Supplementary Table S1: List of primers used in this study

Purpose	Gene	Sequence (5'–3')	
		Forward	Reverse
qRT-PCR	HOXA-AS1	CTCCCCACCGTTCAATGA	CCAGTCTCCAGGTCAATAACTAA
	HOXA-AS2	CTGAACCAGGAATTGTCTC	GCTTCTGCTGTTTATTTGTC
	HOXA-AS3	CAAAGGCACAGAATCTCAAC	CCACTTGCTCACACTCTAT
	HOXA-AS4	CCAGTAAGCCAAAGTCAAG	TGCTGTGCTGTGTTTAATC
	HOXA-AS5	ACATCCGAGGAGACTTCT	CAATGTCACAGCCTTACG
	HOXA-AS6	TGAAAGAGGAAGATTTATGTTACT	CACTAAGGACTGAGGTATGT
	HOXB-AS1	CGGAAGAGGATTGTGAAGT	CCCAAATTAACACACCTTACAT
	HOXB-AS2	TTGTAAAGTGGGAATTGCTAAT	CAGTGTCTATGCGAGTCT
	HOXB-AS3	CCTCCAAGTCCAGTAAGA	TTCAAGCGAAGTCTACCT
	HOXB-AS4	GCAACAAGAGAGGAGTCAAG	GTAGAGCACAAGCCATCAG
	HOXB-AS5	CCGCCTTCTTCTTCCATTCG	GATGTCGCCTGCCATTCG
	HOXC-AS1	GAAAATGCCAGTCCCCGAAG	AGTGTCGCAGAGATGGAGTTG
	HOXC-AS2	ACTGAGTTCTCTTGGCCTG	CGGGCTCGTATTGTCTCTC
	HOXC-AS3	GTAACAGCGCCATCTAGCA	GATACGTGACTCCTCCAAACT
	HOXC-AS4	CAGTGGGGAACTCTGACTCG	GTGCCTGGTGCTCTCTTACC
	HOXC-AS5	GAGCAAATGGACAGGTCTG	TACAACTTCGGCTGGTCTTC
	HOXD-AS1	TGTTCCACCAGAAGATTAGAAGTT	AGCCCACGCATCTCTATTTG
	HOXD-AS2	AACTGCTCTGGTGAACTCC	TTCTTGTGTCCTCTGCTTCC
	MALAT1	TCGTTTGCCTCAGACAGGTA	GCTCCCAGATGAAATGAAGC
	HULC	ATCTGCAAGCCAGGAAGAGTC	CTTGCTTGATGCTTTGGTCTGT
	SOCS1	TTCGCCCTTAGCGTGAAGATGG	TAGTGCTCCAGCAGCTCGAAGA
	ATF3	CGCTGGAATCAGTCACTGTCAG	CTTGTTTCGGCACTTTGCAGCTG
	CDKN1C	AGATCAGCGCCTGAGAAGTCGT	TCGGGGCTCTTTGGGCTCTAAA
	BATF2	GCTGAAGAAGCAGAAGAACCGG	TGCAGGGACTGGATCTCCTTCC
	PRICKLE1	GCAGAACTGCTCAAACCACGGT	CAGGACCGTTTCACACTCAAGG
	AKR1C3	CCGAAGCAAGATTGCAGATGGC	GTGAGTTTTCCAAGGCTGGTCG
	TGFBR2	GTCTGTGGATGACCTGGCTAAC	GACATCGGTCTGCTTGAAGGAC
	NOTCH2	GTGCCTATGTCCATCTGGATGG	AGACACCTGAGTGCTGGCACAA
	SMYD3	TTCACCATCTGTAATGCGGAGA	ACACAATCGAACAGTTGGGGT
	β-ACTIN	TGGCACCCAGCACAATGAA	CTAAGTCATAGTCCGCCTAGAAGCA
Promoter amplification	HOXD-AS2 promoter	GCGTGCTAGCCCGGGCTCGAGCTGAACATAGAGCTTGGCCATCA	CAGTACCGGAATGCCAAGCTTGGTAAGAATCGCCCCCTCCC
	SMYD3 promoter	ATTTCTCTATCGATAGGTACCACAAGCTTCCCATCCTCATTTTAT	TACTTAGATCGCAGACTCGAGTTGGCGGTTGCGAACTTTTC
ORF amplification	SMYD3	TATTTCCGGTGAATTCGGGTAGCCGTCTGAGGTGC	GAGAGGGGCGGGATCCATTCAACAAAGACACACGCCG
ChIP-qPCR	Primer 1	GGGAAATGTAGGGGAGCAG	GCAGCCTTCGGGTAAGAATC
	Primer 2	TACTGCCCCCTTAGACTTCTG	GTCGCTGTCTAAGCCCCTTC

Supplementary Table S2: List of primary antibodies used in this study

Name of Antibody	Manufacturer and catalog No.	Dilution
anti-Cyclin A	Abcam, ab185619	1:1000, WB
anti-Cyclin B1	Abcam, ab32053	1: 5000, WB
anti-Cyclin D1	Abcam, ab134175	1: 20000, WB
anti-Cyclin E1	Abcam, ab33911	1: 5000, WB
anti-MMP1	Abcam, ab134184	1: 1000, WB
anti-MMP2	Abcam, ab92536	1: 1000, WB
anti-MMP9	Abcam, ab137867	1: 1000, WB
anti-MEK1/2	Cell Signaling Technology (CST), 8727T	1: 1000, WB
anti-Phospho-MEK1/2 (Ser217/221)	Cell Signaling Technology (CST), 9154T	1: 1000, WB
anti-Erk1/2	Cell Signaling Technology (CST), 4695T	1: 1000, WB
anti-Phospho-Erk1/2 (Thr202/Tyr204)	Cell Signaling Technology (CST), 4370T	1: 1000, WB
anti-H3K4me3	Abcam, ab8580	1: 2000, WB
anti-H3K4me2	Cell Signaling Technology (CST), 9725T	1: 1000, WB
anti-GAPDH	Cell Signaling Technology (CST), 5174	1: 1000, WB
anti-Histone H3	Cell Signaling Technology (CST), 4499T	1: 2000, WB
anti-Ki67	Santa cruz, sc-23900	1: 200, IHC
anti-PCNA	Proteintech, 10205-2-AP	1: 500, IHC

