469385	0.571216644	0.010580927
NDUFB11	1.452459662	0	0	0.021531029	MTMR9	0.845437229	0.483523244	0.571920927	0.039352683
EMC7	1.137283136	0	0	0.021549958	SRP54	0.237639677	0.138887527	0.584445867	0.045542729
ZNF37A	0.243400477	0	0	0.021906332	INTS8	0.735891743	0.430899918	0.585547972	0.012274513
RAB11FIP4	2.029329974	0	0	0.021974358	PANK3	1.081775137	0.642628728	0.594050192	0.043776699
C1orf123	0.765809788	0	0	0.021997629	PDS5B	1.177825251	0.705028721	0.598585164	0.045202948
IDS	0.266411372	0	0	0.022129911	ARPC3	0.172536745	0.103332776	0.59890301	0.0363195
LAMB3	1.088158138	0	0	0.022198741	EIF4G2	1.631607737	0.984251534	0.603240296	0.048261887
APP	0.395526336	0	0	0.022337122	LRCH1	0.87000119	0.534634688	0.614521789	0.019108118
KCNC4	0.59196985	0	0	0.022341028	HIST1H1C	13.13697557	8.083634201	0.615334493	0.010574701
ELMOD2	1.615965957	0	0	0.022497944	INTS10	1.117311714	0.690888723	0.618349127	0.037117854
ARSA	1.783701694	0	0	0.02258139	ZNF398	1.030754809	0.6379573	0.618922458	0.023542228
TICRR	7.719176625	0	0	0.022600598	HIST1H2AI	16.21957238	10.07467292	0.621142943	0.009603707
HKR1	0.065513385	0	0	0.022679867	SETD7	0.831680323	0.520495544	0.625836069	0.025972691
SLC8A1	2.80129934	0	0	0.022776865	RCC1L	3.621565763	2.268042488	0.626260197	0.009920183
TSC22D1	0.989019185	0	0	0.023001368	NCAPD3	2.718342567	1.707887317	0.628282593	0.039411763
DTWD1	0.099447121	0	0	0.023046555	FKBP1A	0.649284643	0.409380613	0.630510235	0.004134721
MED30	0.30688436	0	0	0.023058385	FLT3	0.919639	0.585231199	0.636370575	0.014352296
TNFSF10	1.599256801	0	0	0.023084921	BTBD7	1.321895743	0.843694248	0.63824568	0.019104726
MPV17	1.128988525	0	0	0.023178831	DIDO1	0.701109425	1.073264568	1.530808929	0.011490345
WDR92	0.956348866	0	0	0.023268372	CFL1	0.7822979	1.20868022	1.545038303	0.038743469
FUNDC2	1.027074996	0	0	0.02341616	WWP2	1.587958023	2.511679642	1.581704054	0.009151501
SUOX	1.242333558	0	0	0.023497312	ATF6B	0.887408097	1.415004449	1.594536329	0.023978281
TRIT1	0.287261826	0	0	0.023573161	RAB27A	0.674345922	1.075496707	1.594873895	0.005496791
DDX39B	0.142283492	0	0	0.023676804	TOP1	0.360107195	0.578444411	1.606311729	0.004919043
FANCF	1.009975696	0	0	0.023742828	ATP1A1	2.251394723	3.621056278	1.60836136	0.000828623
TIMM23	1.897286971	0	0	0.023826284	BTF3	0.178227146	0.290893456	1.63215011	0.010031281
RHOF	5.807131283	0	0	0.02390325	PRPF4	1.100744451	1.808924333	1.643364481	0.024702773
ARHGAP25	0.455075717	0	0	0.023924568	ZMYND19	1.637273234	2.755024101	1.68269049	0.046592563
MRPS17	1.706077653	0	0	0.024120757	SPI1	0.989335379	1.665325	1.683276506	0.003599307
TRADD	5.11823296	0	0	0.024120757	SENP6	0.525963285	0.892519545	1.696923665	0.020575494
ADCK2	10.23646592	0	0	0.024120757	PHKA2	1.246324967	2.190668676	1.757702633	0.003483263
NPEPL1	3.412155306	0	0	0.024120757	PTOV1	4.168959954	7.369500388	1.767707167	0.009920436
IL10RB	0.85061225	0	0	0.024132356	METTL7B	3.744407882	6.801359385	1.816404516	0.020288296
PIBF1	0.236940828	0	0	0.024343168	DNAJC14	1.517033049	2.760705405	1.81980571	0.040174831
USP53	0.436173607	0	0	0.024450492	ARHGAP45	4.566292159	8.334531103	1.825229489	0.027690274
FAM219B	0.509261	0	0	0.024524315	GAB2	0.377776925	0.701425663	1.856719182	0.03133319
SIRPB2	1.753603266	0	0	0.024735892	ELAC2	1.20645796	2.24789269	1.863216759	0.022986356
FBXO4	0.962353399	0	0	0.02481564	PHRF1	1.680034765	3.170940339	1.88742543	0.019998066
PDE8A	0.723063849	0	0	0.024897793	FARSA	2.526044264	4.827676627	1.911160741	0.049848963
POLM	2.157850819	0	0	0.025068635	BOP1	5.5640946	10.75277155	1.932528529	0.040289093
CDK5RAP1	0.423757489	0	0	0.025256802	SAP30BP	0.316697266	0.625197228	1.974116278	0.015880408
ZNF691	1.668028448	0	0	0.025330035	SLC25A19	1.418802604	2.801327887	1.97443103	0.006756375
SCAI	0.750918516	0	0	0.025517795	AKT1	5.561814269	11.07384007	1.991048161	0.049502594
MSI2	0.358500559	0	0	0.025706417	PUM2	1.200187935	2.530368187	2.108309968	0.042001071

