miR-543 regulates the epigenetic landscape of myelofibrosis by targeting TET1 and TET2

SUPPLEMENTAL METHODS

miR-543 precursor sequence for expression Plasmid construction

hsa-mir-543 MI0005565:

UACUUAAUGAGAAGUUGCCCGUGUUUUUUUCGCUUUAUUUGUGACGAAACAUUCGCG
GUGCACUUCUUUUUCAGUAUCTACTTAATGAGAAGTTGCCCGTGTTTTTTTCGCTTTATTT
GTGACGAAACATTCGCGGTGCACTTCTTTTTCAGTATC

480 bp sequence surrounding the hairpin:

agcagctccaggacacaatgccacctgtgcagaggggcagacctgttagatgtctcccaggtcttgaggggttgtatgcacggccatatctttg
tcacCGGTTGCCCGGTGCGCATCAGGACCCATGTGCTCTCAGGAAGCCCGCAGGAGTGATAC
CAGCCGCGGAGAAGCAGTGTTGTCAACGGTGCTGACGTGCGGTACTTAATGAGAAGTTGC
CCGTGTTTTTTTCGCTTTATTTGTGACGAAACATTCGCGGTGCACTTCTTTTTCAGTATCCT
ATTCTGCCTTGAAGACGTCTTGGTTTGGGTGCAACTTCAGGGAAGGCACATGGGCCCCTGT
AGTGGACGCTGATCAGGACCTCCCTACCCCATGTCTTttctccttcctaaatttctccttgttttttttttttttttttttttttttat
gaaagctcccgtcttcccgccgtgtgctttgattgcattgaccctgcccc

Primers (product size: 436 bp):

miR543 1F ggacacaatgccacctgtg

miR543 1R gggaagacgggagctttcat

Restriction enzymes: EcoRI and NotI

Luciferase assay

The identified STAT3 binding site on promoter region of the miR-543 gene was cloned in the pGL3 luciferase reporter vector (Promega) with the following primers;

Binding site-FW- GCATCCTCCTACGCAAGTCT

Binding site-RV- CAACCCAGTGTCCCACAAC

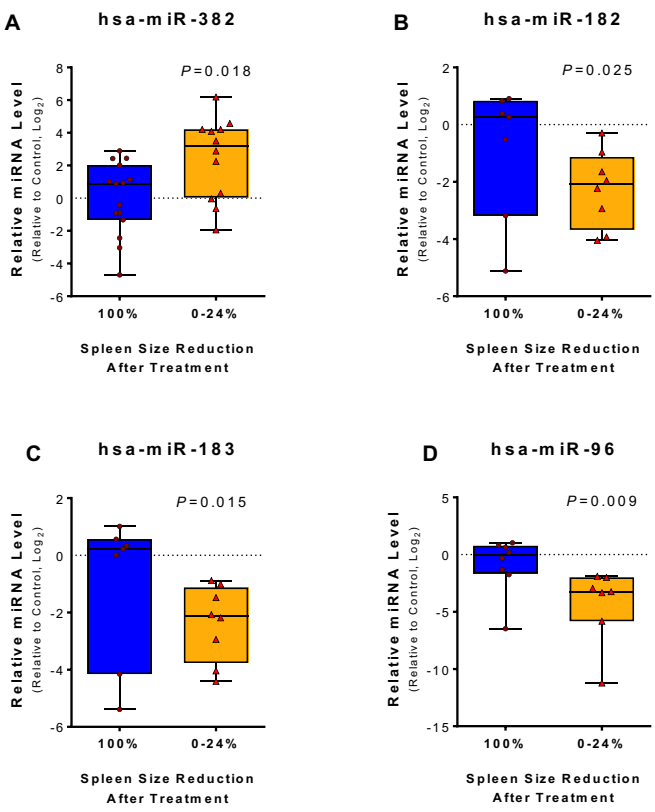
HEK-293 cells were plated ($1x10^5$ cells/well) in 24 well plate before 24 hours transfection. Subconfluent cells were transfected with pGL3 luciferase reporter vectors containing the potential

binding sites for STAT3 (400ug/well), control vector (400ug/well) and 8 ng of the pRLTK reporter (Renilla luciferase for internal control) together with 50 nmol/L miR-543 mimic or control miRNA using lipofectamine 2000 (Life technologies). Cells were harvested 36 hours post-transfection and luciferase activity was measured by the Dual-Luciferase® Reporter 1000 Assay System according to the manufacturer's instructions (Promega). All experiments were performed in triplicate.

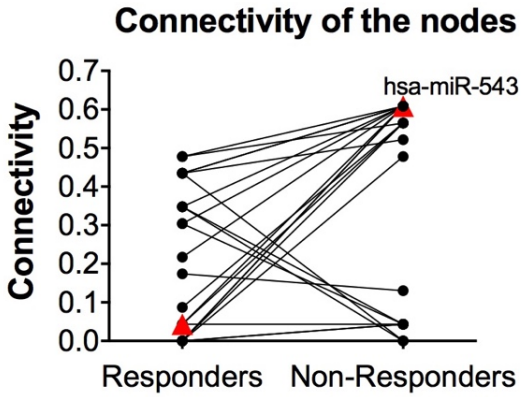
Green fluorescence protein (GFP)-lentiviral-STAT3-shRNA generation and infection

HEK 293FT cells were transfected with seven micrograms of GFP-lentivirus STAT3-shRNA or with GFP-lentivirus empty vector using Lenti-X™ Packaging Single Shots according to the manufacturer's procedures (Takara Bio USA, Inc). HEK 293FT cell culture medium containing viral particles was collected at 48 hours after transfection and filtered with 0.45 μm syringe filter to remove floating cells (Cat#723-2545, Thermo Fisher Scientific, Waltham, MA, USA). K562 cells incubated in six-well plates in with lentiviral supernatant and GFP positive cells were sorted by flow cytometer. Knockdown efficiency of STAT3 determined by Western blot in K562 cells.

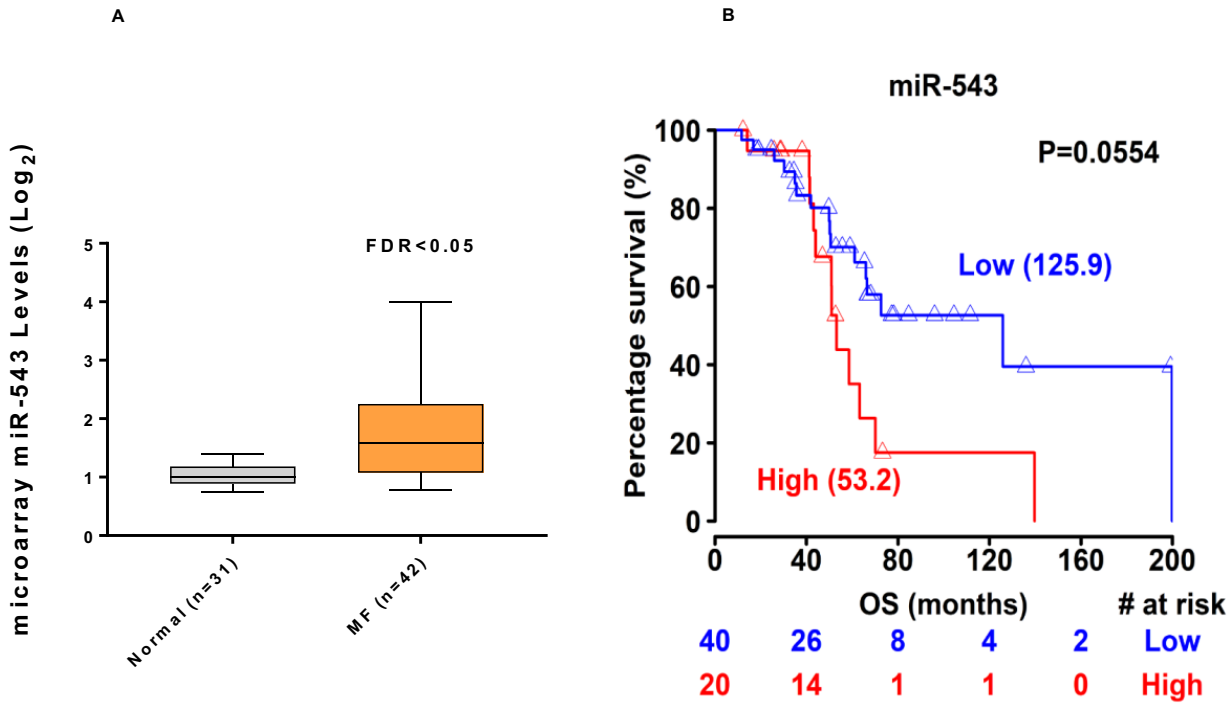
SUPPLEMENTAL FIGURES



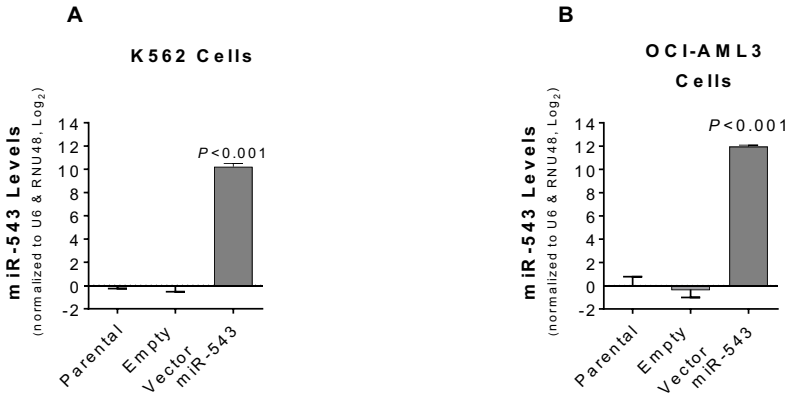
Supplemental Figure 1. MiRNAs expression validation in BM of MF patients differs according to responsiveness to treatment. (A-D) Differential expression of **(A)** miR-382, **(B)** miR-182, **(C)** miR-183, and **(D)** miR-96 according to responsiveness to treatment was further validate by RT-qPCR in the same cohort of patients in **Figure 1**. MiRNA expression levels were normalized by the ΔCt method using small nuclear RNA U6 and the small nucleolar RNA U48 as reference genes.



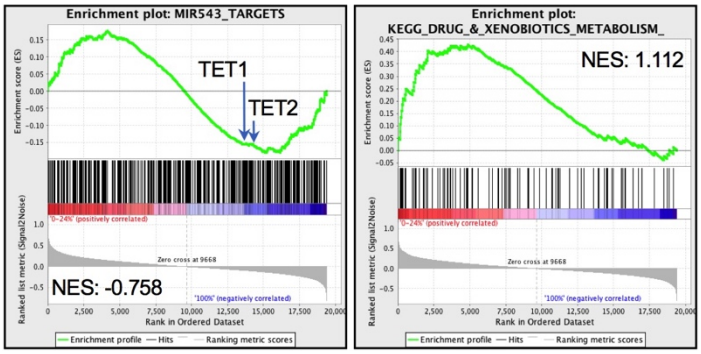
Supplemental Figure 2. Connectivity of the nodes. The connectivity of the nodes of the responders' miRNAs network is significantly lower compared to the node connectivity of the non-responders miRNAs network (*P*=0.0137). Red solid triangles represent hsa-miR-543 in each connectivity of nodes.