Supplementary Table S3: Clinical characteristics of HCC patients from TCGA database used in this study

Clinical characteristic	Levels	Number of patients (%)
Total		374
Gender	Female	121 (32.4%)
	Male	253 (67.6%)
Age	<=60	177 (47.5%)
	>60	196 (52.5%)
T stage	T1	183 (49.3%)
	T2	95 (25.6%)
	T3	80 (21.6%)
	T4	13 (3.5%)
N stage	N0	254 (98.4%)
	N1	4 (1.6%)
M stage	M0	268 (98.5%)
	M1	4 (1.5%)
Pathologic stage	Stage I	173 (49.4%)
	Stage II	87 (24.9%)
	Stage III	85 (24.3%)
	Stage IV	5 (1.4%)
Histologic grade	G1	55 (14.9%)
	G2	178 (48.2%)
	G3	124 (33.6%)
	G4	12 (3.3%)
AFP (ng/ml)	<=400	215 (76.8%)
	>400	65 (23.2%)
Albumin (g/dl)	<3.5	69 (23%)
	>=3.5	231 (77%)
Prothrombin time, n (%)	<=4	208 (70%)
	>4	89 (30%)
Child-Pugh grade, n (%)	A	219 (90.9%)
	B	21 (8.7%)
	C	1 (0.4%)
Fibrosis ishak score, n (%)	0	75 (34.9%)
	1/2	31 (14.4%)
	3/4	28 (13%)
	5/6	81 (37.7%)
Adjacent hepatic tissue inflammation, n (%)	None	118 (49.8%)
	Mild	101 (42.6%)
	Severe	18 (7.6%)
Cirrhosis, n (%)	No	138 (63.6%)
	Yes	79 (36.4%)
HBV positive, n (%)	No	49 (17.8%)
	Yes	226 (82.2%)
HCV positive, n (%)	No	142 (50.9%)

Clinical characteristic	Levels	Number of patients (%)
Vascular invasion, n (%)	Yes	137 (49.1%)
	No	208 (65.4%)
	Yes	110 (34.6%)

Supplementary Table S4: List of 233 differentially expressed genes between HOXD-AS2 knockdown and control Bel-7402 cells

Absolute value of log2 fold change cut-off: 0.6; False discoverry rate (FDR) cut-off: 0.05

Condition pairs: Negative control Bel-7402 cells(**T01**) vs HOXD-AS2 knockdown Bel-7402 cells (**T03**)

Column A: Gene ID

Column B: Gene Symbol

Column C and D: The value of reads count

Column E and F: The value of fragments per kilobase of transcript per million mapped reads (FPKM)

Column G: False discovery rate (FDR)

Column H: log2 fold change

Column I: Regulatory Trends. Up, up-regulation; Down, down-regulation.

Gene ID	Gene_symbol	T01_Count	T03_Count	T01_FPKM	T03_FPKM	FDR	log2FC	Regulated
ENSG00000115361	ACADL	24	2	0.554082	0.0666044	0.026570123	-2.995345399	Down
ENSG00000170293	CMTM8	31	3	1.815909	0.229702206	0.00213688	-2.949389393	Down
ENSG00000157570	TSPAN18	35	6	1.169275216	0.1951101	0.011911019	-2.330327994	Down
ENSG00000184903	IMMP2L	195	75	51.5574187	16.60933488	1.72E-08	-1.353510944	Down
ENSG00000137474	MYO7A	80	33	0.491630063	0.189977893	0.028500691	-1.237578015	Down
ENSG00000163083	INHBB	84	36	1.19153	0.52409	0.034377446	-1.185447837	Down
ENSG00000167861	HID1	185	85	5.176411644	2.076541743	2.62E-05	-1.099954547	Down
ENSG00000088448	ANKRD10	780	371	19.160489	9.105042	0	-1.057906646	Down
ENSG00000169252	ADRB2	155	74	2.53271	1.22143	0.00079097	-1.043535908	Down
ENSG00000151632	AKR1C2	2507	1219	150.6465176	69.31395945	0	-1.027710781	Down
ENSG00000221955	SLC12A8	210	102	4.537269668	1.760989101	3.29E-05	-1.02188377	Down
ENSG00000140945	CDH13	515	257	11.06692572	5.224243958	4.94E-11	-0.987799026	Down
ENSG00000163513	TGFBR2	1208	604	13.16979	6.576848	0	-0.986793806	Down
ENSG00000157978	LDLRAP1	1202	623	18.5087	9.67388	1.11E-16	-0.93501529	Down
ENSG00000160179	ABCG1	368	194	5.921714	3.066583535	4.80E-07	-0.907868697	Down
ENSG00000082014	SMARCD3	210	114	4.4870646	2.432547255	0.001614269	-0.863078574	Down
ENSG00000090238	YPEL3	198	108	11.18942064	6.319794947	0.00332926	-0.855878498	Down
ENSG00000001084	GCLC	2536	1407	39.079135	20.80064028	0	-0.837549809	Down
ENSG00000185585	OLFML2A	212	118	1.525610627	0.860169641	0.003363824	-0.827405781	Down
ENSG00000156239	N6AMT1	231	130	6.758325123	3.059247605	0.002186992	-0.812136841	Down
ENSG00000100154	TTC28	983	566	4.79917	2.562493	1.61E-10	-0.783313002	Down
ENSG00000006756	ARSD	248	145	3.739550894	3.026592831	0.004385185	-0.757841427	Down