CRELD2	2.207642362	0	0	0.025726118	EXOSC10	0.381056519	0.804231786	2.110531498	0.006888624
TMEM120A	1.839701968	0	0	0.025726118	PSMB4	1.615708253	3.434360741	2.12560698	0.000839987
RNFT1	0.696139943	0	0	0.026019485	SND1	0.729608692	1.554347186	2.130384688	0.009106042
AZI2	0.359542043	0	0	0.026118706	UTP18	0.947552627	2.026477469	2.138643714	0.014602646
NLRP1	0.421367988	0	0	0.026132583	CDC123	0.707207858	1.514483085	2.141496404	0.01865422
MED21	0.712725695	0	0	0.026252826	BIN3	1.227648364	2.632071434	2.143994576	0.033647877
THAP12	0.409408386	0	0	0.026313692	PRKCD	1.570636483	3.372116576	2.146974563	0.014124818
ERMAP	0.388473226	0	0	0.026353119	CAMTA2	0.676099879	1.460317688	2.159914139	0.015840925
CRY2	0.879892077	0	0	0.026433687	GPD2	1.75297242	3.78666023	2.160136798	0.00825088
ZYG11A	1.468522021	0	0	0.026507809	GALM	0.329155043	0.711268964	2.160893412	0.029823927
ILIRN	1.661790118	0	0	0.026655907	GBA2	1.18056769	2.554282936	2.16360566	0.039165561
C9orf3	0.140206764	0	0	0.026757893	ABTB2	2.184811721	4.771137073	2.183774935	0.034172828
RNASEL	0.901788671	0	0	0.026807031	PLSCR1	0.422486247	0.938200884	2.220666094	0.030842667
FAM76B	0.471221072	0	0	0.026863066	TRAFD1	1.021426779	2.295037791	2.246894088	0.016418375
TMEM116	0.279437331	0	0	0.027112346	MTMR6	1.103735226	2.506516437	2.270939966	0.026085166
ZNF699	0.385565421	0	0	0.027336442	STAT5A	1.247697932	2.853993454	2.287407377	0.038800022
C1GALT1	0.708825098	0	0	0.027396809	LPCAT4	1.86177737	4.502317809	2.418290114	0.013094723
SOCS3	2.209988781	0	0	0.027630726	RET	1.583688054	3.885244992	2.453289322	0.031046563
BCKDHB	1.068328935	0	0	0.027980474	USP36	0.86228	2.124641413	2.463980857	0.018901045
TEF	5.013065654	0	0	0.028087088	EIF2AK3	0.863906481	2.236328692	2.588623585	0.018630301
C6orf48	0.014764735	0	0	0.028154577	RGS19	8.602893141	22.27575573	2.589333073	0.022909098
PNPLA8	1.152690181	0	0	0.028197595	CNTROB	0.692300753	1.833613119	2.648578831	0.012033287
C21orf91	0.816115416	0	0	0.028239839	PLCG2	0.649115323	1.730750909	2.666322682	0.024246283
TRAPPC4	3.697095605	0	0	0.028317092	TAF2	1.274378296	3.420792529	2.684283419	0.026433434
MPZL1	4.355201749	0	0	0.028395023	CLPB	2.907613571	7.807656295	2.685245513	0.030198559
IER3IP1	2.356855844	0	0	0.028404485	APLP2	0.648727035	1.761364353	2.715108602	0.013183257
NUP85	0.912157044	0	0	0.028770066	SPNS3	1.192249434	3.280022744	2.751121242	0.009664487
CDR2L	3.127395579	0	0	0.028770066	USP16	0.518180481	1.434555294	2.768447185	0.009556065
COX17	0.070147348	0	0	0.028868862	CCDC32	0.835738963	2.314817619	2.769785449	0.047788786
TULP3	1.295496308	0	0	0.028910892	MELTF	1.204423774	3.33868082	2.772015043	0.039504891
KIAA2026	0.249423686	0	0	0.029111472	CERK	1.401854235	3.909081541	2.788507852	0.01195807
UOCR11	6.051985625	0	0	0.029186831	DPY19L1	1.455786592	4.127742629	2.835403659	0.026773148
EEF1B2	0.049085521	0	0	0.029289303	COMMD5	3.808718601	10.81783906	2.840283096	0.021508081
ATG4A	0.662283585	0	0	0.029393991	SLC9A8	0.571602156	1.633784677	2.858254924	0.02732404
PSPN	3.665326266	0	0	0.029447948	USE1	0.856171887	2.57429504	3.006750256	0.016602313
ZNF524	1.680431185	0	0	0.029562451	PGD	0.806864997	2.440696668	3.024913309	0.025279528
NFIL3	0.241852391	0	0	0.029819426	WARS	0.322763628	0.981406259	3.040634613	0.002068232
NAPB	0.254801209	0	0	0.0298685	SCRIB	4.591847229	14.04785703	3.059304095	0.037863457
C1orf52	0.356299635	0	0	0.029948942	RBM45	0.698870241	2.141897173	3.064799511	0.042513983
ZNF280C	0.518802944	0	0	0.029953041	ZSWIM8	0.853317216	2.618451247	3.068555512	0.032538583
CIB1	3.806779726	0	0	0.029961137	DHX16	0.474851007	1.466301027	3.087918116	0.026018609
ARHGAP33	1.745596715	0	0	0.030008143	TSNS54	2.805489215	8.68906266	3.097164877	0.019704406
PIGL	0.200820072	0	0	0.03006283	SPPL2B	0.818962278	2.571920637	3.140462883	0.029994171
BTN2A1	0.246890753	0	0	0.030098305	MYL12B	0.202779724	0.644569651	3.178669141	0.049991545
ATP8B2	2.566191927	0	0	0.030136205	RNF167	2.193521374	7.034079317	3.20675212	0.007790893
PCGF1	0.196495339	0	0	0.030165063	LONP1	0.503069711	1.647274073	3.274444947	0.015395317
DEPTOR	0.537048267	0	0	0.030307706	LMNB1	1.429814605	4.739666358	3.314881763	0.034506899
UAP1	1.827148451	0	0	0.030595947	ATAD1	0.813834804	2.705407348	3.32427089	0.0155177
ABHD10	1.047170987	0	0	0.030771472	MYBBP1A	0.866292236	2.88119223	3.325889475	0.008175582
MALSU1	0.439828866	0	0	0.030860495	MTO1	1.741317864	5.860194318	3.365378854	0.010619853
GAMT	12.80622911	0	0	0.030877167	MT-CO1	0.020461273	0.068978881	3.371192056	0.016179422
COX18	0.375287142	0	0	0.030994974	SLC3A2	0.859679918	2.903673472	3.377621614	0.01061592
RRAGA	0.713544122	0	0	0.031010352	MT-ND1	0.03455747	0.118318833	3.423827989	0.006748734
RP2	2.330150738	0	0	0.031120679	TRIM41	0.320717114	1.099040873	3.426823281	0.043009896
KLHDC4	0.636147849	0	0	0.031132201	ADRM1	6.146597153	21.1020854	3.43313298	0.049053192
ZBTB8OS	0.098425477	0	0	0.03120763	HAUS5	2.78064032	9.708585494	3.491492741	0.033464286
DRAP1	0.481535778	0	0	0.031255245	CYTH2	0.392850212	1.408910321	3.586380452	0.017397603
F11R	0.839526768	0	0	0.031355862	TLE3	0.782822176	2.810741579	3.590523704	0.042634862
C11orf54	0.195827683	0	0	0.031479065	ZNF512B	1.76582586	6.464104889	3.660669512	0.018479757
DHFR	1.923399225	0	0	0.031523277	PPM1D	0.931289735	3.424632586	3.677300906	0.028387694
ANKAR	0.455428423	0	0	0.031752657	ARHGAP27	2.623928703	9.65484434	3.679537607	0.024471664

