

**Table S1.** Set of 676 ubiquitin proteasome system related genes

Categories	Genes
Ubiquitin	RPS27A, UBA52, UBB, UBC
Ubiquitin activating enzymes (E1s)	UBA1, UBA6
Ubiquitin conjugating enzymes (E2s)	UBE2A, UBE2B, UBE2C, UBE2D1, UBE2D2, UBE2D3, UBE2D4, UBE2E1, UBE2E2, UBE2E3, UBE2G1, UBE2G2, UBE2H, UBE2J1, UBE2J2, UBE2K, UBE2L3, UBE2N, UBE2NL, UBE2O, UBE2Q1, UBE2Q2, UBE2QL, UBE2R1, UBE2R2, UBE2S, UBE2T, UBE2U, UBE2V1, UBE2V2, UBE2W, BIRC6, UBE2F, UBE2I, UBE2L6, UBE2M, UBE2Z, ATG10, ATG3
Ubiquitin ligases (E3s)	HECTD4, G2E3, HACE1, HECTD1, HECTD2, HECW1, HERC2, HERC4, HERC6, HUWE1, ITCH, NEDD4, SMURF2, TRIP12, UBE3B, WWP1, WWP2, HERC5, UBE3A, UBE3C, SMURF1, NEDD4L, HECTD3, HERC1, UBE3D, HERC3, TRIP12, HECW2, UBR5, ZNF645, SYVN1, RNF168, BIRC2, CBLB, CNOT4, MARCH7, MSL2, MYLIP, PDZRN3, RAD18, RNF111, RNF125, RNF128, RNF31, RNF6, SIAH2, TRIM24, TRIM28, TRIM5, XIAP, ZNRF2, AMFR, PIAS2, BARD1, BIRC3, BIRC7, BMI1, BRAP, BRCA1, CBL, CBLC, CBLL1, CCNB1IP1, CHFR, DTX1, DTX2, DTX3, DTX3L, RNF7, FANCL, HLTF, RBCK1, TRIM32, LNX1, MARCH1, MARCH11, MARCH2, MARCH3, MARCH4, MARCH6, MARCH8, MARCH9, MDM2, MGRN1, MID1, MID2, MKRN1, MNAT1, MUL1, MYCBP2, NHLRC1, PARK2, PEX10, PEX12, PEX2, PIAS1, PIAS3, PIAS4, PML, RAG1, RBBP6, RBX1, RC3H1, RCHY1, RFFL, RFPL4A, RFWD3, RING1, RNF181, RNF103, RNF11, RNF114, RNF115, RNF121, RNF122, RNF126, RNF13, RNF130, RNF138, RNF139, RNF144B, RNF146, RNF152, RNF167, RNF170, RNF180, RNF182, RNF187, RNF19A, RNF2, RNF213, RNF217, RNF220, RNF34, RNF38, RNF4, RNF40, RNF41, RNF5, RNF8, SH3RF1, SHPRH, SIAH1, TRIM51, TOPORS, TRAF2, TRAF5, TRAF6, TRIM11, TRIM13, TRIM15, TRIM17, TRIM2, TRIM21, TRIM23, TRIM25, TRIM26, TRIM27, TRIM3, TRIM31, TRIM35, TRIM36, TRIM37, TRIM38, TRIM39, TRIM4, TRIM40, TRIM41, TRIM43, TRIM45, TRIM47, TRIM50, TRIM54, TRIM56, TRIM59, TRIM6, TRIM62, TRIM63, TRIM68, TRIM73, TRIM74, TRIM8, TRIM9, TTC3, UHRF1, UHRF2, VPS18, ZNRF1, ZNRF4, BFAR, DZIP3, MDM4, NFX1, PCGF1, PJA1, PJA2, RNF123, RNF133, RNF135, RNF20, RNF25, ZNRF3, LRSAM1, NSMCE2, ZMIZ1, ZMIZ2, NSMCE1, PELI2, PELI1, PELI3, ARIH1, RNF14, RNF19B, RNF216, TRIM46, ZSWIM2, ARIH2, MIB1, TRIM22, MARCH5, RLIM, OSTM1, RNF185, DTX4, TRIM71, NEURL1B, PCGF2, RNF113A, RNF113B, RNF150, RNF186, RNF24, RNF43, RNFT1, TRIM34, TRIM65, VPS41, TRAF3, SH3RF3, LITAF, RNF26, IRF2BP1, LTN1, TRAIIP, MARCH10, MIB2, UBR1, UBR2, TRIM33, UBOX5, CUL9, RFWD2, TRAF7, STUB1, UBE4A, UBE4B, NOSIP, TRAF3IP2, PPIL2, PRPF19, UBR4, HDAC4, RASD2, UFL1, EP300, ZFP91, E4F1, RABGEF1, KAT2B, KCMF1, CBX4, DCUN1D1, DCUN1D3, DCUN1D2, PDLIM2, MAP3K1, AIRE, RWDD3, FUS, RANBP2, STC1,