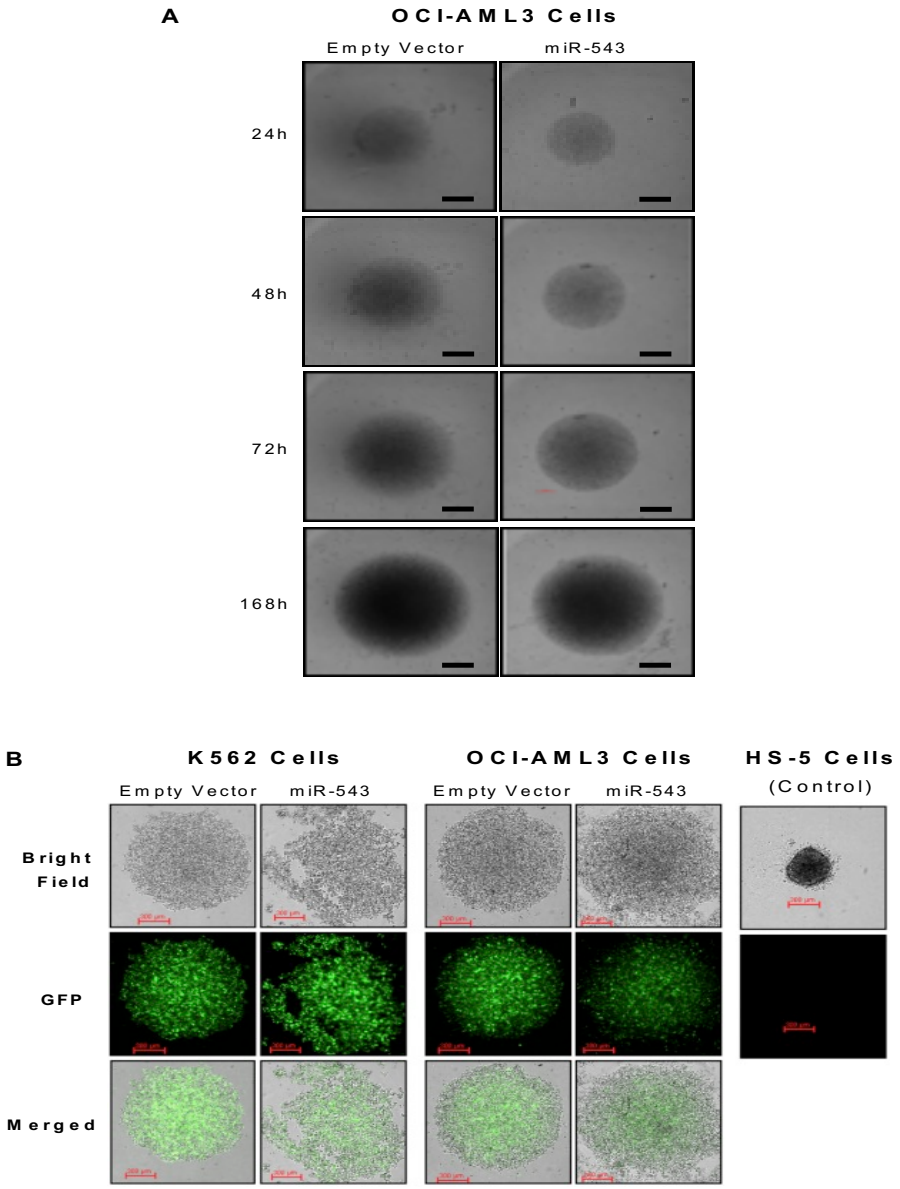
Supplemental Figure 3. The correlation between miR-543 levels and the overall survival of MF patients. (A) Differential expression (FDR<0.05) of miR-543 in primary MF patients (n=42) and healthy donors (peripheral blood n=16 and bone marrow=15). Data generated from the publicly available datasets (microarray GSE53482). **(B)** Kaplan Maier plots displaying association of miR-543 expression with overall survival in a cohort of 60 patients with MF from MD Anderson Cancer Center. For overall survival, time was calculated from diagnosis to death due to any cause or last contact. In order to visualize the survival difference we used the log-rank test to find the point (cut-off) with the most significant (lowest p-value) split in high vs low mRNA level groups. The Kaplan-Meier plots were generated for these cutoffs (0.67). The numbers of patients at risk in low and high miRNA groups at different time points are presented at the bottom of the graph. In brackets, we present median survival months in each group.



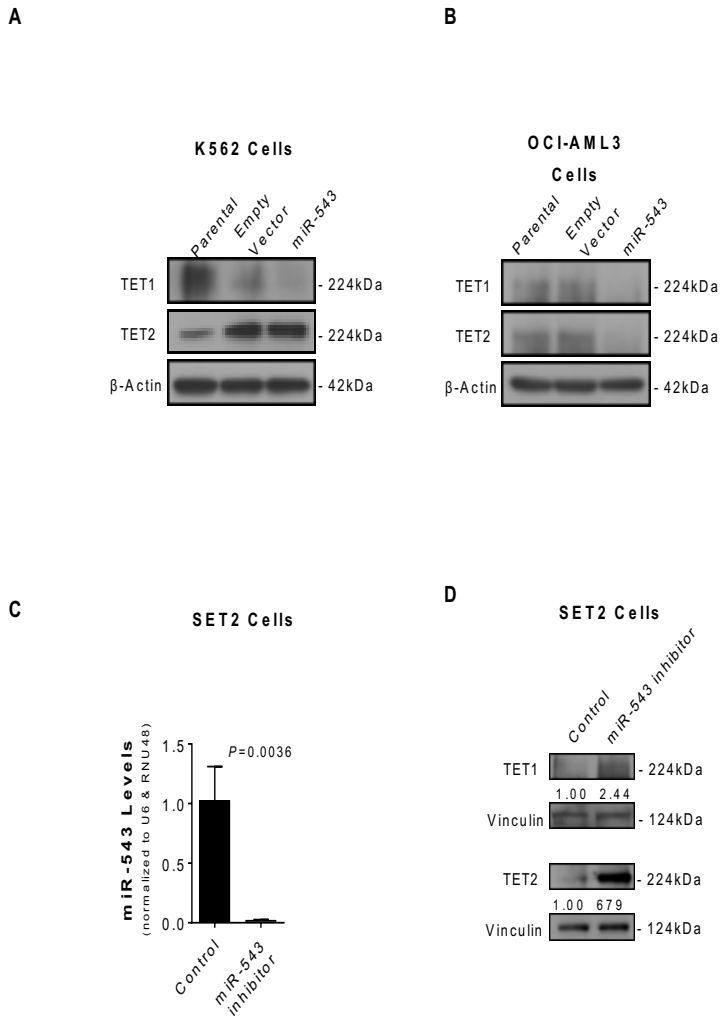
Supplemental Figure 4. RT-qPCR analysis of miR-543 levels in in K562 and OCI-AML3 cells. (A-B) Expression of miR-543 measured by qRT-PCR in K562 parental cells and stable transfected with empty vector (control) or p-miR-543 expression vector. U6 and RNU48 levels were used as normalizers.



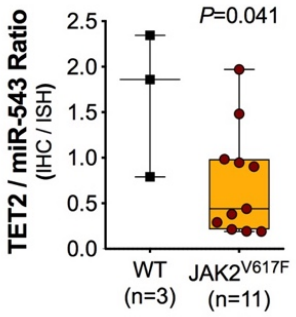
Supplemental Figure 5. miR-543 promotes drug metabolism related gene enrichment in MF patients with no significant response to ruxolitinib treatment. Gene enrichment analysis in MF patients not responding to ruxolitinib treatment (0-24% reduction in splenomegaly) compared to MF patients responding to ruxolitinib treatment (100% elimination of palpable splenomegaly).



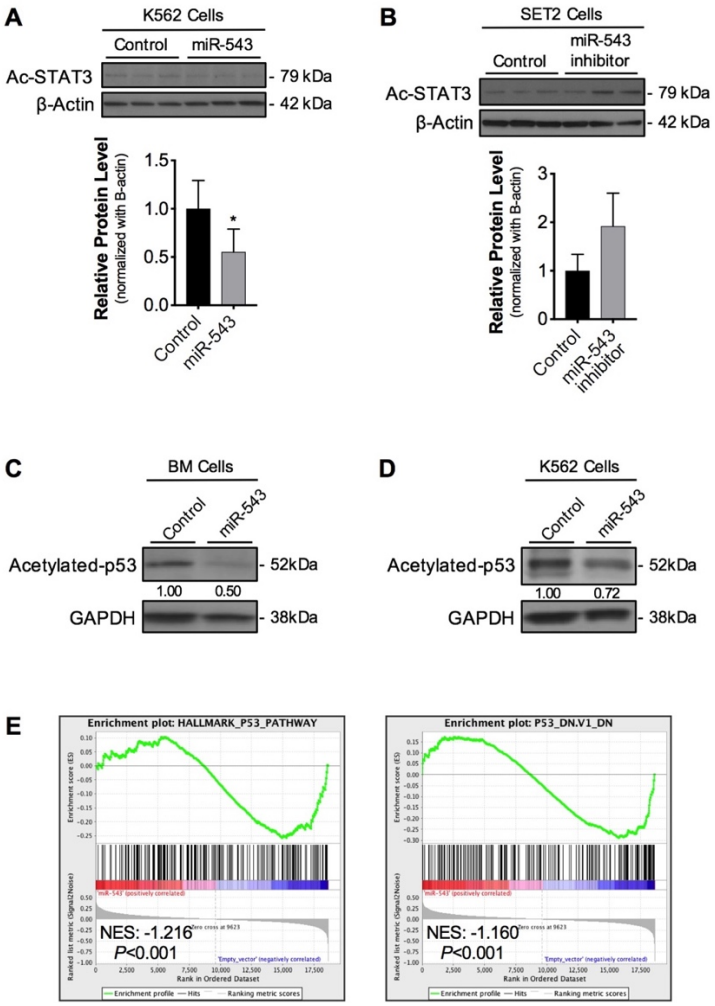
Supplemental Figure 6. Effect of miR-543 in 3D multicellular tumor spheroids (MCTS) formation. (A) The effect of miR-543 in 3D multicellular tumor spheroids (MCTS) formation and growth were monitored at different time points for a period of 7 days (24, 48, 72, and 168 h) in OCI-AML3 cells overexpressing miR-543 compared to those cells stably transduced with empty vector. Scale bars represent 300µm. **(B)** Representative 3D multicellular tumor spheroids of K562 and OCI-AML3 cells stable transfected with empty vector (control) or p-miR-543 expression vector that co-express Green Fluorescence Protein GFP.



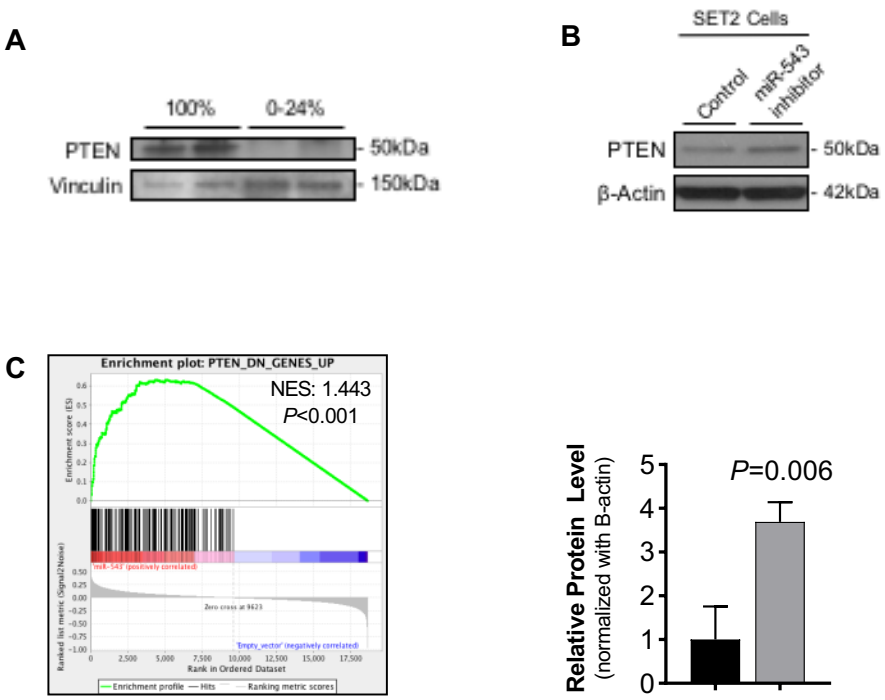
Supplemental Figure 7. (A-B) Representative Western blot analysis of TET1 and TET2 protein in K562 parental and OCI-AML3 cells and stably transduced with empty vector (control) or p-miR-543 expression vector. β-Actin protein levels were used as normalizer. (**C**) Relative expression level of miR-543 after transfection with scramble miRNA inhibitor (control) or miR-543 inhibitor. Relative expression of miR-543 measured by RT-qPCR and normalized to U6 and RNU48 levels (*n*=3; lower panel). **(D)** Representative Western blot analysis of TET1 and TET2 proteins in SET-2 cells transiently transfected with scramble miRNA inhibitor (control) or miR-543 inhibitor. Vinculin protein levels were used as a normalizer.