RYBP	1.307411209	0	0	0.032290303	RRP9	1.439606801	5.297622034	3.679909007	0.006622529
ST3GAL6	0.327152185	0	0	0.032303951	MT-ND5	0.053501193	0.202448703	3.784003527	0.04457032
ADSL	1.040210755	0	0	0.032864178	SETD4	0.123813385	0.485765023	3.923364368	0.015001392
RCOR3	0.505963292	0	0	0.033102822	FBXO41	1.852597511	7.293314841	3.936804836	0.036994263
GIN1	0.455048152	0	0	0.033715966	PIAS4	1.381667902	5.576349911	4.035955314	0.001033165
PPFIA4	0.436534614	0	0	0.0338343	HSPBP1	6.99338779	29.21564343	4.177609523	0.001200694
ZNF286A	0.830817457	0	0	0.033969506	ERCC1	0.395307283	1.675219355	4.237764967	0.016080959
ONECUT2	1.94043974	0	0	0.034089979	MORC2	0.359396475	1.54676437	4.303782807	0.009957881
CREBRF	0.370761862	0	0	0.034301226	GPANK1	0.417616721	1.799712984	4.309484974	0.036504891
TMEM258	0.212519932	0	0	0.034544647	S1PR3	4.752840737	20.55573602	4.324936845	0.008146877
CERS5	0.887597677	0	0	0.034585421	RAP1GAP2	1.275154904	5.596487722	4.388868917	0.026327777
SLC25A23	2.226370206	0	0	0.034597988	TEFM	0.406914663	1.802081538	4.428647335	0.012643831
MED28	0.483944092	0	0	0.034599528	ADA2	0.995503405	4.427896438	4.447896829	0.019692756
DENND6A	0.592584708	0	0	0.034604383	NTMT1	1.310986175	5.891925198	4.494269513	0.024388107
TBCEL	0.476697937	0	0	0.034872016	HIP1	0.760499766	3.419417375	4.496276696	0.009358843
RIN2	0.934903147	0	0	0.03490273	PKP4	0.853511403	3.902524097	4.572316296	0.012076306
HIST2H4B	2.891051296	0	0	0.035033072	DDX51	1.379833185	6.359553847	4.608929482	0.006488017
DRG2	1.242376766	0	0	0.035334647	RPL37A	0.16373622	0.778637755	4.755439908	0.004115598
AURKAIP1	0.93267087	0	0	0.035339179	PMF1	2.036785724	9.848886967	4.835504713	0.031337181
HHAT	0.843827474	0	0	0.035561593	EXT2	2.869983396	14.00957065	4.881411742	0.047712936
AP1S2	0.725521778	0	0	0.035675115	MAPK8	0.347350622	1.738971101	5.006385453	0.033469089
FAM213B	3.98653397	0	0	0.035830578	AP1S1	2.327646574	11.65652227	5.007857464	0.005516992
EXOSC1	0.622997352	0	0	0.03603003	CCT7	3.049117564	15.34303671	5.031959702	0.006280179
DCP1B	1.474403893	0	0	0.036467029	TNKS1BP1	0.394916639	2.005197937	5.077522036	0.027035067
KCTD15	2.235314277	0	0	0.036472043	TCOF1	1.476399213	7.570749839	5.127847382	0.015714782
CTSF	5.815245719	0	0	0.036638671	PIGO	10.67111293	55.44071893	5.195401763	0.039647219
TMEM241	1.559529816	0	0	0.037007162	ZNF226	0.100896474	0.567245653	5.622056257	0.003755709
RAB28	0.610466902	0	0	0.037219778	PTPMT1	1.176226609	6.95990147	5.917143361	0.004874748
GAS2L3	1.424422772	0	0	0.037219778	RRNAD1	1.952868539	11.91604011	6.101813753	0.019278386
DYRK4	0.424407174	0	0	0.037224208	EXOSC7	0.288066537	1.773268134	6.155758848	0.042253664
IFT52	0.73716573	0	0	0.037372202	UOCC2	0.721718351	4.731617335	6.556044097	0.003382317
RIPK3	1.886520716	0	0	0.037408936	FAM50A	0.373286025	2.560704142	6.85989823	0.018854113
HINT3	0.490433762	0	0	0.037561051	TRMT61A	6.831329814	47.68284053	6.980023191	0.04195329
RBKS	0.448973426	0	0	0.037851363	EEF1A2	1.080280296	8.201890364	7.592372456	0.010803826
TAF5	1.427791327	0	0	0.037892256	ZC3H8	0.040618847	0.318588183	7.843358601	0.024744427
BSDC1	0.701288716	0	0	0.038087132	HDLBP	2.165025276	17.01138075	7.85735896	0.04127303
RBM18	1.539806475	0	0	0.03839604	ATG10	0.21543033	1.831245954	8.500409176	0.04520059
ZNF136	0.51041714	0	0	0.038400955	JDP2	0.067497754	0.582691995	8.632761247	0.034496795
EAF2	0.353130713	0	0	0.038589101	DPH7	0.535516902	5.118599673	9.55824112	0.001227332
ZNF296	3.559303404	0	0	0.038763137	TAP2	0.590585699	5.752108063	9.739667033	0.013196921
ZNF543	0.378764527	0	0	0.038823439	EHD2	0.808062938	8.582538228	10.62112594	0.019979007
ADAP1	10.74414164	0	0	0.038845652	RCN1	0.056526909	0.601702378	10.64452999	0.0272391
TRMT112	0.360917337	0	0	0.038930579	KCTD13	0.527991523	6.358824348	12.04342129	0.049684686
RNF141	0.497603971	0	0	0.039103431	MX2	0.311465538	4.278930476	13.73805431	0.028559035
PARS2	2.633706966	0	0	0.039117587	HECTD3	0.269287913	3.914833801	14.53772565	0.009871839
SMYD5	3.497535165	0	0	0.039187718	RTL5	0.085038288	1.68688176	19.83673237	0.003212687
TBCK	0.29527486	0	0	0.039215415	OCEL1	0.190085586	4.485763243	23.59865015	0.0185025
PAM	0.507768201	0	0	0.039365638	LGALS12	0.369309138	16.2157308	43.90828477	0.009933997
CD82	0.774801076	0	0	0.039760681	ADAMTSL5	0	14.05349714	#DIV/0!	0.020008502
COMMD8	0.393730526	0	0	0.039762727					