	<p>MALT1, AURKA, SART1, CREBBP, CRBN, IRF2BPL, CADPS2, RMND5B, KDM2B, TNFAIP3, UCHL1, ANAPC2, CUL4A, CUL5, CUL3, CUL7, CUL1, CUL2, CUL4B, FBXO3, CCNF, FBXO44, FBXL15, FBXL3, FBXO11, FBXO17, FBXO18, FBXO2, FBXO22, FBXO25, FBXO27, FBXO31, FBXO33, FBXO4, FBXO45, FBXO6, FBXO7, FBXO8, FBXW10, FBXO32, FBXO42, FBXL2, FBXL6, FBXL12, FBXW8, FBXL14, FBXL5, FBXL4, SKP2, CDCA3, ZC3HC1, FBXO40, FBXL7, FBXL19, FBXW5, FBXW2, BTRC, FBXW11, FBXW7, TBL1X, TBL1XR1, VHL, MED8, LRRC41, TMF1, ASB1, ASB3, ASB6, ASB8, ASB9, NEURL2, SOCS5, SOCS6, SOCS7, SPSB1, ASB2, ASB4, RAB40C, ASB12, ASB7, SOCS1, SOCS2, SOCS3, SOCS4, SPSB4, CISH, FEM1B, LRR1, ASB15, SPSB2, WSB2, WSB1, CORO7, TCEB1, TCEB2, KLHL42, KLHL12, KLHL17, KLHL8, SPOP, KLHL13, KLHL10, KLHL2, KLHL20, KLHL22, KLHL7, KLHL21, RCBTB1, KBTBD13, KEAP1, KLHL9, KLHL41, GAN, KCTD11, KCTD13, KCTD21, KCTD6, TNFAIP1, ABTB1, BCL6B, RHOBTB1, RHOBTB2, KCTD5, ZBTB18, NACC1, RHOBTB3, VPRBP, DDB2, ERCC8, DTL, GNB2L1, DCAF12, DCAF7, GRWD1, PWP1, WDR53, DCAF4, DCAF5, KATNB1, NUP43, RBBP4, RBBP5, TLE1, TLE2, WDR82, SMU1, WDR26, ATG16L1, CIAO1, DCAF13, DCAF6, EED, GNB2, POC1B, RBBP7, SNRNP40, TLE3, WDR12, WDR5, WDR5B, WDR61, WDR76, DCAF10, DCAF8, WDTC1, PAFAH1B1, BRWD1, NLE1, PHIP, WDR59, AMBRA1, DCAF11, DDB1, TRPC4AP, AHR, HOXB4, RICTOR, DCAF15, DCAF16, DCAF17, ARNT, FZR1, CDC20, CDC27, ANAPC11, ANAPC4, ANAPC5, ANAPC7, ANAPC1, CDC23, ANAPC10, CDC16, CDC26, ANAPC13, AREL1, MAGEA6, MEX3C, MKRN2, MKRN3, MKRN4P, MYC, NEURL1, NEURL3, PDE4D, RNF144A, RNF149, RNF169, SH3RF2, TRIM69, TRIML1, TRIML2, UBE2E3, UBAC1, UBR3, UBR7, UNKL, PRC1, IRAK1, IRAK4</p>
Deubiquitinating enzymes (DUBs)	<p>BAP1, UCHL1, UCHL3, UCHL5, ATXN3, ATXN3L, JOSD1, JOSD2, TNFAIP3, ZA20D1, OTUD7A, OTUD4, PARP11, OTUD6A, YOD1, OTUD6B, OTUD5, OTUB1, OTUB2, OTUD1, ZRANB1, VCPIP1, STAMBIP, STAMBPL1, BRCC3, COPS5, COPS6, EIF3S3, EIF3S5, Q7Z3G8, PSMD14, PRPF8 PSMD7, USP1, USP2, USP3, USP4, USP5, USP6, USP7, USP8, USP9X, USP9Y, USP10, USP11, USP12, USP13, USP14, USP15, USP16, USP18, USP19, USP20, USP21, USP22, USP24, USP25, USP26, USP28, USP29, USP30, USP31, USP32, USP33, USP34, USP35, USP36, USP37, USP38, USP39, USP40, USP41, USP42, USP44, USP45, USP46, USP47, USP48, USP49, USP50, USP51, USP52, USP54, USP43, CYLD</p>
Proteasome	<p>IFNG, POMP, PSMA1, PSMA2, PSMA3, PSMA4, PSMA5, PSMA6, PSMA6P4, PSMA7, PSMA8, PSMB1, PSMB10, PSMB11, PSMB2, PSMB3, PSMB4, PSMB5, PSMB6, PSMB7, PSMB8, PSMB9, PSMC1, PSMC1P4, PSMC2, PSMC3, PSMC4, PSMC5, PSMC6, PSMD1, PSMD11, PSMD12, PSMD13, PSMD14, PSMD2, PSMD3, PSMD4, PSMD6, PSMD7, PSMD8, PSME1, PSME2, PSME3, PSME4, PSMF1, SEM1</p>