Supplemental Figure 8. High miR-543 levels correlate with low TET2 protein in MF *in vivo* model. Ratio of the differential TET2 protein levels measured by immunohistochemistry (IHC) and expression of miR-543 measured by *In Situ* Hybridization (ISH) in wildtype mice and in JAK2^{V617F} transgenic mice.



Supplemental Figure 9. miR-543 induces the decrease of protein acetylation. (A) Representative Western blot analysis of acetylated-STAT3 protein in K562 cells stably transduced with empty vector (control) or p-miR-543 expression vector. β-Actin protein levels were used as normalizer. **(B)** Representative Western blot analysis of acetylated-STAT3 protein in SET-2 cells transiently transfected with scramble miRNA inhibitor (control) or miR-543 inhibitor. β-Actin protein levels were used as normalizer. **(C)** Representative Western blot analysis of acetylated-TP53 protein in K562 cells stable transfected with empty vector (control) or p-miR-543 expression vector. GAPDH protein levels were used as normalizer. **(D)** Representative Western blot analysis of acetylated-TP53 protein in K562 cells stable transfected with empty vector (control) or p-miR-543 expression vector. GAPDH protein levels were used as normalizer. **(E)** Gene enrichment analysis of p53 pathway-related genes (left panel) and genes downregulated when p53 is downregulated (right panel) in K562 cell overexpressing miR-543.



Supplemental Figure 10. Inhibition of miR-543 induces the increase of PTEN protein levels. (A) Representative Western blot analysis of PTEN protein in in non-responder patients compared to responder patients. Vinculin protein levels were used as normalizer. **(B)** Representative Western blot analysis of PTEN protein in SET cells stable transfected with scramble miRNA inhibitor (control) or miR-543 inhibitor. β-Actin protein levels were used as normalizer. **(C)** Gene enrichment analysis of genes upregulated when PTEN is down in K562 cells overexpressing miR-543.

Supplemental Table 1. Demographic data of control patient cohorts.

	Control Cohort 2 (n=9)	**Control Cohort 3** (n=7)
Sex (M/F)	4/5	2/5
Age (mean±SD)	39.3±6.9	38.4±11.8

Supplemental Table 2. Demographic data of MF patient cohort 3.

Characteristic	No. (%)
Patient number	16 patients
Median age (range), y	59.46 (38-78)
Sex:	
Female	7 (43.75)
Male	9 (56.25)
Cytogenetics:	
Abnormal	4 (25)
Diploid (normal)	12 (75)
Overall Response:	
Clinical Improvement	12 (75)
No Response	3 (18.75)
Progressive Disease	1 (6.25)
Median *Jak2*^{V617F} allele burden (range)	45.8 (0, 92.6)
Median WBC level (range)	13.1 (3.4, 60.9)
Median Hemoglobin level (range)	9.9 (7.5, 16.8)
Median Platelets level (range)	284 (105, 760)
Median PB BL level (range)	0.5 (0, 1.9)
Median Neutrophil level (range)	68.1 (11, 82.5)
Median Monocyte level (range)	5.1 (0, 28)
Median Albumin level (range)	4.41 (3.2, 8.5)
Median time overall survival (range in months)	63.1 (9.1-126.8)

WBC – white blood cells; PB BL – Peripheral Blood Blasts

Supplemental Table 3. Pathway analyses of the miR-543 predicted targets by at least 6 different algorithms (out of 9 used)*.

Data base	Pathways	Count	P-value	List Total	Fold Enrichment	FDR
REACTOME	Axon guidance	17	8.72E-05	402	2.932	0.089
KEGG	TGF-beta signaling pathway	25	1.52E-04	651	2.244	0.187
KEGG	Adherens junction	20	0.003	651	2.028	3.697
REACTOME	Signaling by BMP	9	0.003	402	3.307	3.498
KEGG	Axon guidance	28	0.006	651	1.695	6.978

* - Due to the large number of predicted targets, stringent selection criteria were used - only P values lower than 0.01 and FDR lower than 10% were considered.

Supplemental Table 4. Gene Set Enrichment Analysis detailed results for miR-543 target gene set presented in Figure 2A.

NAME	GENE SYMBOL	RANK IN GENE LIST	RANK METRIC SCORE	RUNNING ES	CORE ENRICHMENT
row_0	MMP7	4271	0.066273928	-0.23096986	No
row_1	ITGB8	4302	0.065573774	-0.22966404	No
row_2	C5AR1	4305	0.06554798	-0.22682562	No
row_3	RRAGA	4307	0.065529495	-0.22393326	No
row_4	TMEM181	4406	0.063625053	-0.22643988	No
row_5	ZNF598	4438	0.062845655	-0.22531152	No
row_6	OSBPL2	4510	0.061839003	-0.2264195	No
row_7	TRPS1	4564	0.060790289	-0.22658865	No
row_8	KBTBD11	4606	0.060034316	-0.2261345	No
row_9	ZNF544	4670	0.058719922	-0.22694454	No
row_10	SLC24A4	4763	0.057334814	-0.22940539	No
row_11	FBXL5	4776	0.057070922	-0.22749598	No
row_12	SPATA5	4908	0.055115595	-0.23219293	No
row_13	IYD	4919	0.054894786	-0.23027185	No
row_14	ANKRD50	4947	0.054515552	-0.22929902	No
row_15	CRHBP	4967	0.054298699	-0.22789773	No
row_16	ZNF594	5009	0.053533267	-0.22773595	No
row_17	LIN54	5012	0.053446274	-0.2254418	No
row_18	SLC10A7	5015	0.053409971	-0.22314928	No
row_19	VGLL3	5030	0.053216051	-0.22152281	No
row_20	RNF7	5034	0.053091783	-0.21929938	No
row_21	RAP2A	5091	0.052280392	-0.2200156	No
row_22	COL1A2	5118	0.051794253	-0.21911038	No
row_23	PRRC1	5185	0.050739329	-0.22044367	No
row_24	MTHFD1L	5231	0.050025698	-0.22065875	No
row_25	FBXW2	5247	0.049740724	-0.21924335	No
row_26	STK17B	5297	0.048989616	-0.21972413	No
row_27	SLC35F1	5311	0.048732955	-0.21824451	No
row_28	PAG1	5354	0.048011038	-0.21838586	No
row_29	ELOVL2	5363	0.047854193	-0.21667187	No
row_30	ABHD12B	5365	0.047821485	-0.21457592	No
row_31	TRIM61	5383	0.047579598	-0.21336725	No
row_32	CYR61	5401	0.047219306	-0.2121748	No
row_33	HSPB3	5406	0.047147583	-0.21027349	No
row_34	B4GALT6	5459	0.046521887	-0.21102959	No
row_35	RSBN1	5494	0.046064302	-0.21082029	No

row_36	YOD1	5631	0.04417108	-0.21628332	No
row_37	PSG9	5635	0.044161018	-0.21446155	No
row_38	DPY19L4	5687	0.04352488	-0.21529765	No
row_39	VTI1A	5693	0.043478191	-0.21361615	No
row_40	BTRC	5709	0.043272972	-0.21249163	No
row_41	IL1A	5784	0.042419862	-0.2146373	No
row_42	ZNF264	5958	0.039908763	-0.22231877	No
row_43	MFAP3L	5998	0.039370041	-0.22268441	No
row_44	VIP	6005	0.039180193	-0.22125097	No
row_45	FRMD7	6105	0.037895694	-0.22496952	No
row_46	TEX2	6201	0.036552623	-0.22852936	No
row_47	ATM	6249	0.035874404	-0.22949044	No
row_48	SCD5	6260	0.03571425	-0.22843198	No
row_49	KL	6303	0.035087686	-0.22915456	No
row_50	PDXDC1	6398	0.033901576	-0.23277885	No
row_51	ARFGEF2	6415	0.033718772	-0.2321388	No
row_52	GBF1	6427	0.033527032	-0.23123349	No
row_53	ZRANB2	6473	0.032958012	-0.23221618	No
row_54	ADAT2	6530	0.032239981	-0.2338337	No
row_55	FAM24A	6551	0.031972423	-0.23349129	No
row_56	SNAPC3	6595	0.031468008	-0.23443143	No
row_57	SNX1	6598	0.031435844	-0.23312719	No
row_58	TMF1	6678	0.030599872	-0.23607832	No
row_59	PRPF4B	6700	0.030319352	-0.23586504	No
row_60	GALNT3	6705	0.030303001	-0.2347213	No
row_61	CCL22	6745	0.029802868	-0.23551722	No
row_62	KRAS	6803	0.029249003	-0.23732403	No
row_63	GOLGA3	6964	0.027409751	-0.24485554	No
row_64	TNKS	6981	0.027265074	-0.24450575	No
row_65	PCBP1	7036	0.026737928	-0.24626116	No
row_66	MTF2	7075	0.026305098	-0.24715962	No
row_67	CCDC126	7085	0.026138796	-0.24647704	No
row_68	PAK7	7110	0.025799831	-0.24663134	No
row_69	SMAD2	7200	0.024748757	-0.2503934	No
row_70	ZNF654	7214	0.024630563	-0.24999775	No
row_71	ZBTB33	7236	0.024382859	-0.25005147	No
row_72	KIAA1024	7259	0.024121355	-0.2501717	No
row_73	SHQ1	7279	0.023913886	-0.25013694	No
row_74	VBP1	7369	0.022863721	-0.2539838	No
row_75	NMT2	7407	0.022457546	-0.2550005	No