ENSG00000158163	DZIP1L	220	129	3.79717077	1.879691686	0.013045032	-0.753144844	Down
ENSG00000249992	TMEM158	189	111	5.61992	3.45087	0.042568833	-0.750030125	Down
ENSG00000198270	TMEM116	189	111	12.94758881	6.63888521	0.042568833	-0.750030125	Down
ENSG00000163412	EIF4E3	277	165	4.344921651	2.916094104	0.003328961	-0.731633996	Down
ENSG00000132879	FBXO44	276	165	7.780815041	5.298412781	0.003933105	-0.726437628	Down
ENSG00000280657	SMYD3	777	468	25.834261	16.3394727	1.45E-07	-0.718171162	Down
ENSG00000128694	OSGEPL1	268	163	8.960121718	5.189774386	0.009361819	-0.701652868	Down
ENSG00000122729	ACO1	932	572	11.94588926	7.29943836	8.81E-08	-0.691359591	Down
ENSG00000107242	PIP5K1B	448	275	8.037806384	4.838531831	0.000161018	-0.689948774	Down
ENSG00000129566	TEP1	712	439	3.3631987	1.8921655	2.11E-06	-0.684384805	Down
ENSG00000196139	AKR1C3	15903	9867	680.98193	427.8436189	1.49E-14	-0.676679779	Down
ENSG00000133195	SLC39A11	294	182	16.61935588	6.231342201	0.008706963	-0.676665002	Down
ENSG00000118898	PPL	1725	1071	9.715828541	6.269862725	5.81E-10	-0.675196858	Down
ENSG00000177570	SAMD12	289	180	5.573907427	6.1446047	0.012399081	-0.667857333	Down
ENSG00000115468	EFHD1	320	200	8.631321834	5.555039967	0.006565874	-0.663206895	Down
ENSG00000111181	SLC6A12	442	278	7.64113159	4.513257254	0.000631256	-0.654956164	Down
ENSG00000074219	TEAD2	549	346	12.9844619	7.5647452	0.000105547	-0.652452567	Down
ENSG00000206418	RAB12	504	320	12.04937	7.721035	0.000336886	-0.641655879	Down
ENSG00000175806	MSRA	681	435	26.061872	19.0380883	3.55E-05	-0.633438526	Down
ENSG00000134250	NOTCH2	3637	2356	16.66602425	10.73787447	5.22E-10	-0.614296163	Down
ENSG00000173068	BNC2	370	241	3.776233682	3.352857369	0.012052985	-0.604312607	Down
ENSG00000140265	ZSCAN29	346	522	3.931323614	4.079176	0.000974273	0.603534096	Up
ENSG00000127774	EMC6	951	1437	93.2899	143.6035	2.84E-07	0.606825533	Up
ENSG00000153879	CEBPG	723	1099	9.711169	14.6717	1.40E-06	0.615211488	Up
ENSG00000185112	FAM43A	226	345	4.14451	6.49944	0.011858232	0.619618854	Up
ENSG00000132109	TRIM21	1152	1758	27.839126	42.64755	2.39E-08	0.621171001	Up
ENSG00000096654	ZNF184	256	392	4.306071	6.38859	0.004141393	0.624337648	Up
ENSG00000108771	DHX58	213	327	3.952304	7.259867628	0.013803262	0.627600704	Up
ENSG00000126226	PCID2	1103	1692	33.78808075	50.15391309	1.87E-08	0.628646341	Up
ENSG00000055483	USP36	2892	4436	28.91754023	45.4238925	5.37E-11	0.628865779	Up
ENSG00000005801	ZNF195	1083	1665	26.90107372	35.25770321	1.70E-08	0.631826659	Up
ENSG00000138757	G3BP2	2026	3127	34.97712102	51.11106119	1.40E-10	0.63773027	Up
ENSG00000158373	HIST1H2BD	337	523	29.95662	47.37443	0.000205821	0.64418671	Up

