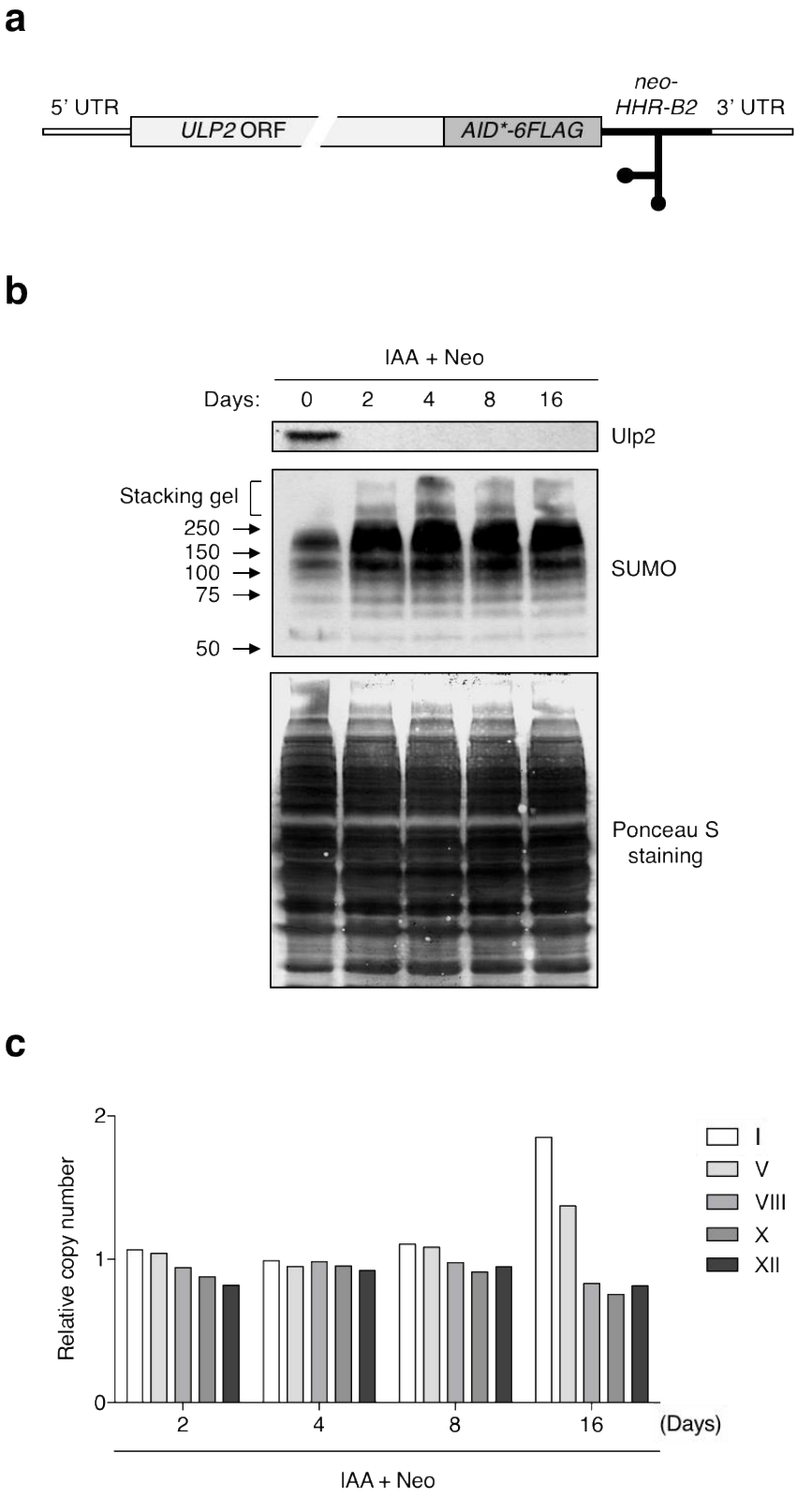
Distinct Adaptive Mechanisms Drive Recovery from Aneuploidy Caused by Loss of the Ulp2 SUMO Protease

Ryu et al.