**Supplemental Table 7. The GO biological process analysis of the genes whose translational efficiency were changed upon circMYBL2 knockdown.**

GO_Term	GO biological process complete	P-value	FDR
GO:0044237	cellular metabolic process	3.50E-18	5.53E-14
GO:0008152	metabolic process	1.25E-17	9.90E-14
GO:0044238	primary metabolic process	1.00E-16	5.29E-13
GO:0006807	nitrogen compound metabolic process	3.32E-16	1.31E-12
GO:0071704	organic substance metabolic process	4.04E-16	1.28E-12
GO:0044260	cellular macromolecule metabolic process	1.82E-15	4.79E-12
GO:0043170	macromolecule metabolic process	3.79E-15	8.57E-12
GO:0050906	detection of stimulus involved in sensory perception	2.14E-14	4.23E-11
GO:0007186	G protein-coupled receptor signaling pathway	1.42E-13	2.49E-10
GO:0051606	detection of stimulus	2.42E-13	3.82E-10
GO:0050907	detection of chemical stimulus involved in sensory perception	8.66E-13	1.25E-09
GO:0007606	sensory perception of chemical stimulus	9.82E-13	1.29E-09
GO:0050877	nervous system process	2.32E-12	2.82E-09
GO:0008150	biological_process	2.95E-12	3.34E-09
GO:0009593	detection of chemical stimulus	3.52E-12	3.48E-09
GO:0034641	cellular nitrogen compound metabolic process	3.80E-12	3.54E-09
GO:0050911	detection of chemical stimulus involved in sensory perception of smell	1.38E-11	1.21E-08
GO:0007608	sensory perception of smell	7.85E-11	6.54E-08
GO:0006139	nucleobase-containing compound metabolic process	8.47E-11	6.69E-08
GO:0090304	nucleic acid metabolic process	9.35E-11	7.04E-08
GO:0044267	cellular protein metabolic process	1.46E-10	1.05E-07
GO:0007600	sensory perception	2.47E-10	1.70E-07
GO:0046483	heterocycle metabolic process	4.30E-10	2.83E-07
GO:0006725	cellular aromatic compound metabolic process	1.91E-09	1.21E-06
GO:0003008	system process	2.59E-09	1.57E-06
GO:0044249	cellular biosynthetic process	2.90E-09	1.70E-06
GO:0043412	macromolecule modification	3.14E-09	1.77E-06
GO:0006464	cellular protein modification process	3.99E-09	2.18E-06
GO:0036211	protein modification process	3.99E-09	2.10E-06
GO:1901360	organic cyclic compound metabolic process	4.40E-09	2.25E-06
GO:1901564	organonitrogen compound metabolic process	6.42E-09	3.17E-06
GO:1901576	organic substance biosynthetic process	1.44E-08	6.91E-06
GO:0009058	biosynthetic process	1.49E-08	6.93E-06
GO:0009987	cellular process	5.75E-08	2.60E-05
GO:0019538	protein metabolic process	1.32E-07	5.79E-05
GO:0019222	regulation of metabolic process	3.08E-07	1.32E-04
GO:0006996	organelle organization	3.91E-07	1.63E-04
GO:0010468	regulation of gene expression	4.90E-07	1.99E-04
GO:0032501	multicellular organismal process	8.61E-07	3.40E-04