ENSG00000275183	LENG9	307	478	6.89833	10.993	0.00037482	0.648714761	Up
ENSG00000156374	PCGF6	316	493	8.330011996	13.023799	0.000257674	0.651654134	Up
ENSG00000103888	CEMIP	939	1465	6.007709316	9.449718891	1.12E-08	0.652942736	Up
ENSG00000086827	ZW10	537	842	9.71476	15.0738	1.28E-06	0.659653127	Up
ENSG00000163545	NUAK2	376	590	5.23558	8.28248	3.64E-05	0.66025719	Up
ENSG00000130803	ZNF317	638	1003	7.967405	12.45676	1.90E-07	0.663620904	Up
ENSG00000089335	ZNF302	263	414	5.676202229	8.320204127	0.000740969	0.664145706	Up
ENSG00000130589	HELZ2	11476	18039	47.88082	77.4802	5.22E-14	0.664320913	Up
ENSG00000180573	HIST1H2AC	760	1197	40.85269	69.82615	2.91E-08	0.666428703	Up
ENSG00000138050	THUMPD2	230	363	6.020769	9.233294942	0.001988059	0.667573599	Up
ENSG00000136826	KLF4	774	1224	14.6690094	21.7897012	1.61E-08	0.672283979	Up
ENSG00000141682	PMAIP1	701	1113	25.37413052	39.518562	2.85E-08	0.677965318	Up
ENSG00000273542	HIST1H4K	278	442	1.93549	3.06769	0.000251718	0.678625953	Up
ENSG00000146674	IGFBP3	2265	3597	48.943374	78.7212204	1.42E-12	0.678885741	Up
ENSG00000156232	WHAMM	352	566	3.34965	5.323678093	1.20E-05	0.695321919	Up
ENSG00000113389	NPR3	858	1379	10.78052383	19.00216192	9.97E-10	0.69571665	Up
ENSG00000115963	RND3	1198	1928	25.1212194	39.75162144	3.23E-11	0.697826897	Up
ENSG00000126217	MCF2L	138	223	1.961258613	3.134765856	0.034831374	0.699694512	Up
ENSG00000258947	TUBB3	607	983	11.728601	19.82208349	1.83E-08	0.706324547	Up
ENSG00000173559	NABP1	372	605	8.970551	14.451562	2.86E-06	0.711792557	Up
ENSG00000170345	FOS	235	383	7.542794883	10.49296686	0.000279879	0.713839324	Up
ENSG00000003989	SLC7A2	178	291	1.46066834	2.344085643	0.002962322	0.717414326	Up
ENSG00000171100	MTM1	135	221	3.436254983	3.885173533	0.025088607	0.718210002	Up
ENSG00000111011	RSRC2	1137	1874	18.58100668	31.8111566	2.52E-12	0.732189427	Up
ENSG00000171700	RGS19	236	390	7.34514	12.36128	0.000118637	0.733796426	Up
ENSG00000160888	IER2	2632	4348	61.31714	104.27458	1.44E-15	0.735817891	Up
ENSG00000197019	SERTAD1	366	608	8.96879	14.9694	6.49E-07	0.742302509	Up
ENSG00000163312	HELQ	129	215	3.030402	4.803504252	0.017787052	0.743733137	Up
ENSG00000116761	CTH	520	865	18.284863	30.30780423	8.08E-09	0.744792724	Up
ENSG00000268043	NBPF12	154	258	1.125113499	2.028422319	0.003334621	0.751999825	Up
ENSG00000104825	NFKBIB	448	751	13.74575311	22.221792	2.51E-08	0.755697989	Up
ENSG00000117899	MESDC2	1187	1989	20.2566	33.628609	1.73E-13	0.756034603	Up
ENSG00000004139	SARM1	126	213	1.602730001	1.703080119	0.012336092	0.763968122	Up

ENSG00000272752	G3L5P-PVRIG2P-PI	657	1109	19.70516761	34.775655	8.94E-11	0.766141171	Up
ENSG00000170684	ZNF296	143	242	4.488413327	6.892508025	0.004072042	0.766153426	Up
ENSG00000116717	GADD45A	770	1302	24.91838565	42.60221837	9.42E-12	0.768794554	Up
ENSG00000119508	NR4A3	430	732	4.371061116	7.304097187	1.03E-08	0.777794192	Up
ENSG00000143507	DUSP10	108	185	2.152675	3.691506	0.025212448	0.782034339	Up
ENSG00000173530	TNFRSF10D	142	245	2.273981838	4.14478	0.001825225	0.793890466	Up
ENSG00000197136	PCNX3	1561	2693	9.67382	16.9708	2.22E-16	0.798171902	Up
ENSG00000243716	NPIPB5	197	341	7.40986258	8.514922519	5.21E-05	0.799915048	Up
ENSG00000139438	FAM222A	101	177	1.2454087	2.323793	0.018965089	0.814288941	Up
ENSG00000101255	TRIB3	2180	3804	42.41960731	75.13586	0	0.814738982	Up
ENSG00000176907	C8orf4	696	1225	24.4438	42.1737	2.78E-13	0.826470504	Up
ENSG00000185022	MAFF	840	1479	14.932963	26.633697	1.64E-14	0.827184099	Up
ENSG00000221944	TIGD1	120	213	2.57037	4.49051	0.002553411	0.833713289	Up
ENSG00000125347	IRF1	615	1088	15.70445546	26.84868633	9.77E-13	0.833725583	Up
ENSG00000203812	HIST2H2AA3	271	481	8.361453465	15.260583	1.69E-07	0.836959577	Up
ENSG00000089597	GANAB	6410	11366	86.42789937	153.4979207	0	0.83808985	Up
ENSG00000196646	ZNF136	108	193	1.847233767	2.846936836	0.005133337	0.842748011	Up
ENSG00000129757	CDKN1C	150	270	4.516198615	8.107176484	0.000129075	0.85499572	Up
ENSG00000151617	EDNRA	269	488	5.928135947	8.701468	3.35E-08	0.868397407	Up
ENSG00000164877	MICALL2	138	253	1.72265774	3.312919982	0.000129103	0.88092828	Up
ENSG00000185864	NPIPB4	75	138	1.704362917	2.301808739	0.039308097	0.881626335	Up
ENSG00000186487	MYT1L	72	133	1.24431911	2.327806014	0.04757059	0.886820693	Up
ENSG00000113739	STC2	1068	1982	11.083768	19.99858	0	0.903205831	Up
ENSG00000167460	TPM4	8198	15238	147.5400579	273.885375	0	0.906110568	Up
ENSG00000139289	PHLDA1	387	725	3.8184452	7.1438353	3.80E-12	0.915533879	Up
ENSG00000182903	ZNF721	162	305	4.910638741	4.308503104	3.82E-06	0.919929533	Up
ENSG00000169105	CHST14	534	1010	9.477341271	19.48383086	2.78E-15	0.929860929	Up
ENSG00000091986	CCDC80	329	625	4.282630283	6.232947615	1.79E-11	0.935269125	Up
ENSG00000060491	OGFR	4060	7758	58.2187915	115.430097	0	0.945885115	Up
ENSG00000266202	RP1-66C13.4	124	238	5.61992189	9.051273666	4.39E-05	0.946154743	Up
ENSG00000196843	ARID5A	94	181	1.8936943	3.609910001	0.00096039	0.948756312	Up
ENSG00000155090	KLF10	592	1135	10.142639	19.227346	0	0.949563478	Up
ENSG00000175197	DDIT3	402	774	23.758773	45.90318	8.86E-14	0.95504035	Up