row_76	HIGD2A	7453	0.021956146	-0.25647798	No
row_77	MED9	7472	0.021764038	-0.25648513	No
row_78	DNAL1	7476	0.021722473	-0.2556725	No
row_79	ATP2B1	7510	0.021262616	-0.25652388	No
row_80	ACYP1	7519	0.021178216	-0.2560096	No
row_81	RPAP2	7547	0.020966318	-0.25654563	No
row_82	METAP1	7619	0.020179022	-0.25952724	No
row_83	ANKFY1	7625	0.020105876	-0.2588969	No
row_84	GK5	7637	0.020007299	-0.2585996	No
row_85	CGGBP1	7675	0.019552635	-0.25974697	No
row_86	MRPS23	7913	0.016852103	-0.2719711	No
row_87	IFT80	7917	0.016829016	-0.27137855	No
row_88	BAZ2B	7942	0.016490156	-0.27195156	No
row_89	RBM47	7975	0.016121589	-0.27297935	No
row_90	TXLNA	8012	0.015723297	-0.27424416	No
row_91	ANKRD13C	8015	0.015706833	-0.2736473	No
row_92	UBA6	8046	0.015413055	-0.27459744	No
row_93	PCYOX1	8229	0.01355424	-0.28395715	No
row_94	ZDHHC17	8318	0.012464057	-0.28821692	No
row_95	ZFAND5	8461	0.01112519	-0.29549485	No
row_96	ZFX	8500	0.010768116	-0.29709208	No
row_97	NFAT5	8504	0.010749063	-0.29677296	No
row_98	PDIA6	8522	0.010623191	-0.2972264	No
row_99	HPS5	8587	0.010045631	-0.3002803	No
row_100	LRRK2	8665	0.009208149	-0.30408397	No
row_101	TAF5	8670	0.00916417	-0.3038909	No
row_102	FAM46C	8702	0.008796202	-0.3051934	No
row_103	LAMA3	8737	0.008481756	-0.30667433	No
row_104	HECA	8762	0.008234319	-0.30761865	No
row_105	RIT1	8793	0.007859119	-0.30890846	No
row_106	ACTL6A	8853	0.007485058	-0.31180364	No
row_107	CRH	8883	0.007221948	-0.31306738	No
row_108	THUMPD1	8899	0.007064102	-0.3135713	No
row_109	SOCS4	8953	0.006543251	-0.3161802	No
row_110	DYNC1LI2	9006	0.006020536	-0.3187578	No
row_111	PPP1CB	9033	0.005629041	-0.31992882	No
row_112	PRKAR2B	9112	0.004827473	-0.3239843	No
row_113	RBM38	9161	0.004360496	-0.32641745	No
row_114	EEF1A1	9221	0.003786441	-0.32947898	No
row_115	NPTN	9246	0.003537315	-0.3306345	No

row_116	SP3	9247	0.003532705	-0.33047563	No
row_117	IQGAP1	9281	0.003115994	-0.33214313	No
row_118	FIGNL1	9330	0.002731805	-0.33464953	No
row_119	FOXJ2	9365	0.002431904	-0.33640257	No
row_120	FBXO11	9380	0.002334684	-0.33706445	No
row_121	SLC2A3	9391	0.002255244	-0.33751076	No
row_122	YTHDC1	9393	0.002239789	-0.3374648	No
row_123	NOL4	9410	0.002099956	-0.3382468	No
row_124	ST6GALNAC5	9417	0.002058557	-0.3384829	No
row_125	UTY	9442	0.001799164	-0.33971658	No
row_126	HMGB2	9454	0.001710556	-0.3402422	No
row_127	AGL	9456	0.001695529	-0.34022072	No
row_128	PDIK1L	9473	0.001587766	-0.34102574	No
row_129	WHSC1	9488	0.001505605	-0.3417249	No
row_130	SPTLC1	9555	7.70E-04	-0.34530553	No
row_131	ERLIN1	9596	8.23E-08	-0.34749657	No
row_132	STXBP4	9621	4.85E-08	-0.3488112	No
row_133	HERPUD1	9696	-6.89E-08	-0.35286468	No
row_134	ENOX2	9743	-8.57E-04	-0.35534585	No
row_135	KIF3A	9774	-0.00117955	-0.3569361	No
row_136	RBBP7	9782	-0.001302792	-0.35726094	No
row_137	TRAPPC6B	9802	-0.001517413	-0.35823345	No
row_138	PCDH11Y	9915	-0.002506263	-0.3642557	No
row_139	PRDX3	9918	-0.002550428	-0.36425054	No
row_140	MAPK1	9955	-0.002822583	-0.36609557	No
row_141	BIRC6	9977	-0.003033058	-0.36710945	No
row_142	ZCCHC14	9985	-0.003184009	-0.3673497	No
row_143	ARHGAP18	9990	-0.003228673	-0.3674236	No
row_144	ARL5A	10014	-0.003450735	-0.36852828	No
row_145	DTX4	10120	-0.004528927	-0.37407613	No
row_146	ID4	10143	-0.004721468	-0.37506884	No
row_147	KLHL24	10171	-0.004973589	-0.37632415	No
row_148	ACBD3	10244	-0.005521351	-0.38001972	No
row_149	MEGF9	10247	-0.005546306	-0.37987983	No
row_150	TRAK2	10262	-0.005688304	-0.38039088	No
row_151	HNRNPC	10267	-0.005714317	-0.380353	No
row_152	MTCH2	10269	-0.005746458	-0.38014933	No
row_153	HBS1L	10304	-0.006037783	-0.38174018	No
row_154	ITLN1	10344	-0.00641294	-0.38358805	No
row_155	NR3C1	10355	-0.00649772	-0.3838436	No

row_156	GREM1	10412	-0.007092192	-0.3865921	No
row_157	SNX30	10452	-0.007442649	-0.38839367	No
row_158	MRPS9	10467	-0.007591891	-0.3888191	No
row_159	FUT9	10479	-0.007664786	-0.38907692	No
row_160	MRPL19	10495	-0.007818601	-0.38954693	No
row_161	SPG21	10528	-0.008153822	-0.39093307	No
row_162	NOLC1	10607	-0.009019763	-0.39479998	No
row_163	CLEC12A	10701	-0.009908782	-0.39944854	No
row_164	DDO	10723	-0.010166725	-0.40014163	No
row_165	PLD1	10735	-0.010260876	-0.40028268	No
row_166	CUL4B	10794	-0.010857075	-0.40297145	No
row_167	MEIS2	10848	-0.011353017	-0.405364	No
row_168	TIAL1	10880	-0.011775685	-0.40653247	No
row_169	PCSK1	10940	-0.012394693	-0.40920684	No
row_170	TCERG1	10944	-0.012428584	-0.4088122	No
row_171	TFRC	10978	-0.012801934	-0.41004407	No
row_172	NRCAM	10987	-0.012872455	-0.40990335	No
row_173	FBXO5	10991	-0.012900294	-0.40948752	No
row_174	CPSF6	11029	-0.013283332	-0.41091684	No
row_175	RBM8A	11036	-0.013382137	-0.41064364	No
row_176	SMC4	11042	-0.013477089	-0.4103114	No
row_177	KIN	11096	-0.014073988	-0.4125816	No
row_178	GDAP2	11110	-0.014159514	-0.41265687	No
row_179	PMPCB	11128	-0.014384021	-0.41294116	No
row_180	NKIRAS1	11129	-0.014386981	-0.41229412	No
row_181	ATG5	11193	-0.014995027	-0.41507065	No
row_182	GDA	11233	-0.015420094	-0.41651344	No
row_183	PAPD5	11245	-0.015485523	-0.41641954	No
row_184	ADAM9	11370	-0.017003721	-0.4224471	No
row_185	TIFA	11435	-0.017689914	-0.4251572	No
row_186	TBC1D1	11477	-0.018091397	-0.42658937	No
row_187	FNBP1	11478	-0.018102806	-0.42577523	No
row_188	ATP6V1A	11480	-0.01811	-0.4250155	No
row_189	TRIM9	11514	-0.01848427	-0.42599183	No
row_190	LCP1	11529	-0.018609017	-0.42592177	No
row_191	NOS3	11665	-0.020080302	-0.43241352	No
row_192	RUFY2	11696	-0.020333817	-0.4331423	No
row_193	CD2AP	11713	-0.020501247	-0.4330967	No
row_194	METTL9	11758	-0.020904534	-0.4345667	No
row_195	ZNF518B	11809	-0.021622555	-0.43633306	No

row_196	TGFBI	11816	-0.021668388	-0.4356872	No
row_197	AKAP11	11852	-0.022100287	-0.43661046	No
row_198	CEBPG	11885	-0.02244037	-0.43735406	No
row_199	CMPK1	11912	-0.022700764	-0.4377573	No
row_200	ZDHHC3	11919	-0.022779083	-0.4370615	No
row_201	SLC25A40	11941	-0.022995161	-0.4371776	No
row_202	PHC3	11969	-0.023453511	-0.43760177	No
row_203	MAPRE1	12000	-0.023792507	-0.43817502	No
row_204	GNA12	12017	-0.023969319	-0.43797344	No
row_205	SEL1L	12028	-0.024084069	-0.43743804	No
row_206	PTEN	12032	-0.024189996	-0.43651444	No
row_207	IREB2	12071	-0.024509884	-0.43749365	No
row_208	GHITM	12122	-0.025147101	-0.4391015	No
row_209	TET2	12144	-0.025401244	-0.4391094	No
row_210	AMFR	12169	-0.025633233	-0.4392712	No
row_211	CREBL2	12172	-0.025693828	-0.4382252	No
row_212	AHCTF1	12189	-0.025837913	-0.43793958	No
row_213	NUFIP1	12244	-0.026478404	-0.43970668	No
row_214	EN2	12288	-0.026973981	-0.44084895	No
row_215	FAM117A	12290	-0.026982125	-0.4396902	No
row_216	SMAD5	12291	-0.026999172	-0.43847594	No
row_217	DDX3X	12339	-0.027410135	-0.4398177	No
row_218	BRD1	12354	-0.027502749	-0.43934765	No
row_219	SYNE1	12363	-0.027573504	-0.43854576	No
row_220	SKAP2	12376	-0.027733084	-0.4379558	No
row_221	PIP4K2C	12409	-0.028237261	-0.4384387	No
row_222	CUL3	12435	-0.028514441	-0.4385257	No
row_223	RRP15	12454	-0.028674854	-0.43822205	No
row_224	EEA1	12531	-0.029626979	-0.44105262	No
row_225	FNDC3B	12593	-0.030224027	-0.44303468	No
row_226	ZNF398	12603	-0.030345442	-0.44216293	No
row_227	RPS6KA5	12627	-0.030553861	-0.44204864	No
row_228	JAZF1	12699	-0.031553425	-0.4445187	No
row_229	FAM104B	12780	-0.032702919	-0.44743	No
row_230	ONECUT2	12805	-0.033112552	-0.44725543	No
row_231	SDAD1	12813	-0.033155415	-0.44614774	No
row_232	FZD4	12831	-0.033349182	-0.44557908	No
row_233	CAPRIN1	12858	-0.033726782	-0.44548646	No
row_234	RHOQ	12883	-0.034002088	-0.44527188	No
row_235	MAL2	12927	-0.034662116	-0.44606835	No

row_236	FAM102B	12996	-0.035470702	-0.4481979	No
row_237	HEY2	13029	-0.035853863	-0.44833824	No
row_238	OSBPL8	13098	-0.036910124	-0.45040303	No
row_239	LAMP2	13134	-0.037252188	-0.45064482	Yes
row_240	CYB5R4	13137	-0.037282582	-0.44907764	Yes
row_241	DYNLRB1	13161	-0.037867717	-0.44863442	Yes
row_242	VTA1	13219	-0.038718287	-0.45001537	Yes
row_243	OSBPL3	13249	-0.039037127	-0.4498482	Yes
row_244	ACVR2B	13260	-0.039232694	-0.44863153	Yes
row_245	ARL5B	13291	-0.03968839	-0.44848987	Yes
row_246	RNF6	13313	-0.040023714	-0.44784015	Yes
row_247	DLX1	13320	-0.040135171	-0.44636375	Yes
row_248	CHML	13383	-0.040983643	-0.4479167	Yes
row_249	METTL10	13425	-0.041537806	-0.4482944	Yes
row_250	TNPO1	13437	-0.041705292	-0.44702128	Yes
row_251	DDX46	13447	-0.041798852	-0.4456344	Yes
row_252	SIAE	13516	-0.042798664	-0.44743437	Yes
row_253	TMOD3	13537	-0.043019697	-0.44659513	Yes
row_254	TMEM135	13558	-0.043342579	-0.44574136	Yes
row_255	ATXN3	13570	-0.043478318	-0.44438848	Yes
row_256	CTNNA1	13581	-0.043610137	-0.44297493	Yes
row_257	UBE2W	13585	-0.043671798	-0.44117516	Yes
row_258	RNF125	13598	-0.043811634	-0.43986207	Yes
row_259	GRAMD4	13691	-0.045072146	-0.44287443	Yes
row_260	ATXN1	13723	-0.045422822	-0.44252965	Yes
row_261	CREBBP	13757	-0.045884807	-0.44227365	Yes
row_262	RNF2	13762	-0.045955911	-0.44042593	Yes
row_263	MTA1	13784	-0.046296291	-0.4394941	Yes
row_264	COX11	13857	-0.047498371	-0.4413018	Yes
row_265	FAM102A	13948	-0.048770148	-0.4440383	Yes
row_266	SRFBP1	13963	-0.049067747	-0.44259837	Yes
row_267	NAPB	13976	-0.049309663	-0.44103804	Yes
row_268	EVI5	13983	-0.049375881	-0.43914604	Yes
row_269	PJA2	13993	-0.049518764	-0.43741196	Yes
row_270	PBX3	13997	-0.049577583	-0.4353466	Yes
row_271	NFXL1	14113	-0.051470656	-0.43933105	Yes
row_272	RTF1	14138	-0.051903095	-0.43831137	Yes
row_273	RAB3IP	14152	-0.052137595	-0.43667862	Yes
row_274	POLR3G	14201	-0.052850429	-0.43693098	Yes
row_275	CYP26B1	14210	-0.053055156	-0.4349831	Yes

