Supplementary Table 1. Ubiquitin-related genes

iUUCD	MsigDB	Human E3 ubiquitin ligases database
ATG7	ABRAXAS1	AFF4
NAE1	ABRAXAS2	AMFR
SAE1	AC023512.1	ANAPC11
UBA1	ACTB	ANKIB1
UBA2	ACTL6A	AREL1
UBA3	ACTR5	ARIH1
UBA5	ACTR8	ARIH2
UBA6	ADRB2	BARD1
UBA7	ADRM1	BFAR
ATG10	AIRE	BIRC2
ATG3	AMFR	BIRC3
BIRC6	ANAPC1	BIRC7
CDC34	ANAPC10	BIRC8
RP11-463D19.2	ANAPC11	BMI1
TMEM189-UBE2V1	ANAPC13	BRAP
TSG101	ANAPC2	BRCA1
UBE2A	ANAPC4	CBL
UBE2B	ANAPC5	CBLB
UBE2C	ANAPC7	CBLC
UBE2D1	ANKZF1	CBLL1
UBE2D2	APC	CCDC36
UBE2D3	AR	CCNB1IP1
UBE2D4	AREL1	CGRRF1
UBE2E1	ARIH2	CHFR
UBE2E2	ARRB1	CNOT4
UBE2E3	ARRB2	CUL9
UBE2F	ASB1	CYHR1
UBE2G1	ASB10	DCST1
UBE2G2	ASB11	DTX1
UBE2H	ASB12	DTX2
UBE2I	ASB13	DTX3
UBE2J1	ASB14	DTX3L
UBE2J2	ASB15	DTX4
UBE2K	ASB16	DZIP3
UBE2L3	ASB17	E4F1
UBE2L5P	ASB18	FANCL
UBE2L6	ASB2	G2E3
UBE2M	ASB3	HACE1
UBE2N	ASB4	HECTD1
UBE2NL	ASB5	HECTD2
UBE2O	ASB6	HECTD3
UBE2Q1	ASB7	HECTD4

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
UBE2Q2	ASB8	HECW1
UBE2R2	ASB9	HECW2
UBE2S	ASXL1	HERC1
UBE2T	ASXL2	HERC2
UBE2U	ATG7	HERC3
UBE2V1	ATXN3	HERC4
UBE2V2	ATXN3L	HERC5
UBE2W	ATXN7	HERC6
UBE2Z	AUP1	HLTF
UFC1	AXIN1	HUWE1
AAMP	AXIN2	IRF2BP1
ABTB1	BABAM1	IRF2BP2
ABTB2	BABAM2	IRF2BPL
AC026348.1	BAG6	ITCH
AHCTF1	BAP1	KCMF1
AHI1	BARD1	KMT2C
AHR	BCAP31	KMT2D
AIRE	BCL10	LNX1
AMBRA1	BECN1	LNX2
AMFR	BIRC2	LONRF1
ANAPC1	BIRC3	LONRF2
ANAPC10	BIRC6	LONRF3
ANAPC11	BLMH	LRSAM1
ANAPC13	BRCA1	LTN1
ANAPC2	BRCC3	MAEA
ANAPC4	BTBD1	MAP3K1
ANAPC5	BTBD6	MDM2
ANAPC7	BTRC	MDM4
ANKIB1	CAV1	MECOM
APAF1	CBL	MEX3A
AREL1	CBLB	MEX3B
ARIH1	CBLC	MEX3C
ARIH2	CBLL2	MEX3D
ARMC4	CCDC47	MGRN1
ARNT	CCNA1	MIB1
ARPC1A	CCNA2	MIB2
ARPC1B	CCNF	MID1
ASB1	CCP110	MID2
ASB11	CDC16	MKRN1
ASB12	CDC20	MKRN2
ASB14	CDC23	MKRN3
ASB15	CDC25A	MKRN4P