ENSG00000153531	ADPRHL1	100	194	3.22215617	6.471963197	0.000349719	0.959991567	Up
ENSG00000139174	PRICKLE1	80	156	1.031110865	2.145490059	0.003097052	0.965391988	Up
ENSG00000165806	CASP7	516	1005	12.14463565	22.93923881	1.11E-16	0.972071018	Up
ENSG00000279765	RP11-437B10.1	2190	4335	33.61594888	52.00614863	0	0.996602117	Up
ENSG00000185338	SOCS1	58	116	2.79382	5.75056	0.025811572	0.997840608	Up
ENSG00000166897	ELFN2	158	316	0.75909175	1.5473307	1.12E-07	1.00667511	Up
ENSG00000196787	HIST1H2AG	183	373	4.54023	9.19789	2.13E-09	1.034630995	Up
ENSG00000180425	C11orf71	53	109	1.99639	4.02377	0.024713538	1.036383904	Up
ENSG00000148339	SLC25A25	742	1514	10.0064279	20.25316277	0	1.039614794	Up
ENSG00000276903	HIST1H2AL	117	240	4.354452	11.736411	2.64E-06	1.041219467	Up
ENSG00000255150	EID3	78	161	2.77461	5.78885	0.000434696	1.046593688	Up
ENSG00000023608	SNAPC1	553	1136	14.01357458	28.154995	0	1.048955672	Up
ENSG00000130956	HABP4	183	378	3.119947629	6.481320874	7.43E-10	1.05378415	Up
ENSG00000177721	ANXA2R	104	217	4.54325	7.69188	5.93E-06	1.064786722	Up
ENSG00000136244	IL6	121	257	6.384780309	13.36440905	1.95E-07	1.091467603	Up
ENSG00000164683	HEY1	63	135	1.722898901	3.145969769	0.001169507	1.097622904	Up
ENSG00000188818	ZDHHC11	46	99	0.994350188	2.385994945	0.023507446	1.098806436	Up
ENSG00000144655	CSRNP1	447	956	6.508850247	14.00500997	0	1.106648111	Up
ENSG00000143367	TUFT1	508	1092	8.36096098	17.64873763	0	1.114212383	Up
ENSG00000138061	CYP1B1	70	152	0.770615652	1.624285371	0.000199195	1.117952789	Up
ENSG00000185947	ZNF267	75	163	1.306334	2.932719	7.88E-05	1.120037664	Up
ENSG00000143333	RGS16	49	111	0.977213	2.19773	0.002697992	1.173091883	Up
ENSG00000099860	GADD45B	419	942	14.655497	31.298652	0	1.178470091	Up
ENSG00000123095	BHLHE41	47	107	0.587395	1.281519047	0.00358866	1.179415781	Up
ENSG00000139269	INHBE	95	217	1.87958778	4.384616097	1.63E-07	1.193895343	Up
ENSG00000171368	TPPP	111	257	0.779508	1.82091	3.58E-09	1.214707044	Up
ENSG00000168675	LDLRAD4	34	80	0.300046483	1.431352036	0.032362285	1.219110797	Up
ENSG00000197714	ZNF460	33	79	0.86988354	1.175920558	0.027506866	1.242873416	Up
ENSG00000068078	FGFR3	123	295	1.942379611	3.550054426	2.92E-11	1.266169971	Up
ENSG00000270276	HIST2H4B	49	120	2.84581	7.04358	0.000173417	1.284479356	Up
ENSG00000162772	ATF3	534	1302	12.91075719	35.53113292	0	1.295874643	Up
ENSG00000204611	ZNF616	58	143	0.954966473	3.760728734	1.19E-05	1.297109254	Up
ENSG00000278828	HIST1H3H	236	584	8.33656	22.16958	0	1.314909988	Up

ENSG00000224420	ADM5	32	83	1.01147	2.64888	0.004447048	1.356049587	Up
ENSG00000115844	DLX2	78	200	1.572100621	4.109981041	7.56E-09	1.357577355	Up
ENSG00000169330	KIAA1024	41	106	0.324699	0.821652	0.000253689	1.358075739	Up
ENSG00000128965	CHAC1	175	450	5.954213994	15.39714313	0	1.368719085	Up
ENSG00000087074	PPP1R15A	746	1924	12.8182095	33.28929495	0	1.377385216	Up
ENSG00000132801	ZSWIM3	47	123	0.873826791	2.239715	2.33E-05	1.378507194	Up
ENSG00000157601	MX1	108	281	1.208725781	3.300951765	1.24E-12	1.382093673	Up
ENSG00000176809	LRRC37A3	55	144	0.496856365	1.384931134	1.84E-06	1.38219558	Up
ENSG00000107742	SPOCK2	32	86	0.335977089	0.757991032	0.001582333	1.406600993	Up
ENSG00000241058	NSUN6	70	188	1.810892378	4.739264366	4.66E-09	1.422580763	Up
ENSG00000124257	NEURL2	24	66	0.980181	2.75451	0.018661262	1.429020976	Up
ENSG00000276410	HIST1H2BB	57	157	4.77985	9.581417	7.85E-08	1.455458038	Up
ENSG00000131471	AOC3	34	96	0.472987083	1.546439093	0.000148851	1.478803218	Up
ENSG00000130487	KLHDC7B	23	66	0.355876	1.02938	0.010293211	1.487590481	Up
ENSG00000278677	HIST1H2AM	102	287	6.460322	13.56666	9.55E-15	1.494033275	Up
ENSG00000105499	PLA2G4C	56	159	1.44922243	4.62845579	2.26E-08	1.498622943	Up
ENSG00000172345	STARD5	21	61	0.228943	0.6611403	0.019205044	1.5007108	Up
ENSG00000184730	APOBR	24	70	0.225087032	0.663083106	0.004323339	1.512526014	Up
ENSG00000171951	SCG2	38	110	0.684349799	1.946553107	1.13E-05	1.517521524	Up
ENSG00000125266	EFNB2	38	110	0.43725	1.24717	1.13E-05	1.517521524	Up
ENSG00000125740	FOSB	36	108	0.465548215	1.504450227	6.64E-06	1.566998793	Up
ENSG00000162733	DDR2	20	61	0.22642069	0.63025274	0.010174874	1.567404301	Up
ENSG00000205085	FAM71F2	47	146	0.516323315	1.682602193	7.97E-09	1.623753597	Up
ENSG00000260458	KCNJ18	18	60	0.387511	1.30597	0.003819793	1.687409534	Up
ENSG00000148677	ANKRD1	92	298	2.38186	7.61802	0	1.695224504	Up
ENSG00000125508	SRMS	35	120	0.566875	1.6181845	3.48E-08	1.756894221	Up
ENSG00000102890	ELMO3	22	77	0.450876738	1.560620998	6.82E-05	1.767569015	Up
ENSG00000147174	ACRC	18	64	0.286559513	1.017931254	0.000724741	1.778856611	Up
ENSG00000179148	ALOXE3	15	54	0.209347665	0.7530314	0.004947469	1.784369291	Up
ENSG00000145506	NKD2	40	142	0.7748856	2.81066	2.62E-10	1.810704157	Up
ENSG00000177606	JUN	400	1404	5.03755	17.9893	0	1.820412067	Up
ENSG00000105963	ADAP1	18	67	0.396290075	1.511028123	0.000201905	1.843828236	Up
ENSG00000159753	CARMIL2	30	110	0.302343094	1.044149951	4.26E-08	1.847438284	Up