row_276	MTL5	14242	-0.053603355	-0.4342704	Yes
row_277	ARRDC4	14252	-0.05382866	-0.4323425	Yes
row_278	CCDC88C	14267	-0.054176074	-0.43067282	Yes
row_279	HK2	14281	-0.054359861	-0.42894015	Yes
row_280	RABGEF1	14285	-0.054389462	-0.42665833	Yes
row_281	ZNF644	14340	-0.055142071	-0.4271363	Yes
row_282	ZZZ3	14374	-0.055852324	-0.426432	Yes
row_283	FBXO34	14386	-0.056044877	-0.424514	Yes
row_284	SLAIN2	14392	-0.056153014	-0.42226243	Yes
row_285	LMO3	14457	-0.057289649	-0.42319158	Yes
row_286	TMEM133	14547	-0.058902789	-0.42541757	Yes
row_287	SMC6	14587	-0.059812032	-0.42486387	Yes
row_288	WASL	14597	-0.060060076	-0.4226557	Yes
row_289	TNFSF11	14627	-0.060553677	-0.42152086	Yes
row_290	MAP1B	14642	-0.060734294	-0.41955626	Yes
row_291	PCGF3	14697	-0.061855692	-0.4197323	Yes
row_292	NAP1L2	14716	-0.062240668	-0.41791904	Yes
row_293	MTX2	14730	-0.062407143	-0.4158244	Yes
row_294	CHCHD7	14760	-0.062999032	-0.41457963	Yes
row_295	PRTG	14789	-0.063542478	-0.4132556	Yes
row_296	CHN1	14852	-0.06464728	-0.41374427	Yes
row_297	FMNL2	14887	-0.065255709	-0.41267186	Yes
row_298	NCK2	14888	-0.06526953	-0.4097364	Yes
row_299	ATP11B	14902	-0.065470897	-0.407504	Yes
row_300	GOPC	14931	-0.065947324	-0.4060718	Yes
row_301	EEF1E1	14954	-0.066270262	-0.40429646	Yes
row_302	LARP4	15010	-0.067343049	-0.40428045	Yes
row_303	CER1	15046	-0.068172902	-0.4031316	Yes
row_304	MED10	15093	-0.068978563	-0.4025491	Yes
row_305	RNF13	15120	-0.069754012	-0.40083614	Yes
row_306	ZNF649	15172	-0.070826605	-0.4004444	Yes
row_307	MZT1	15248	-0.07211864	-0.40130913	Yes
row_308	HOOK1	15438	-0.076548375	-0.4082192	Yes
row_309	IGFBP3	15451	-0.076750249	-0.40542474	Yes
row_310	ING5	15461	-0.077092543	-0.40245056	Yes
row_311	KCNA1	15484	-0.0776053	-0.4001654	Yes
row_312	PER3	15518	-0.078226939	-0.39845482	Yes
row_313	PTPDC1	15520	-0.078236133	-0.394991	Yes
row_314	CCDC117	15524	-0.078369923	-0.3916307	Yes
row_315	USP53	15613	-0.080675393	-0.3928227	Yes

row_316	SH3GLB1	15645	-0.081479229	-0.39085633	Yes
row_317	ZBTB34	15650	-0.081589505	-0.38740602	Yes
row_318	SEMA3E	15697	-0.082846038	-0.3861998	Yes
row_319	LYPD6	15783	-0.085561544	-0.38700774	Yes
row_320	SIRT1	15817	-0.086595878	-0.3849208	Yes
row_321	PSIP1	15820	-0.0868055	-0.38112634	Yes
row_322	DCUN1D1	15861	-0.088149592	-0.37935296	Yes
row_323	PGBD1	15907	-0.089169122	-0.3778076	Yes
row_324	STK24	15939	-0.090106703	-0.37545317	Yes
row_325	TRDMT1	16016	-0.092470296	-0.3754574	Yes
row_326	AK3	16058	-0.093805857	-0.3734844	Yes
row_327	RABL3	16115	-0.095641866	-0.37225047	Yes
row_328	CAND1	16121	-0.095909022	-0.36821094	Yes
row_329	HS3ST3A1	16139	-0.096660696	-0.3647949	Yes
row_330	MCM10	16160	-0.097206689	-0.36151865	Yes
row_331	PTK2	16249	-0.099553026	-0.36186165	Yes
row_332	WNT16	16262	-0.100174226	-0.35801372	Yes
row_333	CPEB2	16297	-0.10110306	-0.3553291	Yes
row_334	LZTFL1	16303	-0.101330854	-0.3510457	Yes
row_335	VANGL1	16313	-0.101493672	-0.3469741	Yes
row_336	PABPC5	16321	-0.101645708	-0.3427861	Yes
row_337	STYX	16323	-0.101710916	-0.33826652	Yes
row_338	KCNG3	16355	-0.102925211	-0.3353356	Yes
row_339	BEX2	16379	-0.103872783	-0.33192387	Yes
row_340	SF3B1	16380	-0.103890009	-0.3272515	Yes
row_341	SCAMP1	16426	-0.105507895	-0.32497132	Yes
row_342	SLC25A21	16468	-0.107161567	-0.32239765	Yes
row_343	HMGA2	16488	-0.107913673	-0.31858507	Yes
row_344	ENAH	16517	-0.109257087	-0.31520507	Yes
row_345	ESCO2	16524	-0.109777153	-0.3105966	Yes
row_346	FKBP4	16664	-0.115234099	-0.31302795	Yes
row_347	TMEM106B	16679	-0.115719311	-0.30859044	Yes
row_348	PDE5A	16688	-0.116377525	-0.30379468	Yes
row_349	SS18L1	16727	-0.117633849	-0.3005857	Yes
row_350	MRGPRX2	16794	-0.121025153	-0.29875794	Yes
row_351	DDX52	16815	-0.121951215	-0.2943688	Yes
row_352	PDS5B	16845	-0.123433277	-0.29040602	Yes
row_353	ARHGAP26	16855	-0.123825774	-0.28533006	Yes
row_354	NRXN3	16880	-0.125059038	-0.28102025	Yes
row_355	ING1	16893	-0.125836998	-0.27601817	Yes

row_356	WASF1	16947	-0.128667012	-0.27313462	Yes
row_357	FBXL3	16981	-0.130577728	-0.2690696	Yes
row_358	ACVR2A	16996	-0.131259158	-0.2639332	Yes
row_359	ATRNL1	17006	-0.131723389	-0.25850204	Yes
row_360	ZBTB24	17012	-0.131863356	-0.2528455	Yes
row_361	NEBL	17016	-0.132165179	-0.2470658	Yes
row_362	SLC38A1	17041	-0.133503616	-0.24237621	Yes
row_363	PLA2G4A	17083	-0.135435998	-0.23853093	Yes
row_364	TET1	17169	-0.140622199	-0.23686257	Yes
row_365	ATG2B	17186	-0.14121893	-0.23138778	Yes
row_366	DDX60	17240	-0.144404367	-0.22779647	Yes
row_367	REPS2	17284	-0.14669317	-0.22355445	Yes
row_368	MAF	17303	-0.147826001	-0.21789208	Yes
row_369	NR1D2	17304	-0.147834107	-0.21124336	Yes
row_370	TWISTNB	17323	-0.149266362	-0.2055162	Yes
row_371	PPP1R3D	17342	-0.149965852	-0.19975759	Yes
row_372	PTPRB	17351	-0.150679603	-0.1934191	Yes
row_373	UNC13C	17353	-0.150871187	-0.18668857	Yes
row_374	AKAP7	17414	-0.155569389	-0.18297856	Yes
row_375	KITLG	17436	-0.157045841	-0.17706585	Yes
row_376	PLAG1	17543	-0.16343832	-0.17552166	Yes
row_377	MSR1	17750	-0.182868138	-0.17858128	Yes
row_378	MAP7	17806	-0.188199326	-0.17312987	Yes
row_379	CASK	18101	-0.223535433	-0.17918085	Yes
row_380	PCDH11X	18130	-0.228267595	-0.17044844	Yes
row_381	PGR	18151	-0.232135624	-0.16110386	Yes
row_382	PDAP1	18182	-0.237499982	-0.15206578	Yes
row_383	PROCR	18217	-0.2461707	-0.14285687	Yes
row_384	PTGER3	18237	-0.249951288	-0.13265626	Yes
row_385	RTKN2	18320	-0.269377857	-0.12503289	Yes
row_386	SLC30A10	18406	-0.296650708	-0.11634726	Yes
row_387	CREB5	18471	-0.320205748	-0.105451964	Yes
row_388	EPS8	18491	-0.331744045	-0.091572806	Yes
row_389	SERPINB5	18497	-0.337338209	-0.07667518	Yes
row_390	ABCA1	18515	-0.349162012	-0.061903097	Yes
row_391	ZDHHC21	18547	-0.369163871	-0.046998326	Yes
row_392	TWIST1	18631	-0.582096994	-0.025365438	Yes
row_393	NTS	18633	-0.584699512	8.76E-04	Yes

Supplemental Table 5. Gene Set Enrichment Analysis detailed results for drug/xenobiotics metabolism gene set presented in Figure 2A.