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
ASB2	CDC26	MNAT1
ASB4	CDC27	MSL2
ASB6	CDC34	MUL1
ASB7	CDC73	MYCBP2
ASB8	CDK1	MYLIP
ASB9	CFTR	NEDD4
ATG16L1	CLSPN	NEDD4L
ATG16L2	COP1	NEURL1
ATG5	CTR9	NEURL1B
AURKA	CUL1	NEURL3
BACH1	CUL2	NFX1
BACH2	CUL3	NFXL1
BARD1	CUL4A	NHLRC1
BAZ1A	CUL4B	NOSIP
BAZ1B	CUL5	NSMCE1
BCL6	CUL7	PARK2
BCL6B	CYLD	PCGF1
BFAR	DCAF1	PCGF2
BIRC2	DDB1	PCGF3
BIRC3	DDB2	PCGF5
BIRC7	DDX58	PCGF6
BOP1	DERL1	PDZRN3
BPTF	DERL2	PDZRN4
BRAP	DERL3	PELI1
BRCA1	DET1	PELI2
BRWD1	DNAJB12	PELI3
BRWD3	DNAJB14	PEX10
BTBD1	DNAJB2	PEX12
BTBD11	DNAJB9	PEX2
BTBD18	DNAJC10	PHF7
BTBD19	DNAJC18	PHRF1
BTBD2	DTX3L	PJA1
BTBD3	DZIP3	PJA2
BTBD6	ECPAS	PLAG1
BTBD7	EDEM1	PLAGL1
BTBD8	EDEM2	PML
BTBD9	EDEM3	PPIL2
BTRC	ELOB	PRPF19
BUB3	ELOC	RAD18
C10orf90	EP300	RAG1
C17orf78	ERCC8	RAPSN
CADPS2	ERLIN1	RBBP6

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
CBL	ERLIN2	RBCK1
CBLB	ESR1	RBX1
CBLC	FAF2	RC3H1
CBLL1	FANCL	RC3H2
CBX4	FBXL12	RCHY1
CCIN	FBXL13	RFFL
CCNB1IP1	FBXL14	RFPL1
CCNF	FBXL15	RFPL2
CCRL2	FBXL16	RFPL3
CDC16	FBXL18	RFPL4A
CDC20	FBXL19	RFPL4AL1
CDC20B	FBXL20	RFPL4B
CDC23	FBXL22	RFWD2
CDC26	FBXL3	RFWD3
CDC27	FBXL4	RING1
CDC40	FBXL5	RLF
CDCA3	FBXL7	RLIM
CDRT1	FBXL8	RMND5A
CFAP44	FBXO10	RMND5B
CFAP52	FBXO11	RNF10
CFAP57	FBXO15	RNF103
CH507-9B2.5	FBXO17	RNF11
CHAF1B	FBXO2	RNF111
CHD3	FBXO21	RNF112
CHD4	FBXO22	RNF113A
CHD5	FBXO27	RNF113B
CHFR	FBXO30	RNF114
CIAO1	FBXO31	RNF115
CISH	FBXO32	RNF121
CNOT4	FBXO4	RNF122
COMMD3-BMI1	FBXO40	RNF123
COPA	FBXO41	RNF125
COPB2	FBXO44	RNF126
CORO1A	FBXO6	RNF128
CORO1B	FBXO7	RNF13
CORO1C	FBXO9	RNF130
CORO2A	FBXW10	RNF133
CORO2B	FBXW11	RNF135
CORO6	FBXW12	RNF138
CORO7	FBXW2	RNF139
CORO7-PAM16	FBXW4	RNF14
CPNE1	FBXW5	RNF141