GO:0031323	regulation of cellular metabolic process	1.78E-06	6.88E-04
GO:0034645	cellular macromolecule biosynthetic process	1.79E-06	6.74E-04
GO:0006974	cellular response to DNA damage stimulus	2.36E-06	8.69E-04
GO:0009059	macromolecule biosynthetic process	2.52E-06	9.04E-04
GO:0006399	tRNA metabolic process	2.64E-06	9.28E-04
GO:0016070	RNA metabolic process	3.83E-06	1.32E-03
GO:0060255	regulation of macromolecule metabolic process	4.21E-06	1.42E-03
GO:0033554	cellular response to stress	5.09E-06	1.68E-03
GO:0006259	DNA metabolic process	5.24E-06	1.69E-03
GO:0051276	chromosome organization	7.10E-06	2.25E-03
GO:0016567	protein ubiquitination	7.13E-06	2.21E-03
GO:0032446	protein modification by small protein conjugation	9.63E-06	2.93E-03
GO:0070647	protein modification by small protein conjugation or removal	9.93E-06	2.96E-03
GO:0010467	gene expression	1.07E-05	3.14E-03
GO:0009889	regulation of biosynthetic process	1.29E-05	3.72E-03
GO:0031326	regulation of cellular biosynthetic process	1.34E-05	3.78E-03
GO:2000112	regulation of cellular macromolecule biosynthetic process	1.38E-05	3.84E-03
GO:0006793	phosphorus metabolic process	1.41E-05	3.84E-03
GO:0006796	phosphate-containing compound metabolic process	1.56E-05	4.19E-03
GO:0044271	cellular nitrogen compound biosynthetic process	1.84E-05	4.84E-03
GO:0007049	cell cycle	2.04E-05	5.29E-03
GO:0019219	regulation of nucleobase-containing compound metabolic process	2.04E-05	5.21E-03
GO:0010556	regulation of macromolecule biosynthetic process	2.05E-05	5.14E-03
GO:0080090	regulation of primary metabolic process	3.82E-05	9.43E-03
GO:0034660	ncRNA metabolic process	4.98E-05	1.21E-02
GO:0051252	regulation of RNA metabolic process	5.69E-05	1.36E-02
GO:0071840	cellular component organization or biogenesis	7.01E-05	1.66E-02
GO:0006270	DNA replication initiation	9.50E-05	2.21E-02
GO:0051171	regulation of nitrogen compound metabolic process	9.66E-05	2.22E-02
GO:0006325	chromatin organization	1.17E-04	2.64E-02
GO:0007155	cell adhesion	1.39E-04	3.10E-02
GO:0022610	biological adhesion	1.41E-04	3.10E-02
GO:0044248	cellular catabolic process	1.47E-04	3.18E-02
GO:0051301	cell division	1.47E-04	3.14E-02
GO:0006281	DNA repair	1.83E-04	3.86E-02
GO:1903506	regulation of nucleic acid-templated transcription	2.03E-04	4.22E-02
GO:0007005	mitochondrion organization	2.31E-04	4.75E-02
GO:2001141	regulation of RNA biosynthetic process	2.39E-04	4.84E-02