**Table S2.** Functional enrichment of the differentially expressed UPSs

Ca	ID	Description	pv	geneID
te			alu	
go			e	
ry				
G	GO: 000020	protein polyubiquitination	2.0	WSB1/RBCK1/TNFAIP3/PSMB10/DTL/PSMB8/PSMB9/HEC
O	000		7E	W1/AREL1/PSMA8/TRAF2/NEDD4L/DDB2/TRIM36/SPSB1/P
-	020		-	ELI2/UBE2C/TRIM2/CHFR/AMFR/FBXO17/HECW2/FBXO2/R
BP	9		23	NF152
G	GO: 000316	proteasome-mediated ubiquitin-dependent protein catabolic process	1.3	DCAF11/RBCK1/PSMB10/RACK1/PML/PSMB8/PSMB9/HEC
O	004		4E	W1/CDC20/AREL1/KCTD13/PSMA8/TRIM9/NEDD4L/SPSB1
-	316		-	/UCHL1/UBE2C/TRIM2/CHFR/AMFR/USP44/FBXO17/FBXL6
BP	1		21	/HECW2/FBXO2
G	GO: 000049	proteasomal protein catabolic process	3.1	DCAF11/RBCK1/PSMB10/RACK1/PML/PSMB8/PSMB9/HEC
O	001		4E	W1/CDC20/AREL1/KCTD13/PSMA8/TRIM9/NEDD4L/SPSB1
-	049		-	/UCHL1/UBE2C/TRIM2/CHFR/AMFR/USP44/FBXO17/FBXL6
BP	8		20	/HECW2/FBXO2
G	GO: 000657	protein deubiquitination	4.0	USP2/TNFAIP3/PSMB10/PSMB8/PSMB9/CDC20/PSMA8/TR
O	001		3E	AF2/BRCC3/USP46/BIRC3/DDB2/USP41/UCHL1/USP44/MD
-	657		-	M4/MYC/STAMBPL1
BP	9		16	
G	GO: 000064	protein modification by small protein removal	1.0	USP2/TNFAIP3/PSMB10/PSMB8/PSMB9/CDC20/PSMA8/TR
O	007		6E	AF2/BRCC3/USP46/BIRC3/DDB2/USP41/UCHL1/USP44/MD
-	064		-	M4/MYC/STAMBPL1
BP	6		15	
G	GO: 000368	post-translational protein modification	3.9	DCAF11/ASB9/WSB1/PSMB10/LRRC41/ASB2/DTL/PSMB8/P
O	004		9E	SMB9/PSMA8/KLHL21/DDB2/SPSB1/KLHL13/FBXO17/FBX
-	368		-	O2/ASB15
BP	7		13	
G	GO: 000217	regulation of protein catabolic process	1.4	ASB9/TNFAIP3/RACK1/PML/DTL/IFNG/HECW1/AREL1/NED
O	004		7E	D4L/CHFR/MDM4/HECW2/TRIM40
-	217		-	
BP	6		08	
G	GO: 000573	positive regulation of protein catabolic	4.1	ASB9/TNFAIP3/RACK1/DTL/IFNG/HECW1/AREL1/NEDD4L/
O	004		8E	CHFR/HECW2
-	573		-	
BP	2		08	