NAME	GENE SYMBOL	RANK IN GENE LIST	RANK METRIC SCORE	RUNNING ES	CORE ENRICHMENT
row_0	GSTA1	304	0.265217513	0.03593513	Yes
row_1	ADH4	334	0.259445846	0.08552915	Yes
row_2	GSTO2	477	0.236348689	0.12448898	Yes
row_3	GSTA3	513	0.231816232	0.16831248	Yes
row_4	ITPA	595	0.218738571	0.20708238	Yes
row_5	XDH	613	0.216563568	0.24886706	Yes
row_6	CYP2B6	650	0.212560475	0.28884014	Yes
row_7	GSTM3	804	0.196622342	0.31937534	Yes
row_8	CYP2F1	1103	0.173201293	0.33749065	Yes
row_9	ADH1B	1311	0.15959768	0.35782018	Yes
row_10	UGT2B17	1393	0.154682279	0.38396022	Yes
row_11	UGT2B15	1464	0.151382148	0.41004145	Yes
row_12	UPB1	1795	0.136071235	0.41911408	Yes
row_13	DHDH	1854	0.133570775	0.4423292	Yes
row_14	CYP2C9	1899	0.131782949	0.46594507	Yes
row_15	CYP2D6	1969	0.129297212	0.48772568	Yes
row_16	DPYS	2156	0.122295387	0.50183034	Yes
row_17	MGST2	2178	0.121293791	0.52461565	Yes
row_18	UPP2	2397	0.113011569	0.535168	Yes
row_19	UGT2B10	2424	0.112107717	0.5558731	Yes
row_20	UMPS	2606	0.106108189	0.56705517	Yes
row_21	MAOA	2935	0.096246414	0.5683833	Yes
row_22	**CYP3A4**	2997	0.094532423	0.5837398	Yes
row_23	TK2	3565	0.080058262	0.5690163	No
row_24	ADH7	4666	0.058823526	0.52142686	No
row_25	GSTZ1	4938	0.054624885	0.5176155	No
row_26	MGST3	5056	0.052741271	0.521719	No
row_27	GSTK1	5100	0.052145213	0.5296867	No
row_28	GSTM5	5343	0.0482115	0.52617115	No
row_29	GSTP1	5408	0.047128487	0.5320198	No
row_30	ADH5	5412	0.047096804	0.5411443	No
row_31	FMO3	5436	0.046801921	0.5491346	No
row_32	CYP2A7	5568	0.044851094	0.5509291	No
row_33	GSTM4	5572	0.04480584	0.55960196	No
row_34	GSTA4	5662	0.043820024	0.5634531	No
row_35	NAT2	5840	0.041551273	0.56212187	No
row_36	TK1	5985	0.039543666	0.5621704	No
row_37	UPP1	6137	0.037505042	0.56144035	No
row_38	UCK1	6584	0.031542808	0.5436618	No
row_39	CYP2C19	7046	0.026658813	0.52411306	No
row_40	FMO1	7144	0.025380753	0.52389807	No
row_41	ADH6	7179	0.0249252	0.5269831	No
row_42	UGT2B7	7366	0.022893751	0.52148896	No
row_43	MAOB	7776	0.018395862	0.50310904	No

row_44	ALDH3B2	8493	0.010877524	0.46672803	No
row_45	IMPDH1	9230	0.003700959	0.4278559	No
row_46	GSTM2	9756	-9.76E-04	0.39979967	No
row_47	CYP2E1	9933	-0.002675161	0.39085713	No
row_48	GMPS	10074	-0.004115209	0.38413557	No
row_49	NAT1	10321	-0.006200953	0.37212172	No
row_50	FMO2	10972	-0.012722735	0.3396558	No
row_51	TPMT	11006	-0.013040002	0.34045124	No
row_52	IMPDH2	11226	-0.015343071	0.3316927	No
row_53	CYP3A5	11503	-0.018402312	0.32047036	No
row_54	GUSB	11606	-0.019474179	0.31882176	No
row_55	UGT2B4	11670	-0.020109713	0.3193969	No
row_56	AKR1C4	11697	-0.020358335	0.32201195	No
row_57	CYP3A43	11717	-0.020512862	0.32503408	No
row_58	GSTO1	11832	-0.021821795	0.32320267	No
row_59	DPYD	12011	-0.023923423	0.318342	No
row_60	ALDH1A3	12279	-0.026891377	0.30927768	No
row_61	CES1	13085	-0.036635872	0.2731866	No
row_62	CYP2C18	13415	-0.041450739	0.2636569	No
row_63	CYP2C8	13688	-0.04504507	0.2579029	No
row_64	HPRT1	13730	-0.045539983	0.26467586	No

Supplemental Table 6. Gene Set Enrichment Analysis detailed results for DNA replication gene set presented in Figure 2A.

NAME	GENE SYMBOL	RANK IN GENE LIST	RANK METRIC SCORE	RUNNING ES	CORE ENRICHMENT
row_0	RPA4	266	0.272727251	0.02242821	No
row_1	PSMB9	925	0.187001824	0.012060368	No
row_2	B9D2	1333	0.158392459	0.011416669	No
row_3	E2F1	1361	0.156718403	0.031117478	No
row_4	PPP2R5B	1975	0.129115507	0.01536897	No
row_5	CENPT	2186	0.121002682	0.020340571	No
row_6	PSMA8	2449	0.111216284	0.021175751	No
row_7	CCNA1	2625	0.105502635	0.02594897	No
row_8	POLD1	2740	0.10214375	0.033570737	No
row_9	PPP2CB	3047	0.093345359	0.02961087	No
row_10	PSMD9	3285	0.087219782	0.02855902	No
row_11	PSMB10	3469	0.082789868	0.029832164	No
row_12	CENPM	4174	0.068262622	9.40E-04	No
row_13	PSMB6	4749	0.057600427	-0.022354024	No
row_14	POLD4	5133	0.051617458	-0.036116846	No
row_15	ORC1	5293	0.049074646	-0.038097225	No
row_16	MAD2L1	5456	0.046563897	-0.040579047	No
row_17	PSMB1	5619	0.044314943	-0.043364555	No
row_18	POLE	5800	0.042075779	-0.04742682	No
row_19	AURKB	5824	0.041686233	-0.043042798	No
row_20	MIS12	6078	0.038205985	-0.051579334	No
row_21	CDC45	6208	0.036402058	-0.053646963	No
row_22	CDKN1B	6372	0.034141313	-0.057860393	No
row_23	PPP2R1B	6397	0.033903234	-0.05458148	No
row_24	PSMF1	6480	0.032819811	-0.054588582	No
row_25	PSMB5	6582	0.031547815	-0.055795975	No
row_26	SEC13	6709	0.030256229	-0.0585311	No
row_27	PCNA	6830	0.02888843	-0.06112613	No
row_28	PSMA2	6843	0.028735703	-0.05789542	No
row_29	PSMB7	6930	0.027994102	-0.05877069	No
row_30	POLA2	7012	0.026933221	-0.05951855	No
row_31	ORC2	7128	0.025561647	-0.062292147	No
row_32	PSMB4	7265	0.024067366	-0.06640431	No
row_33	CENPP	7609	0.020283956	-0.08223292	No
row_34	PSMD1	7835	0.017730381	-0.09201864	No
row_35	DNA2	8075	0.015079034	-0.10292026	No
row_36	POLD2	8150	0.014439997	-0.1049762	No
row_37	RB1	8175	0.01413626	-0.10436651	No
row_38	PSMB2	8190	0.013974234	-0.10323737	No
row_39	SPC24	8213	0.013690704	-0.10257958	No
row_40	PSME1	8228	0.013554796	-0.101507075	No
row_41	PSMD2	8288	0.012868195	-0.102963276	No
row_42	PSMA5	8308	0.012585403	-0.10229234	No
row_43	MCM6	8356	0.012075243	-0.103206016	No
row_44	CDC7	8365	0.012001966	-0.1020184	No

row_45	PSMA7	8654	0.009283779	-0.11635509	No
row_46	PSMD13	8660	0.009219399	-0.11538082	No
row_47	CENPA	8754	0.008366913	-0.119285375	No
row_48	CCNA2	8814	0.007722416	-0.12143643	No
row_49	KNTC1	8850	0.007500383	-0.122318275	No
row_50	MCM3	8985	0.00620092	-0.12873477	No
row_51	INCENP	8996	0.006086494	-0.12845421	No
row_52	UBA52	9130	0.004652083	-0.13502571	No
row_53	PSMC1	9177	0.004250133	-0.13694192	No
row_54	ZW10	9252	0.003437522	-0.14048359	No
row_55	PSMA6	9308	0.002924385	-0.143066	No
row_56	FEN1	9331	0.002708492	-0.1438912	No
row_57	CDC20	9341	0.002613073	-0.14402553	No
row_58	GINS2	9353	0.002525736	-0.14427994	No
row_59	NUP133	9481	0.001537477	-0.15094723	No
row_60	CDKN1A	9525	0.001094356	-0.15312718	No
row_61	DSN1	9558	7.56E-04	-0.15475737	No
row_62	KIF23	9718	-6.68E-04	-0.1632743	No
row_63	CENPL	9740	-8.37E-04	-0.16429806	No
row_64	BUB1B	9794	-0.001446374	-0.1669718	No
row_65	PSMA4	9829	-0.001751763	-0.16857578	No
row_66	MCM5	9935	-0.002679526	-0.17389792	No
row_67	POLA1	10070	-0.004085572	-0.18060006	No
row_68	PPP1CC	10140	-0.004707663	-0.18369955	No
row_69	MCM2	10225	-0.005397663	-0.18751785	No
row_70	RPS27	10240	-0.005501586	-0.18753281	No
row_71	CLASP1	10438	-0.007261591	-0.19721645	No
row_72	NDC80	10458	-0.007518849	-0.19722968	No
row_73	E2F2	10592	-0.0088706	-0.20323154	No
row_74	PPP2CA	10595	-0.008900748	-0.20213789	No
row_75	PSMD6	10639	-0.00935581	-0.20320226	No
row_76	PPP2R5C	10658	-0.009549493	-0.20288715	No
row_77	RPA1	10679	-0.009714151	-0.20265806	No
row_78	PLK1	10700	-0.009900995	-0.20240374	No
row_79	PSMD14	10764	-0.010568201	-0.20438705	No
row_80	CENPH	10797	-0.010871043	-0.20465134	No
row_81	PSMD10	10803	-0.010928138	-0.20344633	No
row_82	RCC2	10838	-0.011280758	-0.20376356	No
row_83	BIRC5	10915	-0.01219511	-0.20623091	No
row_84	GORASP1	10945	-0.012437799	-0.20612124	No
row_85	SPC25	10967	-0.012651132	-0.20554969	No
row_86	FBXO5	10991	-0.012900294	-0.20505276	No
row_87	XPO1	10999	-0.012958166	-0.2036819	No
row_88	PSMD5	11045	-0.013502617	-0.20429456	No
row_89	PSMC5	11091	-0.013993829	-0.2048409	No
row_90	BUB3	11099	-0.014081244	-0.20331839	No
row_91	SMC1A	11127	-0.01435793	-0.20284116	No
row_92	CDK2	11156	-0.0147203	-0.20236914	No
row_93	CDCA8	11175	-0.014872085	-0.20133528	No