**Supplemental Table 8. Proteins identified in specific bands by MS may interact with circMYBL2.**

Protein	Pipette Number	Unique	Protein	Pipette Number	Unique	Protein	Pipette Number	Unique
VPS13D	1	1	TUBA3C	1	1	SYNCRIP	8	8
AKAP13	1	1	FAM90A14P	1	1	EZR	12	12
ACACA	1	1	TRPM7	1	1	ALB	14	10
DHX9	14	14	PLXNB2	1	1	CRY1	1	1
SF3B3	9	9	ZSWIM8	1	1	NELFCD	1	1
DHX30	8	8	LAMB4	1	1	PTBP1	10	8
SND1	8	8	PCF11	1	1	KRT1	26	16
DDX17	2	2	PCF11	1	1	ME2	11	11
NCL	19	19	CCDC18	1	1	KRT2	10	3
SEMA7A	1	1	CLIP1	1	1	HNRNPL	2	2
HNRNPR	6	1	TNS3	1	1	CES1	3	3
SYNCRIP	9	4	RECQL4	1	1	KRT5	6	2
ALB	8	5	PTCH2	1	1	PGM5	1	1
AMY1A	1	1	KIF1C	1	1	KRT9	16	15
THNSL2	1	1	WDR6	3	3	MCCC2	30	29
TRAF4	1	1	MAP4	1	1	NUP58	1	1
EEF1A1P5	6	6	EPHA6	1	1	TCP1	12	12
EEF1A1	6	6	ATP1A4	1	1	CAT	1	1
WDR12	1	1	ATP1A1	1	1	CCT5	3	3
ENO1	4	4	ATP1A2	1	1	CCT8	24	24
SSB	2	2	ATP1A3	1	1	CCT7	10	10
NSUN4	1	1	ZNF316	1	1	YARS	12	12
RTCA	1	1	KCNQ5	1	1	cKRT10	17	14
S100A9	2	2	EEF2	6	6	CCT6A	1	1
ILF2	7	5	KANK2	1	1	PKM	3	3
DST	1	1	HNRNPU	8	8	KRT14	4	1
PCLO	1	1	DDX21	10	10	KRT16	4	1
SSPO	1	1	NSUN2	1	1	EEF1A2	1	1
HERC2	1	1	MPO	12	12	EEF1A1P5	1	1
AKAP13	1	1	ADARB2	1	1	TUBA1B	1	1
PDZD2	1	1	CLPB	2	2	CPOX	1	1
ACACA	2	2	UBC	1	1	EEF1A1	1	1
RP1L1	1	1	NCL	32	31	TUBA1A	1	1
NAV3	1	1	SYN1	1	1	TUBA8	1	1
DOCK6	1	1	HSPA8	1	1	FAM90A2P	1	1
ADAMTS9	1	1	NXF1	5	5	FAM90A20P	1	1
TUBA4A	1	1	HBA1	1	1	VPS13D	1	1



FAM90A23P	1	1	UBA52	1	1	ILF3	1	1
TUBA1C	1	1	HIST1H2BA	1	1	NSUN2	1	1
FAM90A15P	1	1	HIST1H2BM	1	1	NCL	5	5
FAM90A22P	1	1	HIST1H2BL	1	1	ALB	5	5
TUBA3E	1	1	HIST1H2BB	1	1	KRT1	7	7
FAM90A13P	1	1	H2BFS	1	1	KRT9	3	3
FAM90A5P	1	1	HIST1H2BD	1	1	TCP1	1	1
FAM90A24P	1	1	HIST1H2BN	1	1	KRT10	5	5
FAM90A7P	1	1	HIST2H2BE	1	1	CCT4	1	1
FAM90A1	1	1	HIST2H2BF	1	1	EEF1A2	2	2
FAM90A12P	1	1	HIST3H2BB	1	1	EEF1A1P5	2	2
FAM90A16P	1	1	HIST1H2BC	1	1	EEF1A1	2	2
FAM90A9P	1	1	HIST1H2BO	1	1	NSUN4	1	1
FAM90A18P	1	1	HIST1H2BJ	1	1	YBX3	1	1
FAM90A8P	1	1	HIST1H2BH	1	1	HNRNPA1	4	4
FAM90A10P	1	1	HIST1H2BK	1	1	YBX2	1	1
HS3ST3A1	1	1	NEDD8	1	1	YBX1	1	1
FOXD4L1	1	1	ILF3	4	4	YWHAE	1	1
NSUN4	1	1	HNRNPU	2	2	CTSG	1	1
ACTA1	4	4	NSUN2	2	2	ELANE	1	1
ACTC1	4	4	KHSRP	1	1	YWHAG	1	1
ACTA2	4	4	ALB	9	6	YWHAH	1	1
ACTG2	4	4	KRT1	10	6	YWHAB	1	1
ACTG1	4	4	KRT2	7	4	C6orf62	1	1
ACTB	4	4	HNRNPL	1	1	PRSS1	1	1
OR56B4	1	1	KRT5	1	1	UBB	1	1
MAPRE3	1	1	KRT9	3	3	SFN	1	1
APOA1	1	1	CCT3	9	9	YWHAQ	1	1
CELA2A	1	1	KRT10	7	7	YWHAZ	1	1
CELA2B	1	1	AMY1A	1	1	ANP32B	1	1
RPS27A	1	1	AK2	1	1	IGF2BP2	16	13

**Supplemental Table 9. Proteins identified in whole eluted proteins by MS may specifically interact with circMYBL2 compared to tRSA-NC.**