Supplementary Figures

Supplementary Fig. 1



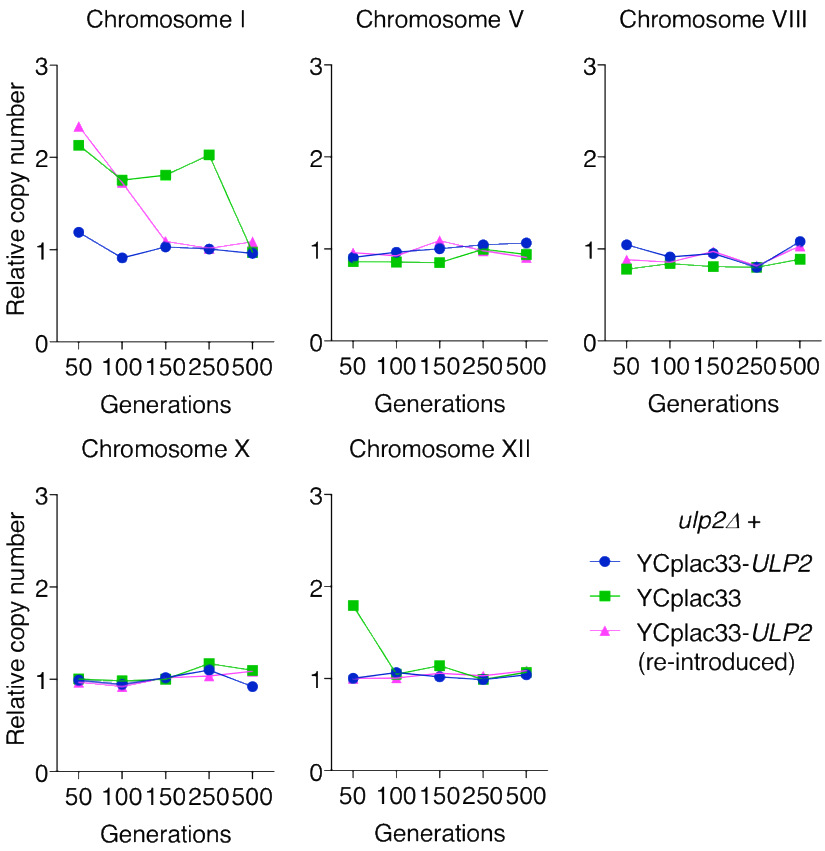
Supplementary Fig. 1 ChrI disomy was generated after 16 days in Ulp2 protein continuously depleted cells.

a Schematic diagram of *ULP2-AID*-6FLAG-neo-HHR-B2*. Gray and dark gray boxes indicate *ULP2* ORF and *AID*-6FlAG* tag, respectively. Neomycin-inducible hammerhead ribozyme (HHR) in the 3′ UTR of *ULP2* is represented by black color.

b Immunoblotting with anti-Flag antibody to detect Ulp2-AID*-6Flag and anti-SUMO antibody to detect sumoylated proteins in extracts prepared from the strains containing *ULP2-AID*-6FLAG-neo-HHR-B2*. Cells were incubated in YPD medium with 500 μM indoleacetic acid (IAA) and 100 μg/ml of neomycin, and the cultures were diluted daily with fresh YPD containing IAA and neomycin.

c Aneuploidy analysis of cells from panel A as in Fig. 4b. The results were normalized to chromosome copy number from day 0 cells harvested at the onset of IAA and neomycin treatment.

Supplementary Fig. 2

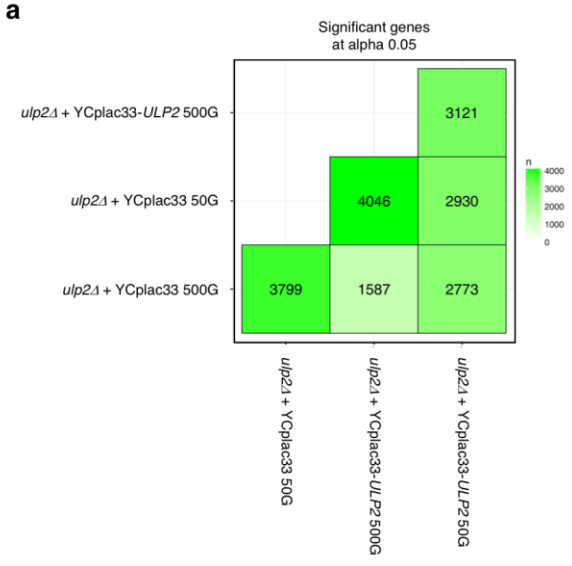


Supplementary Fig. 2 The aneuploidy of *ulp2Δ* cells was reversed during laboratory cell evolution.