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		process		
G	GO:	tumor	6.1	RBCK1/TNFAIP3/PSMB10/RACK1/PSMB8/PSMB9/PSMA8/T
O	003	necrosis	2E	RAF2/BIRC3
-	320	factor-	-	
BP	9	mediated	08	
		signaling		
		pathway		
G	GO:	SCF-	2.3	PSMB10/PSMB8/PSMB9/PSMA8/FBXO17/FBXL6/FBXO2
O	003	dependen	2E	
-	114	t	-	
BP	6	proteaso	07	
		mal		
		ubiquitin-		
		dependen		
		t protein		
		catabolic		
		process		
G	GO:	ubiquitin	4.2	DCAF11/RBCK1/ASB2/DTL/CDC20/KCTD13/UBE2L6/KLHL2
O	000	ligase	9E	1/TRAF2/BRCC3/DDB2/SPSB1/UBE2C/PCGF1/AMFR/KLHL1
-	015	complex	-	3/FBXO17/FBXL6/FBXO2
C	1		18	
C				
G	GO:	cullin-	2.3	DCAF11/DTL/CDC20/KCTD13/KLHL21/DDB2/SPSB1/UBE2C
O	003	RING	5E	/KLHL13/FBXO17/FBXL6/FBXO2
-	146	ubiquitin	-	
C	1	ligase	12	
C		complex		
G	GO:	proteaso	1.2	PSMB10/PSMB8/PSMB9/PSMA8
O	000	me core	8E	
-	583	complex	-	
C	9		06	
C				
G	GO:	proteaso	1.1	PSMB10/PSMB8/PSMB9
O	001	me core	2E	
-	977	complex,	-	
C	4	beta-	05	
C		subunit		
		complex		
G	GO:	nuclear	3.0	CDC20/BRCC3/UBE2C/PCGF1
O	000	ubiquitin	3E	
-	015	ligase	-	
C	2	complex	05	
C				
G	GO:	proteaso	0.0	PSMB10/PSMB8/PSMB9/PSMA8

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O	000	me	00	
-	050	complex	13	
C	2		73	
C			31	
G	GO:	SCF	0.0	SPSB1/FBXO17/FBXL6/FBXO2
O	001	ubiquitin	00	
-	900	ligase	14	
C	5	complex	60	
C			25	
G	GO:	endopepti	0.0	PSMB10/PSMB8/PSMB9/PSMA8
O	190	dase	00	
-	536	complex	14	
C	9		60	
C			25	
G	GO:	Cul4-	0.0	DCAF11/DTL/DDB2
O	008	RING E3	00	
-	000	ubiquitin	34	
C	8	ligase	56	
C		complex	86	
G	GO:	Cul3-	0.0	KCTD13/KLHL21/KLHL13
O	003	RING	00	
-	146	ubiquitin	48	
C	3	ligase	64	
C		complex	37	
G	GO:	ubiquitin-	1.4	BIRC7/RBCK1/TNFAIP3/NEURL3/LNX1/ASB2/DTL/HECW1/
O	000	protein	6E	NEURL1B/AREL1/KCTD13/RNF182/UBE2L6/KLHL21/TRAF2/
-	484	transferas	-	TRIM9/BIRC3/NEDD4L/DDB2/TRIM36/PELI2/RNF149/UBE2
M	2	e activity	45	C/RNF150/TRIM2/CHFR/TRIM59/AMFR/IRF2BPL/CBLC/KLH
F				L13/RNF43/FBXO17/FBXL6/HECW2/UHRF1/PDZRN3/FBXO
				2/RNF152/SH3RF3/ZNRF3
G	GO:	ubiquitin-	2.1	BIRC7/RBCK1/TNFAIP3/NEURL3/LNX1/ASB2/DTL/HECW1/
O	001	like	2E	NEURL1B/AREL1/KCTD13/RNF182/UBE2L6/KLHL21/TRAF2/
-	978	protein	-	TRIM9/BIRC3/NEDD4L/DDB2/TRIM36/PELI2/RNF149/UBE2
M	7	transferas	44	C/RNF150/TRIM2/CHFR/TRIM59/AMFR/IRF2BPL/CBLC/KLH
F		e activity		L13/RNF43/FBXO17/FBXL6/HECW2/UHRF1/PDZRN3/FBXO
				2/RNF152/SH3RF3/ZNRF3
G	GO:	ubiquitin	6.7	BIRC7/NEURL3/ASB2/HECW1/NEURL1B/AREL1/BIRC3/NED
O	006	protein	3E	D4L/PELI2/RNF149/RNF150/TRIM2/CHFR/TRIM59/AMFR/IR
-	163	ligase	-	F2BPL/CBLC/RNF43/FBXO17/FBXL6/HECW2/UHRF1/PDZR
M	0	activity	31	N3/FBXO2/RNF152/SH3RF3/ZNRF3
F				
G	GO:	ubiquitin-	2.0	BIRC7/NEURL3/ASB2/HECW1/NEURL1B/AREL1/BIRC3/NED
O	006	like	5E	D4L/PELI2/RNF149/RNF150/TRIM2/CHFR/TRIM59/AMFR/IR
-	165	protein	-	F2BPL/CBLC/RNF43/FBXO17/FBXL6/HECW2/UHRF1/PDZR