ENSG00000203814	HIST2H2BF	27	100	1.797673	4.893552	2.44E-07	1.857564685	Up
ENSG00000100918	REC8	31	116	0.72546	2.178172001	8.05E-09	1.877695703	Up
ENSG00000010319	SEMA3G	17	65	0.155908686	0.577892557	0.000212208	1.878275321	Up
ENSG00000128564	VGF	40	151	0.628349	2.398183115	7.47E-12	1.898684974	Up
ENSG00000277224	HIST1H2BF	32	122	1.11627	3.35666	1.53E-09	1.905559948	Up
ENSG00000113070	HBEGF	66	249	1.38756	5.18068	0	1.909381383	Up
ENSG00000124216	SNAI1	29	113	0.932194	3.60198	5.47E-09	1.932965631	Up
ENSG00000100156	SLC16A8	9	39	0.258916974	1.016020894	0.026574156	1.996993567	Up
ENSG00000171385	KCND3	18	76	0.1943928	0.485574112	3.83E-06	2.022839375	Up
ENSG00000137877	SPTBN5	15	64	0.0464566	0.2006405	5.86E-05	2.024868934	Up
ENSG00000106948	AKNA	33	137	0.248366157	1.909230508	6.82E-12	2.028513976	Up
ENSG00000117245	KIF17	10	44	0.121517959	0.534410672	0.006407008	2.030665903	Up
ENSG00000276966	HIST1H4E	22	94	8.27535	14.71851	4.58E-08	2.051605112	Up
ENSG00000135436	FAM186B	8	37	0.0868631	0.467604	0.027167825	2.073092456	Up
ENSG00000128165	ADM2	83	369	0.788135	3.533811	0	2.149103833	Up
ENSG00000273802	HIST1H2BG	22	106	1.313513	2.93829	2.02E-10	2.223001717	Up
ENSG00000126562	WNK4	17	85	0.1935501	0.973967	2.27E-08	2.259505184	Up
ENSG00000130653	PNPLA7	7	39	0.116742091	0.521297373	0.003664591	2.314105433	Up
ENSG00000119630	PGF	9	49	0.228422754	1.273492066	0.0002037	2.318013449	Up
ENSG00000130518	KIAA1683	20	107	0.30404988	1.190053653	1.59E-11	2.366846107	Up
ENSG00000168062	BATF2	151	798	4.013191588	18.29846698	0	2.404940061	Up
ENSG00000086730	LAT2	5	33	0.121219653	1.12429011	0.008480457	2.487487079	Up
ENSG00000196890	HIST3H2BB	14	85	0.346249	2.11379	8.23E-10	2.520384254	Up
ENSG00000197406	DIO3	11	72	0.270989	1.78581	1.62E-08	2.603021775	Up
ENSG00000101306	MYLK2	7	48	0.103165439	0.683046115	3.25E-05	2.60605313	Up
ENSG00000204103	MAFB	52	329	0.73581	4.68517	0	2.647142137	Up
ENSG00000146592	CREB5	4	31	0.05243474	0.424118845	0.007132088	2.657030744	Up
ENSG00000144488	ESPNL	6	44	0.071388795	0.490372166	7.74E-05	2.672740674	Up
ENSG00000275713	HIST1H2BH	4	32	0.115833636	7.882844	0.004081337	2.701253032	Up
ENSG00000105550	FGF21	3	26	0.199395778	1.643491	0.030372662	2.725406054	Up
ENSG00000128917	DLL4	15	124	0.19659	1.62998	0	2.966942217	Up
ENSG00000169085	C8orf46	3	35	0.056730271	0.652855946	0.000160484	3.138763773	Up
ENSG00000160161	CILP2	6	62	0.05976379	0.629432874	3.25E-09	3.157013713	Up