Protein	NC Peptide	circMYBL2 Peptide	Protein	NC Peptide	circMYBL2 Peptide	Protein	NC Peptide	circMYBL2 Peptide
CCT8	0	13	PGAM5	0	3	TACC2	0	1
SF3B3	0	13	NAT10	0	2	HLCS	0	1
TOP2B	0	20	RPS9	0	2	KRI1	0	1
CCT3	0	10	RPL7	0	2	RCC2	0	1
CCT7	0	8	RPS3A	0	2	SUSD5	0	1
HIST1H1E	0	6	MATR3	0	1	SPATA1	0	1
RARS	0	7	SON	0	1	CTCF	0	1
PUS7	0	7	SNRPD3	0	1	MUC16	0	1
IARS	0	8	EIF3B	0	2	DDX21	1	14
TCP1	0	8	DDX23	0	2	YBX1	1	9
IGF2BP2	0	8	HP1BP3	0	2	ACLY	2	15
TOP1	0	9	LMNA	0	2	IGF2BP1	1	6
EEF1G	0	6	RPP38	0	2	SND1	3	15
CCT2	0	9	MYBBP1A	0	1	HNRNPL	1	5
CCT6A	0	8	RPN1	0	2	HIST1H1B	1	5
LARS	0	7	WDR4	0	1	EIF2S1	1	5
SRSF3	0	4	FARSB	0	2	HNRNPUL2	1	5
NARS	0	8	EIF3A	0	2	EPRS	3	12
HNRNPDL	0	4	AP2A2	0	1	HNRNPA3	1	4
FUBP1	0	6	AP2A1	0	1	STRBP	2	7
CCT4	0	6	SF3B2	0	2	IQGAP1	3	10
YARS	0	10	CPSF1	0	1	ZFR	4	12
PDCD11	0	10	RTCB	0	2	DDX6	3	9
EFTUD2	0	6	PRKRA	0	1	FAM120A	3	9
CCT5	0	7	SMC1A	0	2	ADAR	1	3
KARS	0	7	SNRPB	0	2	HIST1H2BH	1	3
DKC1	0	4	SNRPN	0	2	HIST1H2BN	1	3
PPIB	0	4	SRSF5	0	1	HIST1H2BC	1	3
KRT16	0	4	SRSF6	0	1	HIST1H2BK	1	3
KRT6B	0	5	SRSF4	0	1	HIST2H2BF	1	3
XRCC6	0	4	HIST1H4A	0	1	HIST1H2BM	1	3
SF3B1	0	4	SRSF7	0	1	HIST1H2BD	1	3
PURA	0	4	TARS	0	1	H2BFS	1	3
LRPPRC	0	3	STAU1	0	1	HIST1H2BL	1	3
CTSG	0	4	HADHA	0	1	MSN	9	26
RPP30	0	3	GRSF1	0	1	DDX5	6	16
DARS	0	5	VASP	0	1	KHS	3	8
EEF1D	0	2	DARS2	0	2	HNRNPA2B1	2	5
LMNB1	0	6	NUDT21	0	2	PABPC4	5	12

XRCC5	0	4	SNRPA	0	1	DHX15	5	12
PRPF19	0	3	SNRPB2	0	1	ILF2	6	14
RPL22	0	2	ACTL6A	0	1	ILF3	11	24
COPB2	0	3	CPSF2	0	1	HNRNPD	5	10
EIF2S3	0	4	DDX39B	0	1	EWSR1	1	2
FUS	0	2	DDX39A	0	1	DCD	1	2
QARS	0	5	COPA	0	1	ERI3	1	2
RBMX	0	4	ASPH	0	1	ME2	1	2
AP2B1	0	3	CSDE1	0	1	DDX17	8	15
HNRNPM	0	2	HAS1	0	1	NSUN2	8	15
PSPC1	0	2	POLR3A	0	1	PABPC1	12	22
SRSF2	0	2	DDX18	0	1	HNRNPA1	4	7
SRSF8	0	2	SRBD1	0	1	NONO	4	7
PES1	0	4	RPL31	0	1	HNRNPU	12	20
PTBP1	0	2	RBM28	0	1	KHDRBS1	3	5
RSL1D1	0	4	RAP1GAP2	0	1	MCCC2	7	11
ACADVL	0	3	EIF2S2	0	1	HNRNPR	11	17
HNRNPUL1	0	2	VAV1	0	1	SYNCRIP	12	18
CCAR2	0	3	RPSA	0	1	PABPN1	6	9
CHI3L1	0	2	ESRP1	0	1	GAPDH	4	6
HNRNPK	0	2	ESRP2	0	1	HSPA8	4	6
HDLBP	0	2	TRPV5	0	1	HNRNPAB	2	3
SRSF1	0	1	NEB	0	1	HNRNPF	2	3
SKIV2L2	0	1	XRN2	0	1	DHX9	27	40
NOP56	0	3	DLST	0	1	NCL	15	22

### Supplemental Table 10. Translation involving proteins

Kinds of Proteins	Name of Proteins
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Ribosomal proteins	RPL22, RSL1D1, RPS9,RPL7, RPS3A, RPL31,RPSA
Eukaryotic translation initiation factors	EIF2S3, EIF3B, EIF2S2,EIF2S1, EIF3A
Eukaryotic translation elongation factors	EEF1G, EEF1D

**Supplemental Table 11. Information of antibodies used in this study.**

Antibody	corporation	Cat.No.	Antibody	corporation	Cat.No.
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anti-MYBL2	Santa Cruz	sc-390198	anti-STAT5	CST	#25656
anti-FLT3	CST	#3462	anti-Phospho-STAT5	CST	#4322
anti-phospho-FLT3	CST	#4577	anti-c-MYC	CST	#5605
anti-PTBP1	Proteintech	12582-1-AP	anti-DHX9	Santa Cruz	sc-137198
anti-IGF2BP2	Santa Cruz	sc-377014	anti-ILF2	Santa Cruz	sc-365283
anti-SYNCRIP	Santa Cruz	sc-271003	anti-hnRNPA1	CST	#8443
anti-Flag	Sigma	F7425	anti-GAPDH	Proteintech	10494-1-AP

## Supplemental materials and methods

### RNA isolation and quantitative real-time PCR (RT-PCR)

Total RNA was extracted using TRIzol reagent (Invitrogen, USA) in accordance with the manufacturer's instructions and was then stored at -80°C. RNA was reverse transcribed into cDNA using the RT reagent Kit RR047A (Takara, Japan) for real-time PCR with a SYBR Premix ExTaq real-time PCR Kit (Takara, Japan). All gene expression levels were normalized to GAPDH. Oligonucleotide sequences are shown in **supplemental Table 5**.

