

**Table S1. Gene ontology analysis of derepressed genes by *Ring1B*-KO or *Ring1A/B*-dKO in ES cells****Derepressed genes by *Ring1A/B*-dKO (4 days after OHT treatment)**

Category	GO description	P value
Biological process	Development	2.3E-29
	Regulation of transcription	8.0E-17
	Pattern specification	1.1E-14
	Cell adhesion	1.2E-14
	Signal transduction	1.1E-13
	Organ morphogenesis	1.0E-11
	G-protein coupled receptor protein signaling pathway	1.9E-11
	Immune response	4.3E-10
	Antigen processing and presentation of endogenous antigen	3.2E-09
	Antigen processing and presentation of endogenous peptide antigen via MHC class I	8.6E-09
	Ion transport	1.3E-08
	Transmembrane receptor protein tyrosine kinase signaling pathway	1.7E-08
	Phosphate transport	7.9E-08
	Axon guidance	8.5E-08
	Cell fate commitment	3.3E-07
Molecular function	Sequence-specific DNA binding	1.2E-23
	Receptor activity	2.2E-23
	Transcription factor activity	4.2E-23
	Ion channel activity	4.3E-13
	Calcium ion binding	1.8E-12
	Signal transducer activity	5.3E-12
	Voltage-gated ion channel activity	2.3E-10
	G-protein coupled receptor activity	2.1E-09
	GPI anchor binding	2.8E-09
	Structural molecule activity	3.2E-09
	Rhodopsin-like receptor activity	1.0E-08
	Extracellular matrix structural constituent conferring tensile strength	4.8E-08
MHC class I receptor activity	6.2E-08	
Cellular component	Extracellular space	9.0E-58
	Membrane	1.6E-31
	Integral to membrane	4.3E-30
	Extracellular matrix (sensu Metazoa)	5.5E-24
	Extracellular region	5.1E-23
	Transcription factor complex	2.3E-19
	Integral to plasma membrane	9.3E-14
	Collagen	6.3E-09
	External side of plasma membrane	3.2E-08
	Plasma membrane	6.2E-08
MHC class I protein complex	4.2E-07	

**Derepressed genes by *Ring1B*-KO (4 days after OHT treatment)**

Category	GO description	P value
Biological process	Development	6.7E-14
	Pattern specification	4.4E-12
	Immune response	3.0E-11
	Organ morphogenesis	1.6E-10
	Ion transport	8.8E-10
	Signal transduction	1.8E-08
	Defense response	2.9E-08
	Regulation of transcription	2.7E-07
	Cell adhesion	3.6E-07
	Molecular function	Receptor activity
Sequence-specific DNA binding		5.9E-12
Ion channel activity		1.1E-11
Calcium ion binding		9.2E-11
G-protein coupled receptor activity		1.8E-10
Signal transducer activity		1.4E-09
Transcription factor activity		2.8E-09
Sugar binding	3.4E-07	
Cellular component	Extracellular space	7.4E-18
	Extracellular region	9.6E-18
	Membrane	3.7E-16
	Integral to membrane	4.9E-16
	Integral to plasma membrane	2.0E-14
	External side of plasma membrane	3.4E-07