

**Table S1 Main components in ERAD**

Classification	Factor	Function	References
lectin	OS9/XTP3-B	Recognition for unfolded or misfolded protein	[1-3]
Chaperone	HSP/Bip	Recognition for unfolded or misfolded protein	[4-6]
Chaperone	EDEMs	Recognition for unfolded or misfolded protein	[7-9]
Adaptor	SEL1	Hrd1 complex member	[3]
Adaptor	Herp	Hrd1 complex member	[10]
Dislocons	Derlin1, Derlin2, Derlin3	Hrd1 complex member	[11, 12]
ATP hydrolase	p97	Retrotranslocation	[13, 14]
p97 cofactors	Ufd1	Retrotranslocation	[15-17]
p97 cofactors	Npl4	Retrotranslocation	[15-17]
p97 cofactors	UBXD2	Retrotranslocation	[15-21]
p97 cofactors	UBXD8	Retrotranslocation	[15-21]
E1 Ubiquitin-activating enzyme	UBA1	Activate ubiquitin molecules	[22, 23]
E2 Ubiquitin-conjugating enzyme	UBC6e/Ube2j1, Ube2j2	Bound ubiquitin on E2 enzyme	[24]
E2 Ubiquitin-conjugating enzyme	UbcH5a/UBE2D1, UbcH5b /UBE2D2, UbcH5c /UBE2D3	Bound ubiquitin on E2 enzyme	[25-27]
E2 Ubiquitin-conjugating enzyme	UBE2K/E2-25K	Bound ubiquitin on E2 enzyme	[28]
E2 Ubiquitin-conjugating enzyme	UBE2G2	Bound ubiquitin on E2 enzyme	[29, 30]
E3 Ubiquitin ligase enzyme	Hrd1	Add ubiquitin chains to substrate proteins	[31]
E3 Ubiquitin ligase enzyme	TEB4/MARCH6	Add ubiquitin chains to substrate proteins	[32]
E3 Ubiquitin ligase enzyme	gp78	Add ubiquitin chains to substrate proteins	[33]
E3 Ubiquitin ligase enzyme	CHIP	Add ubiquitin chains to substrate proteins	[34, 35]
E3 Ubiquitin ligase enzyme	RMA1/RNF5	Add ubiquitin chains to substrate proteins	[36-38]
E3 Ubiquitin ligase enzyme	RNF4	Add ubiquitin chains to substrate proteins	[39]
E3 Ubiquitin ligase enzyme	RNF145	Add ubiquitin chains to substrate proteins	[40]

E3 Ubiquitin ligase enzyme	RNF170	Add ubiquitin chains to substrate proteins	[41-43]
E3 Ubiquitin ligase enzyme	RNF103/ KF-1	Add ubiquitin chains to substrate proteins	[44]
E3 Ubiquitin ligase enzyme	RNF185	Add ubiquitin chains to substrate proteins	[45]
E3 Ubiquitin ligase enzyme	Trc8	Add ubiquitin chains to substrate proteins	[46, 47]
E3 Ubiquitin ligase enzyme	RFP2	Add ubiquitin chains to substrate proteins	[48, 49]
E3 Ubiquitin ligase enzyme	SCF <sup>Fbx2/Fbs1</sup>	Add ubiquitin chains to substrate proteins	[50-52]
E3 Ubiquitin ligase enzyme	SCF <sup>Fbx6/Fbs2</sup>	Add ubiquitin chains to substrate proteins	[53, 54]
E3 Ubiquitin ligase enzyme	SCF <sup><math>\beta</math>-TrCP</sup>	Add ubiquitin chains to substrate proteins	[55, 56]
E3 Ubiquitin ligase enzyme	Parkin	Add ubiquitin chains to substrate proteins	[57]
E3 Ubiquitin ligase enzyme	NRDP1/RNF41	Add ubiquitin chains to substrate proteins	[58]
E3 Ubiquitin ligase enzyme	NIXIN/ ZNRF4	Add ubiquitin chains to substrate proteins	[59]
E3 Ubiquitin ligase enzyme	TMEM129	Add ubiquitin chains to substrate proteins	[60-62]
E3 Ubiquitin ligase enzyme	SMURF1	Add ubiquitin chains to substrate proteins	[63]
E3 Ubiquitin ligase enzyme	RFP2/TRIM13	Add ubiquitin chains to substrate proteins	[64, 65]
E4 Ubiquitin extension enzyme	UBE4A/B	Extend the ubiquitin chain	[66]
Deubiquitinase	USP13	cleave the ubiquitin chain	[67]
Deubiquitinase	USP14	cleave the ubiquitin chain	[68]
Deubiquitinase	USP19	cleave the ubiquitin chain	[69]
Deubiquitinase	USP25	cleave the ubiquitin chain	[70]
Deubiquitinase	RPN11	cleave the ubiquitin chain	[68]
Deubiquitinase	UCH37	cleave the ubiquitin chain	[68]
Deubiquitinase	OTUB1	cleave the ubiquitin chain	[71]
Deubiquitinase	OTUD2 /YOD1	cleave the ubiquitin chain	[72]
Deubiquitinase	Ataxin-3	cleave the ubiquitin chain	[73, 74]
Ubiquitin-binding proteins	HR23a, HR23b	transfer the ubiquitinated substrate to proteasome	[75]
Ubiquitin-binding proteins	Rpn10	transfer the ubiquitinated substrate to proteasome	[76]

peptide: N-glycanase	NGLY1	Deglycosylation	[53]
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