ENSG00000164362	TERT	4	45	0.054935414	0.48626442	2.29E-06	3.178865989	Up
ENSG00000080031	PTPRH	2	28	0.025403186	0.30476201	0.002002481	3.227394735	Up
ENSG00000205710	C17orf107	2	32	0.0277776	0.542094	0.000171462	3.413049587	Up
ENSG00000134198	TSPAN2	1	22	0.020644931	0.560597621	0.013359649	3.448712664	Up
ENSG00000140488	CELF6	1	23	0.028636443	0.383664054	0.007089726	3.509784975	Up
ENSG00000135702	CHST5	1	24	0.024782174	0.5932463	0.003747114	3.568376624	Up
ENSG00000118160	SLC8A2	5	92	0.079155744	1.165762726	0	3.935792731	Up
ENSG00000198576	ARC	16	264	0.220636	3.68856	0	3.963487539	Up
ENSG00000149781	FERMT3	2	70	0.089554185	1.767994961	8.10E-15	4.515456497	Up
ENSG00000115850	LCT	0	27	0	0.204913	4.45E-05	4.642302508	Up
ENSG00000010295	IFFO1	0	38	0	0.614932659	2.64E-08	5.118521953	Up
ENSG00000185668	POU3F1	0	46	0	0.713324	1.24E-10	5.386915915	Up
ENSG00000074181	NOTCH3	4	219	0.036083126	1.286479	0	5.433536957	Up

Supplementary Table S5: GO enrichment of 233 DEGs between HOXD-AS2 knockdown and control Bel-7402 cells

Term	Count	%	P-Value	Genes
GO:0006334~nucleosome assembly	13	5.60344828	2.04E-08	HIST1H2BB, BRD2, HIST1H4K, HIST1H2BD, HIST1H2BF, HIST1H2BG, HIST2H2BF, HIST1H2BH, SMYD3, HIST1H4E, HIST3H2BB, HIST1H3H, HIST2H4B
GO:0048661~positive regulation of smooth muscle cell proliferation	7	3.01724138	8.20E-05	NOTCH3, CDH13, IL6, JUN, TGFBR2, HBEGF, NR4A3
GO:0061314~Notch signaling involved in heart development	4	1.72413793	1.37E-04	NOTCH2, HEY1, DLL4, SNAI1
GO:0045746~negative regulation of Notch signaling pathway	5	2.15517241	3.81E-04	DLX2, HEY1, CHAC1, DLL4, C8ORF4
GO:0070059~intrinsic apoptotic signaling pathway in response to endoplasmic reticulum stress	5	2.15517241	6.33E-04	CHAC1, TRIB3, PMAIP1, PPP1R15A, DDIT3
GO:0045944~positive regulation of transcription from RNA polymerase II promoter	25	10.7758621	7.42E-04	AKNA, HELZ2, ANKRD1, FOS, HEY1, POU3F1, SERTAD1, MAFF, IL6, MAFB, CEBPG, SMYD3, TEAD2, NR4A3, FOSB, DDIT3, NOTCH3, DLX2, CDH13, ADRB2, ATF3, CSRNP1, JUN, IRF1, KLF4
GO:0006915~apoptotic process	17	7.32758621	0.0014111	NUAK2, PTPRH, TGFBR2, PMAIP1, ELMO3, DDIT3, NOTCH2, CASP7, CSRNP1, C8ORF4, IRF1, MX1, GADD45B, IGFBP3, GADD45A, PPP1R15A, PHLDA1
GO:0006342~chromatin silencing	5	2.15517241	0.0020595	HIST2H2AA3, HIST1H2AC, HIST1H2AG, HIST1H2AM, HIST1H2AL
GO:0003416~endochondral bone growth	3	1.29310345	0.0020923	FGFR3, BNC2, DDR2
GO:0035914~skeletal muscle cell differentiation	5	2.15517241	0.0028214	MAFF, FOS, ATF3, MYLK2, ANKRD1
GO:0032200~telomere organization	4	1.72413793	0.0040551	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:0000122~negative regulation of transcription from RNA polymerase II promoter	18	7.75862069	0.0062794	KLF10, ZNF296, TRIB3, ANKRD1, NR4A3, FOSB, SNAI1, DDIT3, NOTCH3, CDKN1C, DLX2, ATF3, HEY1, PCGF6, DLL4, ZNF136, BHLHE41, KLF4
GO:0006335~DNA replication-dependent nucleosome assembly	4	1.72413793	0.0065805	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:0006469~negative regulation of protein kinase activity	6	2.5862069	0.0068834	IL6, SOCS1, SMYD3, TRIB3, GADD45B, GADD45A
GO:0009409~response to cold	4	1.72413793	0.009146	FOS, IL6, ADRB2, VGF
GO:0006366~transcription from RNA polymerase II promoter	14	6.03448276	0.0093151	AKNA, MAFF, MAFB, CEBPG, CREB5, FOSB, FOS, DLX2, ATF3, JUN, ZNF136, CSRNP1, IRF1, KLF4
GO:0000183~chromatin silencing at rDNA	4	1.72413793	0.0098662	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:0071260~cellular response to mechanical stimulus	5	2.15517241	0.0105485	GCLC, IRF1, HABP4, ANKRD1, GADD45A
GO:0045444~fat cell differentiation	5	2.15517241	0.0116002	INHBB, ALOXE3, SOCS1, NR4A3, KLF4
GO:0007219~Notch signaling pathway	6	2.5862069	0.0126751	NOTCH3, NOTCH2, HEY1, CHAC1, DLL4, TGFBR2
GO:0051290~protein heterotetramerization	4	1.72413793	0.0139535	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:1904837~beta-catenin-TCF complex assembly	4	1.72413793	0.0148696	HIST1H4K, HIST1H4E, TERT, HIST2H4B
GO:0007568~aging	7	3.01724138	0.014894	CDKN1C, FOS, IL6, GCLC, CASP7, JUN, TGFBR2
GO:0035994~response to muscle stretch	3	1.29310345	0.015466	FOS, JUN, ANKRD1
GO:0032870~cellular response to hormone stimulus	4	1.72413793	0.0168019	FOS, PGF, JUN, FOSB
GO:0030968~endoplasmic reticulum unfolded protein response	4	1.72413793	0.0168019	CTH, STC2, FGF21, PPP1R15A
GO:0045892~negative regulation of transcription, DNA-templated	13	5.60344828	0.0177924	GCLC, KLF10, ARID5A, TRIB3, DDIT3, CDKN1C, PRICKLE1, HEY1, PCGF6, JUN, IRF1, BHLHE41, KLF4
GO:0051591~response to cAMP	4	1.72413793	0.0178182	FOS, JUN, FOSB, VGF
GO:0045653~negative regulation of megakaryocyte differentiation	3	1.29310345	0.0194116	HIST1H4K, HIST1H4E, HIST2H4B
GO:0008285~negative regulation of cell proliferation	11	4.74137931	0.0218176	NOTCH2, CDH13, HIST1H2AC, IL6, CYP1B1, JUN, DLL4, KLF10, IRF1, IGFBP3, KLF4
GO:0045814~negative regulation of gene expression, epigenetic	4	1.72413793	0.0222197	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:0071277~cellular response to calcium ion	4	1.72413793	0.0234043	AKR1C3, FOS, JUN, FOSB
GO:1902895~positive regulation of pri-miRNA transcription from RNA polymerase II promoter	3	1.29310345	0.0237306	FOS, JUN, TERT
GO:0030335~positive regulation of cell migration	7	3.01724138	0.024035	CDH13, SEMA3G, CARMIL2, FERMT3, CEMIP, HBEGF, SNAI1
GO:0007050~cell cycle arrest	6	2.5862069	0.0278896	CDKN1C, NOTCH2, IRF1, GADD45A, PPP1R15A, DDIT3
GO:0016233~telomere capping	3	1.29310345	0.030866	HIST1H4K, HIST1H4E, HIST2H4B
GO:0009612~response to mechanical stimulus	4	1.72413793	0.03409	INHBB, JUN, TGFBR2, FOSB
GO:0019369~arachidonic acid metabolic process	3	1.29310345	0.0360331	CYP1B1, ALOXE3, PLA2G4C
GO:0002227~innate immune response in mucosa	3	1.29310345	0.0360331	HIST1H2BD, HIST1H2BF, HIST1H2BG
GO:0045815~positive regulation of gene expression, epigenetic	4	1.72413793	0.0386458	HIST1H4K, HIST1H4E, HIST1H3H, HIST2H4B
GO:0060395~SMAD protein signal transduction	4	1.72413793	0.0386458	INHBB, FOS, INHBE, JUN
GO:0006336~DNA replication-independent nucleosome assembly	3	1.29310345	0.0387328	HIST1H4K, HIST1H4E, HIST2H4B
GO:0006357~regulation of transcription from RNA polymerase II promoter	11	4.74137931	0.0410987	MAFF, FOS, BRD2, ATF3, BATF2, MAFB, SMARCD3, CEBPG, ARID5A, FOSB, ZSCAN29
GO:0032436~positive regulation of proteasomal ubiquitin-dependent protein catabolic process	4	1.72413793	0.0418465	GCLC, NKD2, PRICKLE1, TRIB3
GO:2000352~negative regulation of endothelial cell apoptotic process	3	1.29310345	0.0443536	FGF21, TERT, SCG2
GO:0001569~patterning of blood vessels	3	1.29310345	0.0443536	EDNRA, DLL4, TGFBR2
GO:0071395~cellular response to jasmonic acid stimulus	2	0.86206897	0.047261	AKR1C3, AKR1C2
GO:0006534~cysteine metabolic process	2	0.86206897	0.047261	CTH, GCLC
GO:0043542~endothelial cell migration	3	1.29310345	0.0472703	CDH13, CYP1B1, SCG2
GO:0048662~negative regulation of smooth muscle cell proliferation	3	1.29310345	0.0472703	NPR3, IGFBP3, KLF4
GO:0045893~positive regulation of transcription, DNA-templated	12	5.17241379	0.0473831	CDKN1C, FOS, IL6, SMARCD3, PCID2, JUN, IRF1, CREB5, POU3F1, SNAI1, KLF4, DDIT3