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M	9	ligase	30	N3/FBXO2/RNF152/SH3RF3/ZNRF3
F		activity		
G	GO:	thiol-	4.5	USP2/TNFAIP3/BRCC3/USP46/USP41/UCHL1/USP44/STAM
O	000	dependen	7E	BPL1
-	484	t	-	
M	3	ubiquitin-	08	
F		specific		
		protease		
		activity		
G	GO:	thiol-	8.0	USP2/TNFAIP3/BRCC3/USP46/USP41/UCHL1/USP44/STAM
O	003	dependen	9E	BPL1
-	645	t	-	
M	9	ubiquitinyl	08	
F		hydrolase		
		activity		
G	GO:	ubiquitinyl	8.0	USP2/TNFAIP3/BRCC3/USP46/USP41/UCHL1/USP44/STAM
O	010	hydrolase	9E	BPL1
-	100	activity	-	
M	5		08	
F				
G	GO:	ubiquitin-	1.4	USP2/TNFAIP3/BRCC3/USP46/USP41/UCHL1/USP44/STAM
O	001	like	6E	BPL1
-	978	protein-	-	
M	3	specific	07	
F		protease		
		activity		
G	GO:	threonine	2.9	PSMB10/PSMB8/PSMB9/PSMA8
O	000	-type	2E	
-	429	endopepti	-	
M	8	dase	06	
F		activity		
G	GO:	threonine	2.9	PSMB10/PSMB8/PSMB9/PSMA8
O	007	-type	2E	
-	000	peptidase	-	
M	3	activity	06	
F				
KE	hsa	Ubiquitin	2.8	BIRC7/PML/CDC20/UBE2L6/BIRC3/NEDD4L/DDB2/UBE2C/
G	041	mediated	5E	CBLC/KLHL13/FBXO2
G	20	proteolysi	-	
		s	12	
KE	hsa	Proteaso	8.8	PSMB10/IFNG/PSMB8/PSMB9/PSMA8
G	030	me	2E	
G	50		-	
			07	

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KE	hsa	Small cell	2.7	BIRC7/TRAF2/BIRC3/DDB2/MYC
G	052	lung	8E	
G	22	cancer	-	
			05	
KE	hsa	Necroptos	0.0	RBCK1/TNFAIP3/IFNG/TRAF2/BIRC3
G	042	is	00	
G	17		37	
			22	
			11	
KE	hsa	IL-17	0.0	TNFAIP3/IFNG/TRAF2/TRAF3IP2
G	046	signaling	00	
G	57	pathway	49	
			12	
			97	
KE	hsa	NOD-like	0.0	RBCK1/TNFAIP3/TRAF2/BRCC3/BIRC3
G	046	receptor	00	
G	21	signaling	67	
		pathway	40	
			31	

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