row_94	PPP2R5A	11232	-0.015400457	-0.20228714	No
row_95	PSMC3	11286	-0.015916988	-0.20300685	No
row_96	KIF2C	11292	-0.01601707	-0.20111465	No
row_97	SEH1L	11303	-0.016131176	-0.19947772	No
row_98	RFC4	11306	-0.016239164	-0.19739313	No
row_99	POLD3	11351	-0.016846346	-0.19750015	No
row_100	NUP43	11353	-0.016848633	-0.19527914	No
row_101	MCM8	11397	-0.017352488	-0.19526367	No
row_102	PSMD4	11542	-0.018735401	-0.2005289	No
row_103	CENPI	11584	-0.019157046	-0.2001615	No
row_104	GMNN	11604	-0.019444879	-0.19856429	No
row_105	CENPN	11694	-0.02031971	-0.20063828	No
row_106	CLIP1	11737	-0.020687219	-0.20011838	No
row_107	RFC5	11764	-0.021011135	-0.19868861	No
row_108	CENPO	11791	-0.021429796	-0.19720231	No
row_109	KIF2B	11880	-0.022366891	-0.19894572	No
row_110	ITGB3BP	11882	-0.022375619	-0.19597836	No
row_111	PSMA3	11887	-0.022464192	-0.19316144	No
row_112	PSME4	11933	-0.022923419	-0.19250198	No
row_113	MAPRE1	12000	-0.023792507	-0.19286196	No
row_114	PSMD8	12059	-0.024390291	-0.19270813	No
row_115	RPA2	12132	-0.025276512	-0.19319251	No
row_116	PPP2R5D	12180	-0.025751742	-0.1922594	No
row_117	AHCTF1	12189	-0.025837913	-0.18920346	No
row_118	MCM7	12196	-0.025900668	-0.18603076	No
row_119	NUDC	12360	-0.027554072	-0.1911337	No
row_120	STAG2	12467	-0.028858161	-0.19297495	No
row_121	CASC5	12870	-0.033832002	-0.21016796	No
row_122	PSMD7	12963	-0.035054125	-0.21041468	No
row_123	NUP37	13010	-0.035719406	-0.20808144	No
row_124	PPP2R1A	13028	-0.035851203	-0.20416056	No
row_125	PSMA1	13178	-0.03812639	-0.207078	No
row_126	PSMC4	13206	-0.038560357	-0.2033326	No
row_127	NUF2	13228	-0.038782779	-0.19923238	No
row_128	PSMC2	13560	-0.043359209	-0.21129544	Yes
row_129	ORC5	13633	-0.044281837	-0.20921344	Yes
row_130	PSMD3	13696	-0.045125268	-0.20647623	Yes
row_131	CDT1	13705	-0.045208052	-0.20080464	Yes
row_132	ORC6	13805	-0.04660701	-0.19987024	Yes
row_133	RPA3	13823	-0.046910457	-0.19445598	Yes
row_134	SKA2	13843	-0.047256727	-0.18910322	Yes
row_135	NUP85	13890	-0.047984596	-0.18511376	Yes
row_136	MCM4	13897	-0.048083164	-0.17894566	Yes
row_137	NDEL1	13930	-0.048505224	-0.17412804	Yes
row_138	ORC3	13944	-0.048703462	-0.16825512	Yes
row_139	PSMB3	14033	-0.050114714	-0.16625161	Yes
row_140	RFC2	14105	-0.051316418	-0.16316557	Yes
row_141	PSMC6	14213	-0.053108502	-0.16178632	Yes
row_142	GINS4	14245	-0.053702537	-0.15621275	Yes

row_143	KIF20A	14256	-0.053991742	-0.14946333	Yes
row_144	PPP2R5E	14294	-0.054556161	-0.14409928	Yes
row_145	SMC3	14332	-0.055055123	-0.13866787	Yes
row_146	POLE2	14345	-0.055176992	-0.13186666	Yes
row_147	RANGAP1	14417	-0.05666266	-0.12805869	Yes
row_148	SGOL2	14450	-0.057184514	-0.12206906	Yes
row_149	E2F3	14583	-0.059753597	-0.12114582	Yes
row_150	PRIM2	14622	-0.060501236	-0.11503312	Yes
row_151	KIF18A	14656	-0.061017372	-0.10858006	Yes
row_152	STAG1	14778	-0.063382812	-0.10657129	Yes
row_153	RFC3	14806	-0.063871153	-0.09940807	Yes
row_154	KIF2A	14818	-0.064129725	-0.091343805	Yes
row_155	PSMD11	14953	-0.066266589	-0.08964935	Yes
row_156	PSMD12	15013	-0.067371167	-0.08374576	Yes
row_157	CENPK	15015	-0.067405671	-0.07469781	Yes
row_158	PRIM1	15244	-0.072060764	-0.077309445	Yes
row_159	ZWINT	15328	-0.073835105	-0.0718322	Yes
row_160	BUB1	15515	-0.078157432	-0.07134699	Yes
row_161	CENPQ	15561	-0.079336472	-0.06306981	Yes
row_162	DBF4	15578	-0.079763658	-0.053165093	Yes
row_163	RANBP2	15887	-0.088590801	-0.057875257	Yes
row_164	NSL1	15942	-0.090272851	-0.048608486	Yes
row_165	SKA1	15955	-0.090695322	-0.03701108	Yes
row_166	ERCC6L	15971	-0.091025256	-0.025531521	Yes
row_167	CDC6	16004	-0.092079617	-0.014829847	Yes
row_168	ORC4	16074	-0.094187342	-0.005846482	Yes
row_169	SGOL1	16143	-0.09670084	0.003530426	Yes
row_170	MCM10	16160	-0.097206689	0.01579056	Yes
row_171	GINS1	16416	-0.105271667	0.016201943	Yes
row_172	NUP107	16521	-0.109604813	0.025372542	Yes
row_173	LIG1	16620	-0.113361239	0.03537519	Yes
row_174	MAD1L1	16721	-0.117332175	0.045805782	Yes
row_175	ZWILCH	17055	-0.134059504	0.04588214	Yes
row_176	PSMB8	18415	-0.298826069	0.012667161	Yes

Supplemental Table 7 Gene Set Enrichment Analysis detailed results for G2M check point gene set presented in Figure 2A.

NAME	GENE SYMBOL	RANK IN GENE LIST	RANK METRIC SCORE	RUNNING ES	CORE ENRICHMENT
row_0	E2F1	1361	0.156718403	-0.054789737	No
row_1	PLK4	1483	0.150512129	-0.043174542	No
row_2	CDC25B	1934	0.130821139	-0.051753722	No
row_3	CCNF	3006	0.094376273	-0.09836331	No
row_4	RAD54L	3067	0.092824861	-0.09040792	No
row_5	SQLE	3459	0.083015643	-0.10156241	No
row_6	ABL1	3533	0.081001498	-0.09573825	No
row_7	ESPL1	4136	0.068823054	-0.12003292	No
row_8	NOTCH2	4288	0.065757483	-0.12027305	No
row_9	CTCF	4324	0.065185934	-0.11430002	No
row_10	CKS2	4400	0.063803278	-0.11066015	No
row_11	ATRX	4407	0.063618734	-0.10330575	No
row_12	WRN	4691	0.058345981	-0.11158917	No
row_13	NUMA1	4867	0.055762067	-0.1143356	No
row_14	SMAD3	5156	0.05124452	-0.123747006	No
row_15	MEIS1	5233	0.049977235	-0.12183022	No
row_16	MAD2L1	5456	0.046563897	-0.12823229	No
row_17	CDK4	5466	0.046447389	-0.123113096	No
row_18	POLQ	5584	0.044651363	-0.124059595	No
row_19	SAP30	5670	0.043742169	-0.12338284	No
row_20	PTTG1	5780	0.04244959	-0.12416186	No
row_21	FANCC	5787	0.042313077	-0.119379245	No
row_22	POLE	5800	0.042075779	-0.11495021	No
row_23	AURKB	5824	0.041686233	-0.111163914	No
row_24	MAPK14	6133	0.037556317	-0.123310745	No
row_25	DTYMK	6155	0.037303891	-0.11994513	No
row_26	CDC45	6208	0.036402058	-0.11836722	No
row_27	CDKN1B	6372	0.034141313	-0.12307358	No
row_28	HNRNPD	6434	0.033420198	-0.12234301	No
row_29	TACC3	6616	0.031302478	-0.12836686	No
row_30	SMC2	6644	0.031033905	-0.12608302	No
row_31	PRPF4B	6700	0.030319352	-0.12540182	No
row_32	H2AFV	6774	0.029500287	-0.1257943	No
row_33	CUL1	6792	0.029309858	-0.12317701	No
row_34	AURKA	6793	0.029294247	-0.11964094	No
row_35	KATNA1	6933	0.027955245	-0.12379425	No
row_36	POLA2	7012	0.026933221	-0.124767385	No
row_37	SLC7A5	7074	0.026318856	-0.124894015	No
row_38	MTF2	7075	0.026305098	-0.12171876	No
row_39	H2AFZ	7140	0.025453743	-0.12211229	No
row_40	RACGAP1	7333	0.023281993	-0.1297	No
row_41	MT2A	7345	0.023153204	-0.12750092	No
row_42	SLC7A1	7485	0.021533174	-0.13242944	No
row_43	TLE3	7846	0.017618023	-0.14979914	No

row_44	CCNT1	7885	0.017202659	-0.14978057	No
row_45	MYC	7922	0.01674936	-0.1497084	No
row_46	MNAT1	7928	0.016606465	-0.14797466	No
row_47	MKI67	7940	0.016519159	-0.14657636	No
row_48	TNPO2	8036	0.015465423	-0.14985442	No
row_49	SRSF1	8207	0.013818503	-0.15739301	No
row_50	CBX1	8332	0.012285059	-0.1626255	No
row_51	MCM6	8356	0.012075243	-0.16241352	No
row_52	PAPD7	8359	0.012042931	-0.16106814	No
row_53	CDC7	8365	0.012001966	-0.15989019	No
row_54	LBR	8466	0.011102905	-0.16396563	No
row_55	SYNCRIP	8680	0.009076724	-0.17440532	No
row_56	TGFB1	8720	0.008628708	-0.17547587	No
row_57	CENPA	8754	0.008366913	-0.17625307	No
row_58	KIF22	8761	0.008249633	-0.1755822	No
row_59	CCNA2	8814	0.007722416	-0.17746618	No
row_60	TRA2B	8855	0.007460824	-0.17873186	No
row_61	DR1	8889	0.007147476	-0.17965625	No
row_62	SUV39H1	8973	0.006327106	-0.1833875	No
row_63	MCM3	8985	0.00620092	-0.18323472	No
row_64	INCENP	8996	0.006086494	-0.1830416	No
row_65	CKS1B	9020	0.005781781	-0.18358928	No
row_66	CHMP1A	9187	0.004068344	-0.19208819	No
row_67	NEK2	9321	0.002809053	-0.19895191	No
row_68	CDC20	9341	0.002613073	-0.19966547	No
row_69	GINS2	9353	0.002525736	-0.19995631	No
row_70	YTHDC1	9393	0.002239789	-0.20179807	No
row_71	H2AFX	9419	0.002046646	-0.20290492	No
row_72	KIF5B	9444	0.001788466	-0.20398879	No
row_73	TRAIP	9460	0.001690289	-0.20459712	No
row_74	WHSC1	9488	0.001505605	-0.2058776	No
row_75	HMGN2	9709	-5.40E-04	-0.2177269	No
row_76	KIF23	9718	-6.68E-04	-0.21807949	No
row_77	CDKN2C	9805	-0.001565887	-0.22254793	No
row_78	LMNB1	9847	-0.001902872	-0.22453865	No
row_79	MCM5	9935	-0.002679526	-0.22892684	No
row_80	CCNB2	9992	-0.003238774	-0.23156865	No
row_81	UBE2S	10154	-0.004780072	-0.23971085	No
row_82	CENPE	10163	-0.004903676	-0.23955218	No
row_83	PRC1	10193	-0.00518409	-0.24049696	No
row_84	TOP2A	10220	-0.005380796	-0.24125552	No
row_85	MCM2	10225	-0.005397663	-0.2408206	No
row_86	MARCKS	10280	-0.005799085	-0.24304505	No
row_87	BRCA2	10410	-0.007079724	-0.24917665	No
row_88	MYBL2	10413	-0.007110312	-0.24842669	No
row_89	CHAF1A	10422	-0.007144003	-0.2479976	No
row_90	TMPO	10427	-0.00718301	-0.24734718	No
row_91	NDC80	10458	-0.007518849	-0.24806428	No
row_92	UPF1	10468	-0.007593007	-0.24763514	No