Chromosome copy number of *ulp2Δ* strains was monitored as shown in Fig. 1b.

Supplementary Fig. 3

a



b

Significantly differentially expressed (SDE) genes

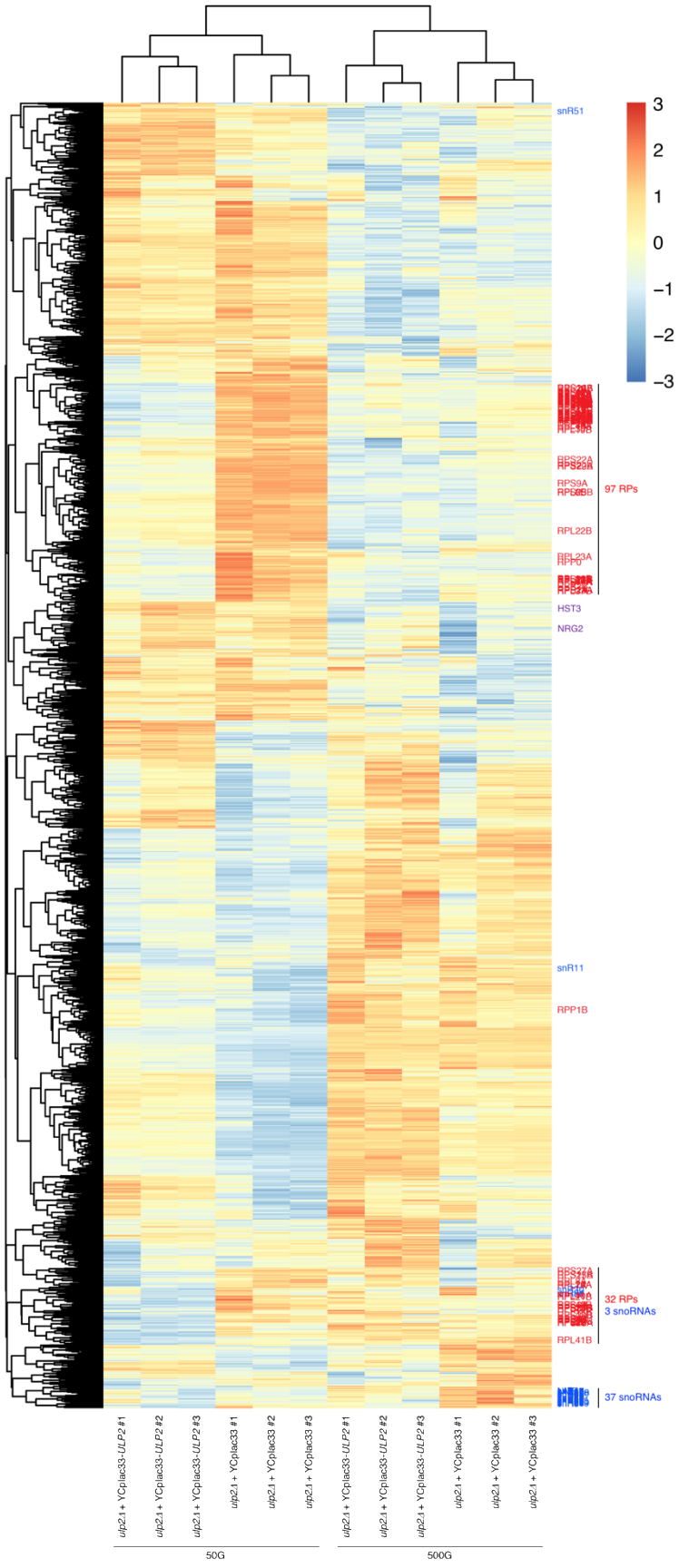
Strain	Upregulated	Downregulated
ulp2Δ + YCplac33-*ULP2* 500G	122	157
ulp2Δ + YCplac33 50G	250	69
ulp2Δ + YCplac33 500G	134	92