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
CRBN	FBXW7	RNF144A
CREBBP	FBXW8	RNF144B
CSTF1	FBXW9	RNF145
CUL1	FKBP8	RNF146
CUL2	FOXK1	RNF148
CUL3	FOXK2	RNF149
CUL4A	FOXO4	RNF150
CUL4B	FOXRED2	RNF151
CUL5	FZR1	RNF152
CUL7	GAN	RNF157
CUL9	GATA3	RNF165
DAW1	GLMN	RNF166
DCAF1	H2AC1	RNF167
DCAF10	H2AC11	RNF168
DCAF11	H2AC12	RNF169
DCAF12	H2AC13	RNF17
DCAF12L1	H2AC14	RNF170
DCAF12L2	H2AC15	RNF175
DCAF13	H2AC16	RNF180
DCAF15	H2AC17	RNF181
DCAF16	H2AC18	RNF182
DCAF17	H2AC19	RNF183
DCAF4	H2AC20	RNF185
DCAF4L2	H2AC21	RNF186
DCAF5	H2AC4	RNF187
DCAF6	H2AC6	RNF19A
DCAF7	H2AC7	RNF19B
DCAF8	H2AC8	RNF2
DCAF8L1	H2AW	RNF20
DCAF8L2	H2BC1	RNF207
DCUN1D1	H2BC10	RNF208
DCUN1D2	H2BC11	RNF212
DCUN1D3	H2BC12	RNF212B
DCUN1D5	H2BC13	RNF213
DDB1	H2BC14	RNF214
DDB2	H2BC15	RNF215
DENND3	H2BC17	RNF216
DIDO1	H2BC18	RNF217
DMWD	H2BC21	RNF219
DMXL1	H2BC3	RNF220
DMXL2	H2BC4	RNF222
DNAI1	H2BC5	RNF223

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
DNAI2	H2BC6	RNF224
DPF1	H2BC7	RNF225
DPF2	H2BC8	RNF24
DPF3	H2BC9	RNF25
DPH7	H2BU1	RNF26
DTL	HACE1	RNF31
DTX1	HCFC1	RNF32
DTX2	HECTD1	RNF34
DTX3	HECTD2	RNF38
DTX3L	HECTD3	RNF39
DTX4	HECW2	RNF4
DYNC1I1	HERC1	RNF40
DYNC1I2	HERC2	RNF41
DZIP3	HERC3	RNF43
E4F1	HERC4	RNF44
EED	HERC5	RNF5
EFCAB8	HERC6	RNF6
EIF3I	HERPUD1	RNF7
ELP2	HGS	RNF8
EML1	HIF1A	RNFT1
EML2	HLA-A	RNFT2
EML3	HLTF	RSPRY1
EML4	HSP90B1	SCAF11
EML5	HSPA5	SH3RF1
EML6	HUWE1	SH3RF2
ENC1	IDE	SH3RF3
EP300	IFIH1	SHPRH
ERCC8	IKBKG	SIAH1
FAM53C	IL33	SIAH2
FANCL	INO80	SIAH3
FBXL12	INO80B	SMURF1
FBXL14	INO80C	SMURF2
FBXL15	INO80D	STUB1
FBXL17	INO80E	SYVN1
FBXL19	ITCH	TMEM129
FBXL2	JKAMP	TOPORS
FBXL20	JOSD1	TRAF2
FBXL21	JOSD2	TRAF3
FBXL3	KAT2A	TRAF4
FBXL4	KAT2B	TRAF5
FBXL5	KBTBD13	TRAF6
FBXL6	KBTBD6	TRAF7

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
FBXL7	KBTBD7	TRAIP
FBXL8	KBTBD8	TRIM10
FBXO10	KCTD6	TRIM11
FBXO11	KCTD7	TRIM13
FBXO15	KDM1B	TRIM15
FBXO17	KEAP1	TRIM17
FBXO18	KLHL11	TRIM2
FBXO2	KLHL13	TRIM21
FBXO22	KLHL2	TRIM22
FBXO25	KLHL20	TRIM23
FBXO27	KLHL21	TRIM24
FBXO28	KLHL22	TRIM25
FBXO3	KLHL25	TRIM26
FBXO30	KLHL3	TRIM27
FBXO31	KLHL41	TRIM28
FBXO32	KLHL42	TRIM3
FBXO33	KLHL5	TRIM31
FBXO4	KLHL9	TRIM32
FBXO40	LEO1	TRIM33
FBXO42	LMO7	TRIM34
FBXO44	LNPEP	TRIM35
FBXO45	LNX1	TRIM36
FBXO48	LONRF1	TRIM37
FBXO6	LRR1	TRIM38
FBXO7	LRRC41	TRIM39
FBXO8	LRSAM1	TRIM4
FBXO9	LTN1	TRIM40
FBXW10	MAN1B1	TRIM41
FBXW11	MAP3K1	TRIM42
FBXW2	MAP3K7	TRIM43
FBXW4	MARCHF6	TRIM43B
FBXW5	MAT2B	TRIM45
FBXW7	MAVS	TRIM46
FBXW8	MBD5	TRIM47
FBXW9	MBD6	TRIM48
FEM1B	MCRS1	TRIM49
FEM1C	MDM2	TRIM49B
FUS	MDM4	TRIM49C
FYCO1	MEX3C	TRIM49D1
FZR1	MGRN1	TRIM5
G2E3	MIB2	TRIM50
GAN	MID1	TRIM51