row_93	E2F2	10592	-0.0088706	-0.25322565	No
row_94	NOLC1	10607	-0.009019763	-0.25289506	No
row_95	KPNA2	10610	-0.009030681	-0.2519133	No
row_96	PLK1	10700	-0.009900995	-0.25553808	No
row_97	CDC25A	10773	-0.010647349	-0.25815213	No
row_98	MEIS2	10848	-0.011353017	-0.2607893	No
row_99	KIF4A	10884	-0.011835299	-0.26125616	No
row_100	BIRC5	10915	-0.01219511	-0.2614088	No
row_101	SNRPD1	10929	-0.012336033	-0.26062375	No
row_102	HN1	10935	-0.012357932	-0.25940284	No
row_103	CDC27	10983	-0.012831502	-0.2603993	No
row_104	FBXO5	10991	-0.012900294	-0.25922123	No
row_105	XPO1	10999	-0.012958166	-0.25803617	No
row_106	SMC4	11042	-0.013477089	-0.25868395	No
row_107	G3BP1	11077	-0.013836495	-0.25885507	No
row_108	ODF2	11085	-0.01392013	-0.2575539	No
row_109	BUB3	11099	-0.014081244	-0.2565582	No
row_110	SMC1A	11127	-0.01435793	-0.2562873	No
row_111	TROAP	11153	-0.014698663	-0.25586694	No
row_112	CUL5	11290	-0.015987195	-0.26130244	No
row_113	KIF2C	11292	-0.01601707	-0.2594232	No
row_114	RAD23B	11467	-0.017970007	-0.2666773	No
row_115	HNRNPU	11615	-0.019587684	-0.2722739	No
row_116	ILF3	11857	-0.022144739	-0.28265256	No
row_117	EXO1	11900	-0.02262456	-0.28219613	No
row_118	HMGB3	12111	-0.025044467	-0.29054594	Yes
row_119	KIF11	12115	-0.02508856	-0.28768	Yes
row_120	RPA2	12132	-0.025276512	-0.2854954	Yes
row_121	SRSF10	12141	-0.025343958	-0.2828694	Yes
row_122	EZH2	12208	-0.026082395	-0.28329536	Yes
row_123	GSPT1	12304	-0.027047446	-0.28517538	Yes
row_124	RBM14	12315	-0.027178461	-0.28243625	Yes
row_125	CASP8AP2	12370	-0.027624356	-0.2820262	Yes
row_126	CUL3	12435	-0.028514441	-0.28205028	Yes
row_127	RBL1	12564	-0.029948598	-0.28536725	Yes
row_128	TFDP1	12581	-0.030111782	-0.282599	Yes
row_129	RPS6KA5	12627	-0.030553861	-0.28134793	Yes
row_130	NCL	12735	-0.032019675	-0.28327763	Yes
row_131	HMGA1	12789	-0.032835197	-0.28218442	Yes
row_132	CASC5	12870	-0.033832002	-0.28243312	Yes
row_133	ARID4A	13087	-0.036650982	-0.28970686	Yes
row_134	TOP1	13143	-0.037474807	-0.28816193	Yes
row_135	TPX2	13187	-0.038370389	-0.28585902	Yes
row_136	CENPF	13239	-0.03892329	-0.2839226	Yes
row_137	PBK	13279	-0.039455779	-0.28127205	Yes
row_138	E2F4	13333	-0.040298577	-0.27927795	Yes
row_139	HIF1A	13386	-0.041028004	-0.27714166	Yes
row_140	KIF20B	13545	-0.043129083	-0.28049234	Yes
row_141	CDKN3	13548	-0.043235697	-0.2753817	Yes

row_142	ORC5	13633	-0.044281837	-0.27458566	Yes
row_143	AMD1	13664	-0.044659648	-0.27081954	Yes
row_144	SFPQ	13767	-0.046027981	-0.27078754	Yes
row_145	ORC6	13805	-0.04660701	-0.26716545	Yes
row_146	SS18	13907	-0.048222572	-0.26681438	Yes
row_147	EWSR1	14015	-0.049758371	-0.26660284	Yes
row_148	KPNB1	14080	-0.05091409	-0.2639231	Yes
row_149	DDX39A	14238	-0.05356881	-0.26595944	Yes
row_150	HUS1	14352	-0.055302564	-0.26540363	Yes
row_151	BARD1	14357	-0.055410054	-0.2589318	Yes
row_152	CHEK1	14475	-0.057654131	-0.25830874	Yes
row_153	E2F3	14583	-0.059753597	-0.25689068	Yes
row_154	PRIM2	14622	-0.060501236	-0.25164562	Yes
row_155	EGF	14625	-0.060540184	-0.2444462	Yes
row_156	STAG1	14778	-0.063382812	-0.24502712	Yes
row_157	SMARCC1	14803	-0.063813373	-0.23862405	Yes
row_158	CDK1	14859	-0.064751908	-0.23378654	Yes
row_159	NUP50	15136	-0.070052542	-0.24027778	Yes
row_160	PRMT5	15251	-0.072256193	-0.23772968	Yes
row_161	STIL	15254	-0.072285421	-0.2291125	Yes
row_162	SETD8	15355	-0.074522823	-0.2255326	Yes
row_163	NASP	15360	-0.074680902	-0.21673459	Yes
row_164	PURA	15380	-0.075120121	-0.20869592	Yes
row_165	HOXC10	15486	-0.07763321	-0.20501134	Yes
row_166	BUB1	15515	-0.078157432	-0.19709344	Yes
row_167	DBF4	15578	-0.079763658	-0.19082297	Yes
row_168	HMMR	15597	-0.080221504	-0.18211435	Yes
row_169	SLC12A2	15699	-0.08292491	-0.1775744	Yes
row_170	NUSAP1	15707	-0.0832614	-0.16790311	Yes
row_171	RASAL2	15872	-0.088339306	-0.16612145	Yes
row_172	KIF15	15890	-0.088737033	-0.15633078	Yes
row_173	CDC6	16004	-0.092079617	-0.15133566	Yes
row_174	TTK	16009	-0.092156589	-0.14042819	Yes
row_175	CUL4A	16034	-0.092999697	-0.13050206	Yes
row_176	LIG3	16189	-0.097893432	-0.12702557	Yes
row_177	CCND1	16222	-0.098884001	-0.116822414	Yes
row_178	PDS5B	16845	-0.123433277	-0.13560829	Yes
row_179	SLC38A1	17041	-0.133503616	-0.13005376	Yes
row_180	PML	18090	-0.220967993	-0.16013703	Yes
row_181	EFNA5	18199	-0.240506396	-0.1369547	Yes
row_182	UBE2C	18251	-0.252355397	-0.10925519	Yes
row_183	DMD	18585	-0.43001008	-0.075383335	Yes
row_184	FOXN3	18644	-0.652773023	2.71E-04	Yes

Supplemental Table 8. Mutations identified in the used human cell lines.

Gene	Exon	OCI-AML3	K562	SET2
TET1	E2	rs12773594 (T/A) rs12221107 (C/T)	rs10823229 (A/G)	rs12773594 (T/A homo) rs12221107 (C/T) rs150689919 (C/T)
	I3-4	rs966578 (T/C)		
	E4	rs370296152 (C/T) rs71483917 (ATA/GTG) rs3998860 (A/G)	rs3998860 (A/G homo)	rs3998860 (A/G homo)
	I4-I5	rs36081642 C/T) rs34757215 (A/C) rs12243354 (G/A)		
	E11			no rs (c.5363C>A)
DNMT3A	E9	rs2276599 (C>T homo)	rs2276599 (C>T homo)	rs2276599 (C>T)
	E18			rs2289195 (G>A)
	E23	rs377577594 (C>T) R882C		
JAK2	E14			rs77375493 (V617F)

Supplemental Table 9. Primers for mutation analysis in cell lines.

Name	Forward primer (5'-3')	Reverse primer (5'-3')	Amplicon size (bp)
TET1_E1_1	CTGGGCAACAGAATGAGACC	GTCGCCTGCTAAGAGAGGTG	591
TET1_E1_2	AGGGAGCCAACAAAAATGTG	TGGGGAACCACTGGTATCAT	626
TET1_E1_3	GGTCGTAGCCAAATCCAAAA	CAGGAAGGAAGACAGGCAAG	944
TET1_E1_4	ATGATACCAGTGGTTCCCCA	GACCAGCCTGAGAGAGTTGG	912
TET1_E1_5	CTTGCCTGTCTTCCTTCCTG	CAAGTGTCAGCTGTCTCCCA	672
TET1_E1_6	CCAACTCTCTCAGGCTGGTC	GCTAAGGCATCACTGCACAA	531
TET1_E2	GCAAGCAAGATGGCTACCTC	GCAACACCACAAATGCAGAT	653
TET1_E3	TCGCTGAATGTGTGAAAAGC	TGGGGAGGAATTCTCTGATG	905
TET1_E4_1	GTAAATGGCCCCAAGTCAGA	AAGTTTTGGTGGCTCTCCCT	870
TET1_E4_2	AGAATTCGGCAAGACATTGG	GGTATGGGTTGCATCCTGAC	874
TET1_E4_3	CATCAGAGAATTCCTCCCCA	CAAATGTCGCATATTGTGCC	859
TET1_E4_4	CATCAGTTGCCACCAAGAAA	GCAATGTTGGCAGTCTCTGA	907
TET1_E4_5	GGCTCAAACGAGGTCCATTA	TATTTTTCCACTTGAGCGGG	856
TET1_E4_6	TCAGAGACTGCCAACATTGC	TATTTTTCCACTTGAGCGGG	552
TET1_E5	GTTAGGGGCAGGAAGAAAGG	ATGATGGGTGGCTCAGTAGG	468
TET1_E6	CCCTTGACACTGCATACCCT	GCTCTGGAATAACAAGCTTCAAA	420
TET1_E7	GTTGAGGCAGTGGAAAGTCC	TGCACCTGGTCACAGTGAAG	753
TET1_E8	AACCGGTTCTTTAGGCATCC	CAGGGACAATTGGAATTTGG	482
TET1_E9	TTAACCACCATCAGCCATGA	CAGCATTTTTGGAGGGTGAG	333
TET1_E10	TTGTGCTCCATGCTTTCTTTT	AAGGACTGCAGCCTAAGCAT	227
TET1_E11	TCCCATTTCATGTTTTTCTCC	CCAGGTTCCATAGGGCTCAC	400
TET1_E12_1	ATTGAACAGAGTTGGGTGGC	CAAGGCAAAGTCCAAACACA	596
TET1_E12_2	CCAACCAACACAACATCAGC	GGGGTCATCAGATAGGGGTT	659
TET1_E12_3	CTCCACTGAAGAATGACGCA	AGGCATTAAGAGGGGGAGAA	859
TET1_E12_4	AACCCCTATCTGATGACCCC	AATACCCACCCCGTTTTGTT	648
DNMT3A_E7-8	ATGGTCCCCTTGAGTGTCAG	CATCACCCCAATTCCAGACT	836
DNMT3A_E9-10	CTGTATCTGGTCCCCTCCAG	CTCCCTAAGCATGGCTTTCC	747
DNMT3A_E11-12	GGGAACAAGTTGGAGACCAG	GGTCCCATGTCATTCAAACC	490
DNMT3A_E13	GTCACAGTGCCTCCCTTTTC	TGGACACAGTCAGCCAGAAG	308
DNMT3A_E14	CAGGGCTTAGGCTCTGTGAG	AGGTGTGCTACCTGGAATGG	359
DNMT3A_E15-16	CGGTCTTTCCATTCCAGGTA	CATCATTTCGTTTTGCCAGA	614
DNMT3A_E17	GACTTGGGCCTACAGCTGAC	CAAAATGAAAGGAGGCAAGG	345
DNMT3A_E18-19	CTTCCTGTCTGCCTCTGTCC	ATGAAGCAGCAGTCCAAGGT	552
DNMT3A_E19b-20	GCAGCACTGTGCAATATGGT	CTTCCCCACTATGGGTCATC	549
DNMT3A_E21	GCGGGGAGTTTGAAGAGAGT	CCACACTAGCTGGAGAAGCA	342
DNMT3A_E22	TTTGGTAGACGCATGACCAG	CAGGACGTTTGTGGAAAACA	301
DNMT3A_E23	TCCTGCTGTGTGGTTAGACG	CCTCTCTCCCACCTTTCCTC	654
JAK2_E14	TCCTCAGAACGTTGATGGCAG	ATTGCTTTCCTTTTTCACAAGAT	453