Supplementary Fig. 3 Levels of many RNAs were significantly different in *ulp2Δ* strains following *in vitro* evolution.

a A large portion of transcripts have significantly different levels (alpha value less than 0.05) when compared between the pairs of strains.

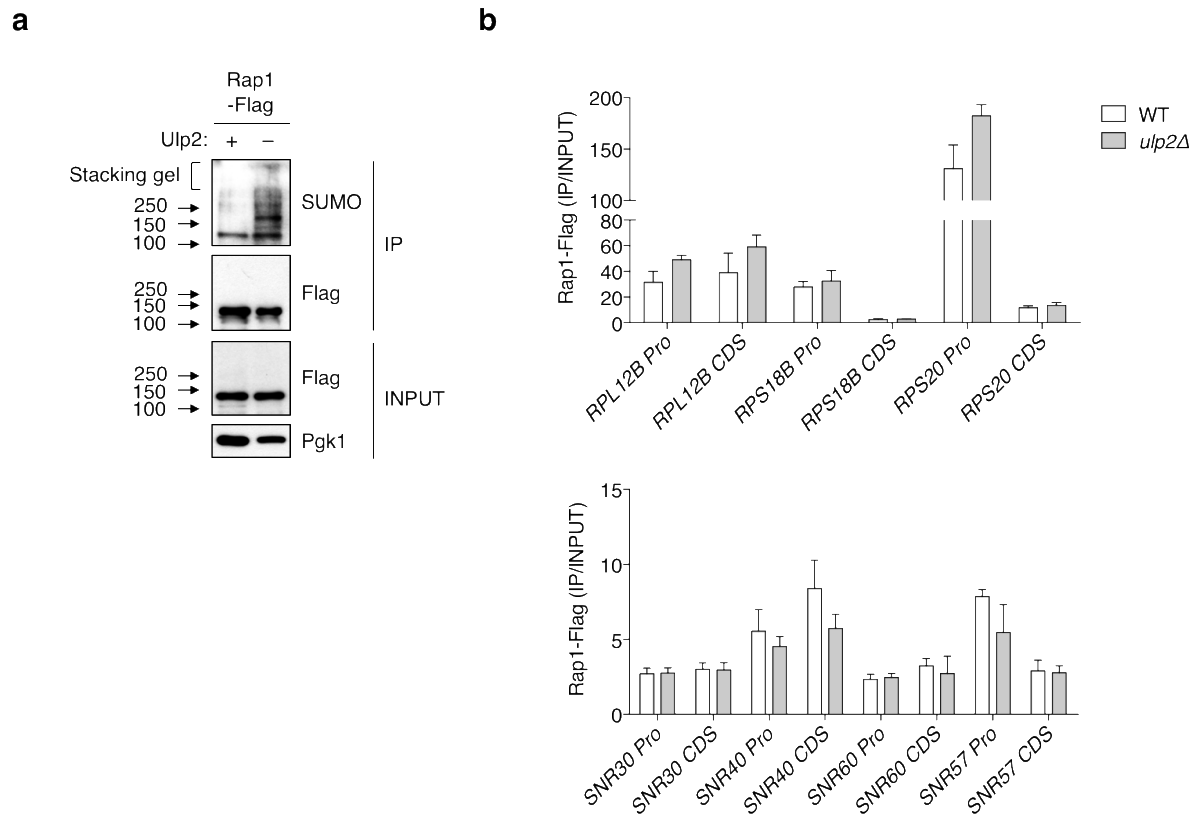
b Table of significantly differentially expressed (SDE) genes that are upregulated or downregulated in the indicated mutant strain as compared to MHY1379 (*ulp2Δ* + YCplac33-*ULP2*) 50G.