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
GEMIN5	MKRN1	TRIM52
GNB1	MUL1	TRIM54
GNB1L	MYC	TRIM55
GNB2	MYLIP	TRIM56
GNB3	MYSM1	TRIM58
GNB4	NCCRP1	TRIM59
GNB5	NEDD4	TRIM6
GPR75-ASB3	NEDD4L	TRIM60
GRWD1	NEDD8	TRIM61
GTF2H2C	NFE2L2	TRIM62
GTF3C1	NFKBIA	TRIM63
GTF3C2	NFRKB	TRIM64
GZF1	NHLRC1	TRIM64B
HACE1	NLRP3	TRIM64C
HDAC4	NOD1	TRIM65
HECTD1	NOD2	TRIM67
HECTD2	NPEPPS	TRIM68
HECTD3	NPLOC4	TRIM69
HECTD4	OGT	TRIM7
HECW1	OS9	TRIM71
HECW2	OTUB1	TRIM72
HERC1	OTUB2	TRIM73
HERC2	OTUD3	TRIM74
HERC3	OTUD5	TRIM75P
HERC4	OTUD7A	TRIM77
HERC5	OTUD7B	TRIM8
HERC6	OTULIN	TRIM9
HIC1	PAF1	TRIML1
HIC2	PCNA	TRIML2
HIRA	PEX10	TRIP12
HLTF	PEX12	TTC3
HOXB4	PEX13	UBE3A
HUWE1	PEX14	UBE3B
IBTK	PEX2	UBE3C
IFT122	PEX5	UBE3D
IFT172	PIAS1	UBE4A
IFT80	PIAS2	UBE4B
ING1	PIAS3	UBOX5
ING2	PIAS4	UBR1
ING3	PJA1	UBR2
ING4	PJA2	UBR3
ING5	PML	UBR4

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
INTS12	POLB	UBR5
IPP	PPIL2	UBR7
IRF2BP1	PRKDC	UHRF1
IRF2BPL	PRKN	UHRF2
ITCH	PRPF19	UNK
IVNS1ABP	PSMA1	UNKL
JADE1	PSMA2	VPS11
KAT2B	PSMA3	VPS18
KAT6A	PSMA4	VPS41
KATNB1	PSMA5	VPS8
KBTBD12	PSMA6	WDR59
KBTBD13	PSMA7	WDSUB1
KBTBD2	PSMA8	WWP1
KBTBD3	PSMB1	WWP2
KBTBD4	PSMB10	XIAP
KBTBD6	PSMB11	ZBTB12
KBTBD7	PSMB2	ZFP91
KBTBD8	PSMB3	ZFPL1
KCMF1	PSMB4	ZNF280A
KCTD10	PSMB5	ZNF341
KCTD11	PSMB6	ZNF511
KCTD13	PSMB7	ZNF521
KCTD17	PSMB8	ZNF598
KCTD2	PSMB9	ZNF645
KCTD21	PSMC1	ZNRF1
KCTD3	PSMC2	ZNRF2
KCTD5	PSMC3	ZNRF3
KCTD6	PSMC4	ZNRF4
KCTD7	PSMC5	ZSWIM2
KCTD9	PSMC6	ZXDC
KDM2A	PSMD1	
KDM2B	PSMD10	
KDM5A	PSMD11	
KDM5B	PSMD12	
KDM5C	PSMD13	
KDM5D	PSMD14	
KDM7A	PSMD2	
KEAP1	PSMD3	
KIF21A	PSMD4	
KIF21B	PSMD5	
KLHL1	PSMD6	
KLHL10	PSMD7	