### **Immunoblotting**

Proteins were resolved by 10% or 12% Bis-Tris polyacrylamide gels and transferred to polyvinylidene fluoride membranes. Membranes were blocked in 5% BSA for 1h and probed with the appropriate antibody overnight at 4°C and then incubated with horseradish peroxidase-conjugated secondary antibodies at room temperature for 1h. Membranes were visualized with an enhanced chemoluminescence detection system. Detail information of antibody was mentioned in **supplemental Table 10**.

### **CircRNA overexpression vector construction**

We constructed a universal exon circRNA expression vector containing flanking introns which insure the correct splicing and thus we need to only insert the exon sequences to express circRNA. The introns we used from SUZ12 are a natural pair of introns surrounding the same exon, because its 5' intron has a canonical branch point site to facilitate a correct splicing and the 3' intron is short. We also add a sequence which is the reverse complement repeats of the first 100 bp of 5' intron component into the vector following the 3' intron to promote the interaction between the flanking introns, facilitating circRNA product. All intron sequences were cloned in pCDH-CMV-MCS-EF1-Puro-copGFP vector. Sequences of exon 8-9 of MYBL2 were inserted into the vector and circMYBL2 was highly expressed about 100 fold in 293t.

### **Cell transfection and lentivector expression systems**

Transient transfection of recombinant vectors were performed using the

Lipofectamine 2000/3000 (Invitrogen, USA) system, and transient transfections of siRNAs was performed using the Neon Transfection System with 10 µl reactions according to the manufacturer's guidelines (Invitrogen, USA). For stable expression assays, lentiviral expression vectors, including pGreenPuro™ shRNA and recombinant pCDH-CMV-MCS-EF1-Puro-copGFP eukaryotic expression vector, were packaged into lentiviruses using Lentivector Expression Systems (System Biosciences, Germany) consisting of pPACKH1-GAG, pPACKH1-REV, and pVSV-G. Finally, the lentiviruses were transformed into THP-1, MV4-11 and Molm13 cells, and the transformed cells were then selected with puromycin.

### **Cell proliferation CCK-8 assays and flow cytometric analysis.**

Cell proliferation was measured using Cell Counting Kit-8 (Dojindo Molecular Technologies, China). For the CCK-8 assay, cells transfected with siRNAs were seeded at a density of 20,000 cells per well in 100 µL of complete medium in 96-well plates. Absorbance was measured on a VICTOR™ X5 Multilabel Plate Reader (PerkinElmer, USA) at wavelengths of 480 and 630 nm at 0, 24, 48, 72 and 96 hours. For cell-cycle progression analysis, cells were stained with propidium iodide (Lianke, China) for 30 minutes in the dark and were analyzed by flow cytometry (BD, USA). For apoptosis analysis, cells were stained with Annexin V/FITC and 7AAD for 15 minutes in the dark (Lianke, China) and were then analyzed by flow cytometry (BD, USA). For differentiation analysis, cells were stained with human PE-conjugated anti-CD14 and APC-conjugated anti-CD11b (BD Biosciences) and analyzed by flow cytometry (BD, USA).

### **Colony forming cell (CFC) assay**

A total of 1000 MOLM-13 cells were used per CFC assay and were added to 3 mL of methylcellulose media (R&D, USA). The vial was vigorously vortexed to thoroughly mix cells with the media. Media was allowed to stand until air bubbles disappeared. Next, we added 1.1 mL of the final cell mixture to each 35 mm culture dish. Two sample dishes and an uncovered dish containing 3-4 mL of sterile water were then

placed into a 100 mm culture dish with a cover. Cells were incubated for 8 days at 37°C and 5% CO<sub>2</sub>.

### **Ribosome profiling**

Sh-NC and sh-circMYBL2 MOLM-13 cells were pretreated with cycloheximide (100ug/ml; Sigma, Germany) for 5 minutes and then detergent lysis was performed with flash-freezing in liquid nitrogen. For ribosome profiling, DNase I-treated lysates were treated with RNase I, and ribosome-protected fragments were purified as previously described.<sup>59</sup> For RNA-seq, total RNA was extracted and ribosomal RNA was depleted with RiboMinus Eukaryote Kit (Thermo,USA). Library construction was used QIAseq® miRNA Library Kit. Ribosome profiling and RNA-seq libraries were sequenced with Illumina NextSeq 500 and Illumina Novaseq.

### **TRSA RNA pull-down assay**

TRSA RNA pull-down assays were performed based on previous publications<sup>50,51</sup> with modifications. The linearized form of the circMYBL2 sequence was cloned into the pcDNA3 plasmid with the tRSA tag at its 5' end. RNA products were transcribed in vitro using the TranscriptAid T7 High Yield Transcription Kit (Thermo, USA) and were then purified using the GeneJET RNA Purification Kit (Thermo, USA). The RNA pulldown assay was performed using the Pierce Magnetic RNA-Protein Pull-Down Kit in accordance with the manufacturer's instructions.

### **RNA In Situ Hybridization**

Cy3-labeled oligonucleotide probes were designed and synthesized by RiboBio corporation. Cells were fixed with 3.6% PFA and 10% acetic acid for 15 minutes and then permeabilized with 0.5% Triton X-100 for 5 min on ice. Cells were incubated with Cy3-labeled FISH probes dissolved by 50% formamide in 2xSSC at 37°C overnight. The nuclei were counterstained with DAPI.