Supplementary Fig. 4



Supplementary Fig. 4 Transcriptome analysis of *ulp2Δ* strains during laboratory evolution. Two-dimensional agglomerative hierarchical clustering of significantly up- or down-regulated (5,271) genes ($P < 0.05$) in triplicate RNA samples. Ribosomal protein (RP) genes highly expressed in *ulp2Δ* + YCplac33 50G, as compared to MHY1379 (*ulp2Δ* + YCplac33-*ULP2*) 50G, are marked in red color at right. *HST3*/*NRG2* downregulated transcripts and snoRNAs upregulated in *ulp2Δ* + YCplac33 500G are marked with purple and blue colors, respectively.

Supplementary Fig. 5

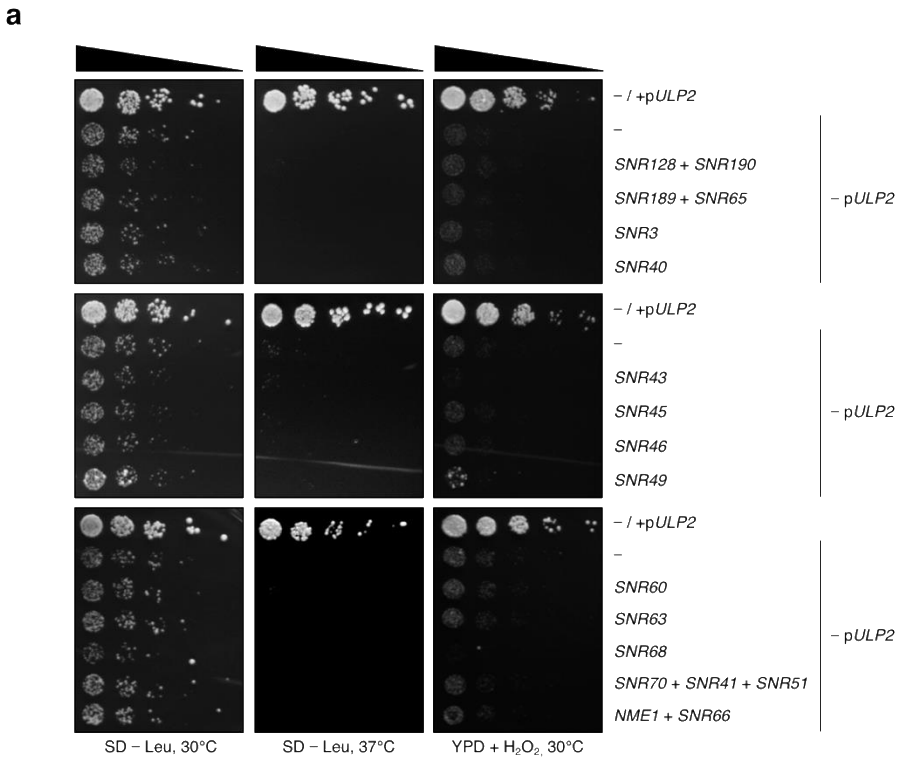


Supplementary Fig. 5 Ulp2 reduces (poly)SUMO-Rap1 levels, but it does not appear to affect recruitment of Rap1 to RP and snoRNA genes.

a Immunoprecipitation (IP) of Rap1-Flag with anti-Flag agarose from denatured yeast extracts in WT and *ulp2Δ* strains expressing Flag-tagged Rap1 followed by immunoblot analysis with anti-SUMO or anti-Flag antibodies. Anti-PGK was used as a loading control for protein input.

b ChIP analysis of WT and *ulp2Δ* strains expressing Flag-tagged Rap1 as in Fig. 2a**.** The error bars indicate the SD from two experiments.