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
KLHL11	PSMD8	
KLHL12	PSMD9	
KLHL13	PSME1	
KLHL14	PSME2	
KLHL15	PSME3	
KLHL17	PSME4	
KLHL18	PSMF1	
KLHL2	PTEN	
KLHL20	PTRH2	
KLHL21	RAD18	
KLHL22	RAD23A	
KLHL23	RAD23B	
KLHL24	RBBP6	
KLHL25	RBCK1	
KLHL26	RBX1	
KLHL28	RCE1	
KLHL29	RCHY1	
KLHL3	RHBDD2	
KLHL30	RHOA	
KLHL31	RHOBTB2	
KLHL32	RHOT1	
KLHL33	RIPK1	
KLHL34	RIPK2	
KLHL35	RLIM	
KLHL36	RNF103	
KLHL38	RNF111	
KLHL4	RNF114	
KLHL40	RNF115	
KLHL41	RNF121	
KLHL42	RNF123	
KLHL5	RNF126	
KLHL6	RNF128	
KLHL7	RNF130	
KLHL8	RNF135	
KLHL9	RNF138	
KMT2A	RNF14	
KMT2B	RNF144A	
KMT2C	RNF144B	
KMT2D	RNF146	
LDB2	RNF152	
LLGL1	RNF175	
LLGL2	RNF181	

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
LNX1	RNF182	
LONRF1	RNF185	
LONRF2	RNF19A	
LONRF3	RNF19B	
LRR1	RNF20	
LRRC41	RNF213	
LRSAM1	RNF217	
LRWD1	RNF220	
LTN1	RNF25	
LYST	RNF34	
LZTR1	RNF4	
MALT1	RNF40	
MAP3K1	RNF41	
MAPKBP1	RNF5	
MDM2	RNF6	
MDM4	RNF7	
MED16	RPS27A	
MED8	RRAGA	
MGRN1	RTF1	
MIB1	RUVBL1	
MIB2	SAE1	
MID1	SEC61B	
MID2	SEL1L	
MIOS	SEL1L2	
MKRN1	SELENOS	
MLST8	SEM1	
MNAT1	SENP8	
MSL2	SGTA	
MTF2	SGTB	
MUL1	SH3RF1	
MYCBP2	SHPRH	
MYLIP	SIAH1	
MYNN	SIAH2	
NACC1	SKP1	
NACC2	SKP2	
NBEA	SMAD1	
NBEAL1	SMAD2	
NBEAL2	SMAD3	
NEDD1	SMAD4	
NEDD4	SMAD7	
NEDD4L	SMURF1	
NEURL1B	SMURF2	

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
NEURL2	SNX3	
NEURL3	SOCS1	
NFX1	SOCS3	
NHLRC1	SPSB1	
NLE1	SPSB2	
NOL10	SPSB4	
NOSIP	STAM	
NSD1	STAM2	
NSMAF	STAMBP	
NSMCE1	STAMBPL1	
NSMCE2	STT3B	
NUP37	STUB1	
NUP43	SUDS3	
NUP62	SVIP	
NWD1	SYVN1	
OSTM1	TAB1	
PAAF1	TADA2B	
PAFAH1B1	TADA3	
PAK1IP1	TAF10	
PARK2	TAF9B	
PATZ1	TFPT	
PCGF1	TGFB1	
PCGF2	TGFBR1	
PCGF3	TGFBR2	
PCGF5	THOP1	
PCGF6	TMEM129	
PDLIM2	TMEM67	
PDZRN3	TMUB1	
PDZRN4	TMUB2	
PELI1	TNFAIP3	
PELI2	TNIP1	
PELI3	TNIP2	
PEX10	TNIP3	
PEX12	TNKS	
PEX2	TNKS2	
PEX7	TOMM20	
PHF1	TOMM70	
PHF10	TP53	
PHF14	TPP2	
PHF2	TRAF2	
PHF21A	TRAF3	
PHF8	TRAF6	