Supplementary Table S6: KEGG pathway enrichment of 233 DEGs between HOXD-AS2 knockdown and control Bel-7402 cells

KEGG Term	Count	P-Value	Genes
hsa05322:Systemic lupus erythematosus	17	9.21E-12	HIST2H2AA3, HIST1H2BB, HIST1H2AC, HIST1H2BD, HIST1H4K, HIST1H2BF, HIST1H2AG, HIST1H2BG, HIST1H2BH, TRIM21, HIST2H4B, HIST2H2BF, HIST1H4E, HIST3H2BB, HIST1H2AM, HIST1H2AL, HIST1H3H
hsa05034:Alcoholism	18	6.66E-11	HIST2H2AA3, HIST1H2BB, HIST1H2AC, HIST1H2BD, HIST1H4K, HIST1H2BF, HIST1H2AG, HIST1H2BG, HIST1H2BH, CREB5, FOSB, HIST2H4B, HIST2H2BF, HIST1H4E, HIST3H2BB, HIST1H2AM, HIST1H2AL, HIST1H3H
hsa05203:Viral carcinogenesis	13	1.12E-05	HIST1H2BB, HIST1H4K, HIST1H2BD, HIST1H2BF, HIST1H2BG, HIST2H2BF, JUN, HIST1H2BH, HIST1H4E, CREB5, PMAIP1, HIST3H2BB, HIST2H4B
hsa04010:MAPK signaling pathway	10	0.005202369	FOS, FGFR3, JUN, TGFBR2, DUSP10, FGF21, GADD45B, PLA2G4C, GADD45A, DDIT3
hsa05031:Amphetamine addiction	5	0.010254039	FOS, ARC, JUN, CREB5, FOSB
hsa05133:Pertussis	5	0.015844245	FOS, IL6, CASP7, JUN, IRF1
hsa04668:TNF signaling pathway	5	0.049414139	FOS, IL6, CASP7, JUN, CREB5