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
PHIP	TRAF7	
PHRF1	TRAIP	
PIAS1	TRIM11	
PIAS2	TRIM13	
PIAS3	TRIM21	
PIAS4	TRIM25	
PIK3R4	TRIM32	
PJA1	TRIM36	
PJA2	TRIM37	
PLAA	TRIM39	
PLRG1	TRIM4	
PML	TRIM41	
POC1A	TRIM50	
POC1B	TRIM63	
PPARA	TRIM69	
PPARG	TRIM71	
PPIL2	TRIM9	
PPP2R2A	TRIP12	
PPP2R2B	TRRAP	
PPP2R2C	UBA1	
PPP2R2D	UBA2	
PPWD1	UBA3	
PREB	UBA5	
PRPF19	UBA52	
PRPF4	UBA6	
PWP1	UBA7	
PWP2	UBAC1	
RAB40A	UBB	
RAB40AL	UBC	
RAB40B	UBE2A	
RAB40C	UBE2B	
RACK1	UBE2C	
RAD18	UBE2D1	
RAE1	UBE2D2	
RAG1	UBE2D3	
RANBP2	UBE2D4	
RASD2	UBE2E1	
RBBP4	UBE2E2	
RBBP5	UBE2E3	
RBBP6	UBE2F	
RBBP7	UBE2G1	
RBCK1	UBE2G2	

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
RBX1	UBE2H	
RC3H1	UBE2I	
RC3H2	UBE2J1	
RCBTB1	UBE2J2	
RCBTB2	UBE2K	
RCHY1	UBE2L3	
RFFL	UBE2L6	
RFPL4A	UBE2M	
RFPL4B	UBE2N	
RFWD2	UBE2NL	
RFWD3	UBE2O	
RHOBTB1	UBE2Q1	
RHOBTB2	UBE2Q2	
RHOBTB3	UBE2QL1	
RICTOR	UBE2R2	
RING1	UBE2S	
RLIM	UBE2T	
RMND5A	UBE2U	
RNF10	UBE2V1	
RNF103	UBE2V2	
RNF11	UBE2W	
RNF111	UBE2Z	
RNF113A	UBE3A	
RNF113B	UBE3B	
RNF114	UBE3C	
RNF115	UBE3D	
RNF121	UBE4A	
RNF122	UBE4B	
RNF123	UBOX5	
RNF125	UBQLN1	
RNF126	UBQLN2	
RNF128	UBR1	
RNF13	UBR2	
RNF130	UBR4	
RNF133	UBR5	
RNF135	UBXN4	
RNF138	UBXN8	
RNF139	UCHL1	
RNF14	UCHL3	
RNF141	UCHL5	
RNF144A	UFD1	
RNF144B	UFL1	

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
RNF145	UIMC1	
RNF146	UNKL	
RNF148	USP10	
RNF149	USP11	
RNF150	USP12	
RNF151	USP13	
RNF152	USP14	
RNF157	USP15	
RNF165	USP16	
RNF166	USP17L1	
RNF167	USP17L10	
RNF168	USP17L11	
RNF170	USP17L12	
RNF175	USP17L13	
RNF180	USP17L15	
RNF181	USP17L17	
RNF182	USP17L18	
RNF185	USP17L19	
RNF186	USP17L2	
RNF187	USP17L20	
RNF19A	USP17L21	
RNF19B	USP17L22	
RNF2	USP17L24	
RNF20	USP17L25	
RNF208	USP17L26	
RNF212	USP17L27	
RNF212B	USP17L28	
RNF213	USP17L29	
RNF215	USP17L3	
RNF216	USP17L30	
RNF217	USP17L4	
RNF220	USP17L5	
RNF222	USP17L8	
RNF223	USP18	
RNF225	USP19	
RNF24	USP2	
RNF25	USP20	
RNF26	USP21	
RNF31	USP22	
RNF32	USP24	
RNF34	USP25	
RNF38	USP26	

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
RNF39	USP28	
RNF4	USP3	
RNF40	USP30	
RNF41	USP33	
RNF43	USP34	
RNF44	USP37	
RNF5	USP4	
RNF6	USP42	
RNF7	USP44	
RNF8	USP47	
RNFT1	USP48	
RNFT2	USP49	
RP11-385D13.1	USP5	
RP11-432B6.3	USP7	
RP11-574F21.3	USP8	
RP1-27O5.3	USP9X	
RPTOR	VCP	
RRP9	VCPIP1	
RSPRY1	VDAC1	
RWDD3	VDAC2	
SART1	VDAC3	
SCAF11	VHL	
SCAP	WAC	
SEC13	WDR20	
SEC31A	WDR48	
SEC31B	WDR61	
SEH1L	WFS1	
SETMAR	WSB1	
SH3RF1	WWP1	
SH3RF2	WWP2	
SH3RF3	XIAP	
SHKBP1	YOD1	
SHPRH	YY1	
SIAH1	ZBTB16	
SIAH2	ZNRF1	
SKP1	ZNRF2	
SKP2	ZRANB1	
SLX4		
SMU1		
SMURF1		
SMURF2		
SNRNP40		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
SOCS1		
SOCS2		
SOCS3		
SOCS4		
SOCS5		
SOCS6		
SOCS7		
SPAG16		
SPOP		
SPOPL		
SPSB1		
SPSB2		
SPSB4		
SRM		
SSR3		
STC1		
STRAP		
STRN		
STRN3		
STRN4		
STUB1		
STXBP5		
STXBP5L		
SYVN1		
TAF3		
TAF5		
TAF5L		
TBC1D31		
TBL1X		
TBL1XR1		
TBL1Y		
TBL2		
TBL3		
TCEB1		
TCEB2		
TCEB3		
TEP1		
THOC3		
THOC6		
TLE1		
TLE2		
TLE3		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
TLE4		
TLE6		
TMEM129		
TMEM183A		
TMF1		
TNFAIP1		
TOPORS		
TRAF2		
TRAF3		
TRAF3IP2		
TRAF4		
TRAF5		
TRAF6		
TRAF7		
TRAIP		
TRIM10		
TRIM11		
TRIM13		
TRIM15		
TRIM16		
TRIM17		
TRIM2		
TRIM21		
TRIM22		
TRIM23		
TRIM24		
TRIM25		
TRIM26		
TRIM27		
TRIM28		
TRIM3		
TRIM31		
TRIM32		
TRIM33		
TRIM35		
TRIM36		
TRIM37		
TRIM38		
TRIM39		
TRIM4		
TRIM40		
TRIM41		

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
TRIM43		
TRIM45		
TRIM46		
TRIM47		
TRIM48		
TRIM5		
TRIM50		
TRIM51		
TRIM52		
TRIM54		
TRIM55		
TRIM56		
TRIM58		
TRIM59		
TRIM6		
TRIM60		
TRIM61		
TRIM62		
TRIM63		
TRIM65		
TRIM66		
TRIM68		
TRIM69		
TRIM6-TRIM34		
TRIM7		
TRIM71		
TRIM72		
TRIM73		
TRIM74		
TRIM8		
TRIM9		
TRIML1		
TRIP12		
TRPC4AP		
TSSC1		
TTC3		
UBE3A		
UBE3B		
UBE3C		
UBE3D		
UBE4A		
UBE4B		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
UBOX5		
UBR1		
UBR2		
UBR4		
UBR5		
UFL1		
UHRF1		
UHRF2		
UPF1		
UTP15		
UTP18		
UTP4		
VHL		
VPS18		
VPS41		
WDFY1		
WDFY2		
WDFY3		
WDFY4		
WDHD1		
WDR1		
WDR11		
WDR12		
WDR13		
WDR17		
WDR18		
WDR20		
WDR24		
WDR25		
WDR26		
WDR27		
WDR3		
WDR31		
WDR33		
WDR34		
WDR36		
WDR37		
WDR38		
WDR4		
WDR41		
WDR43		
WDR44		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
WDR45		
WDR45B		
WDR47		
WDR48		
WDR49		
WDR5		
WDR53		
WDR54		
WDR55		
WDR59		
WDR5B		
WDR6		
WDR60		
WDR61		
WDR62		
WDR63		
WDR64		
WDR66		
WDR7		
WDR70		
WDR72		
WDR74		
WDR75		
WDR76		
WDR77		
WDR78		
WDR81		
WDR82		
WDR83		
WDR86		
WDR87		
WDR88		
WDR89		
WDR90		
WDR91		
WDR92		
WDR97		
WDSUB1		
WDTC1		
WHSC1		
WHSC1L1		
WIPI2		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
WRAP53		
WRAP73		
WSB1		
WSB2		
WWP1		
WWP2		
XIAP		
ZBTB1		
ZBTB10		
ZBTB11		
ZBTB14		
ZBTB16		
ZBTB17		
ZBTB18		
ZBTB2		
ZBTB20		
ZBTB21		
ZBTB22		
ZBTB24		
ZBTB25		
ZBTB3		
ZBTB33		
ZBTB34		
ZBTB37		
ZBTB38		
ZBTB39		
ZBTB4		
ZBTB40		
ZBTB41		
ZBTB42		
ZBTB43		
ZBTB44		
ZBTB45		
ZBTB46		
ZBTB47		
ZBTB48		
ZBTB49		
ZBTB5		
ZBTB6		
ZBTB7A		
ZBTB7B		
ZBTB7C		

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Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
ZBTB8A		
ZBTB8B		
ZBTB9		
ZC3HC1		
ZFP91		
ZMIZ1		
ZMIZ2		
ZNF106		
ZNF131		
ZNF645		
ZNRF1		
ZNRF2		
ZNRF3		
ZNRF4		
ZSWIM2		
ATXN3		
ATXN3L		
BAP1		
BRCC3		
COPS5		
COPS6		
CYLD		
EIF3F		
EIF3H		
JOSD1		
JOSD2		
MINDY1		
MINDY2		
MINDY3		
MINDY4		
MPND		
MYSM1		
OTUB1		
OTUB2		
OTUD1		
OTUD3		
OTUD4		
OTUD5		
OTUD6A		
OTUD6B		
OTUD7A		
OTUD7B		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
PAN2		
PARP11		
PSMD14		
PSMD7		
SENP1		
SENP2		
SENP3		
SENP3-EIF4A1		
SENP5		
SENP6		
SENP7		
SENP8		
STAMBPL1		
TAF1D		
TNFAIP3		
TRIM44		
UCHL1		
UCHL3		
UCHL5		
UFD1L		
UFSP1		
UFSP2		
USP1		
USP10		
USP11		
USP12		
USP13		
USP14		
USP15		
USP16		
USP17L1		
USP17L10		
USP17L11		
USP17L12		
USP17L13		
USP17L15		
USP17L17		
USP17L18		
USP17L19		
USP17L2		
USP17L20		
USP17L21		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
USP17L22		
USP17L23		
USP17L24		
USP17L3		
USP17L4		
USP17L5		
USP17L7		
USP17L8		
USP18		
USP19		
USP2		
USP20		
USP21		
USP22		
USP24		
USP25		
USP26		
USP27X		
USP28		
USP29		
USP3		
USP30		
USP31		
USP32		
USP33		
USP34		
USP35		
USP36		
USP37		
USP38		
USP39		
USP4		
USP40		
USP41		
USP42		
USP43		
USP44		
USP45		
USP46		
USP47		
USP48		
USP49		

Supplementary Table 1. Continued

iUUCD	MsigDB	Human E3 ubiquitin ligases database
USP5		
USP50		
USP51		
USP53		
USP54		
USP6		
USP7		
USP8		
USP9X		
USP9Y		
USPL1		
VCPIP1		
YOD1 ZC3H12A		
ZRANB1		

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