Supplementary Fig. 6



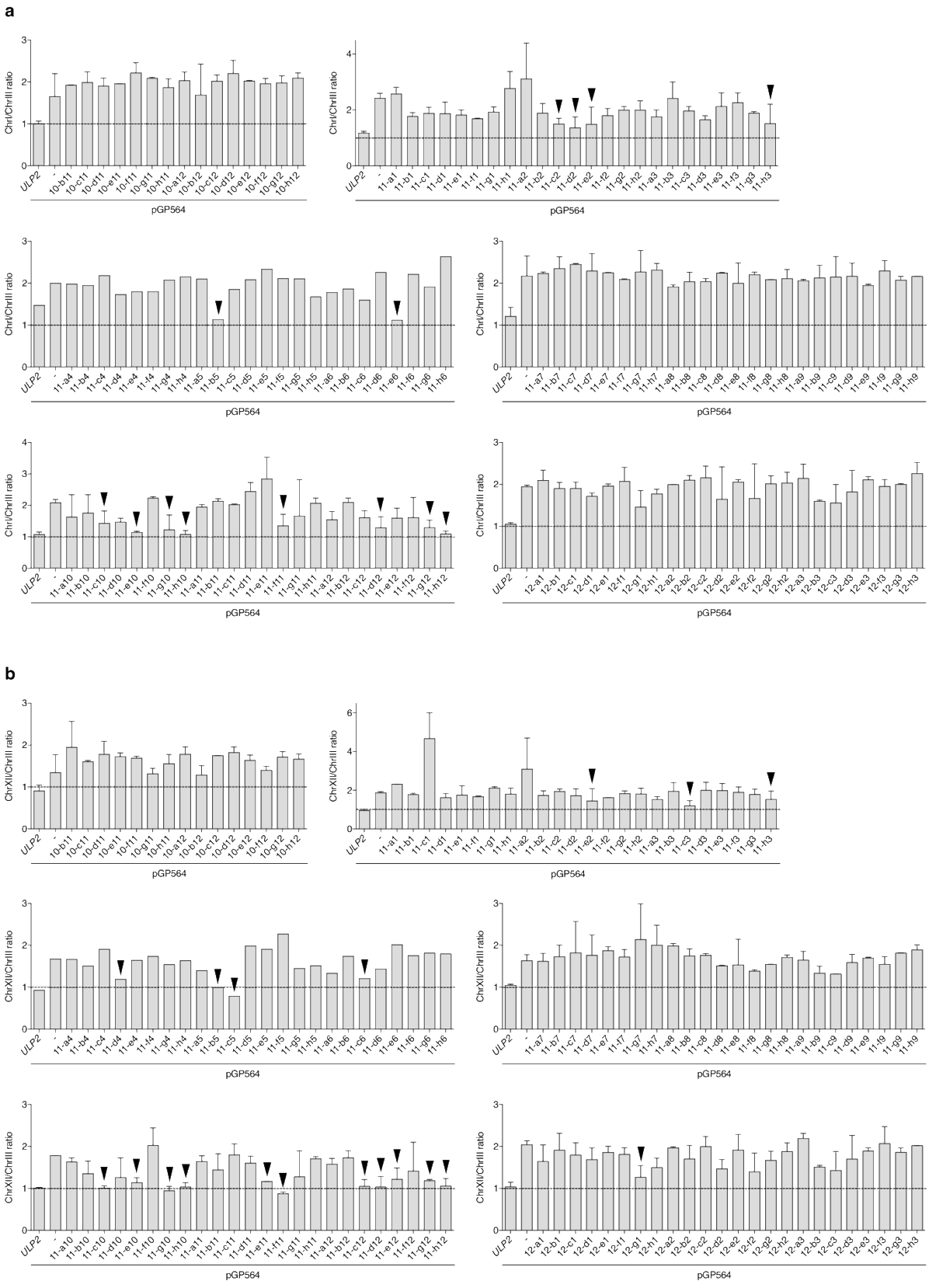
Supplementary Fig. 6 High-copy expression of the indicated individual snoRNAs has no effect on the growth defects, aneuploidy or accumulation of high molecular weight SUMO conjugates caused by acute loss of Ulp2.

a Growth assays of yeast transformants. After spotting cells in five-fold serial dilutions on the indicated plates, the plates were incubated for 2-5 days at the temperatures shown.

b qPCR ploidy assays were performed in the indicated strains as in Fig. 4b.

c Immunoblot analysis of SUMO-conjugated proteins in extracts from the indicated strains as in Fig. 1e.

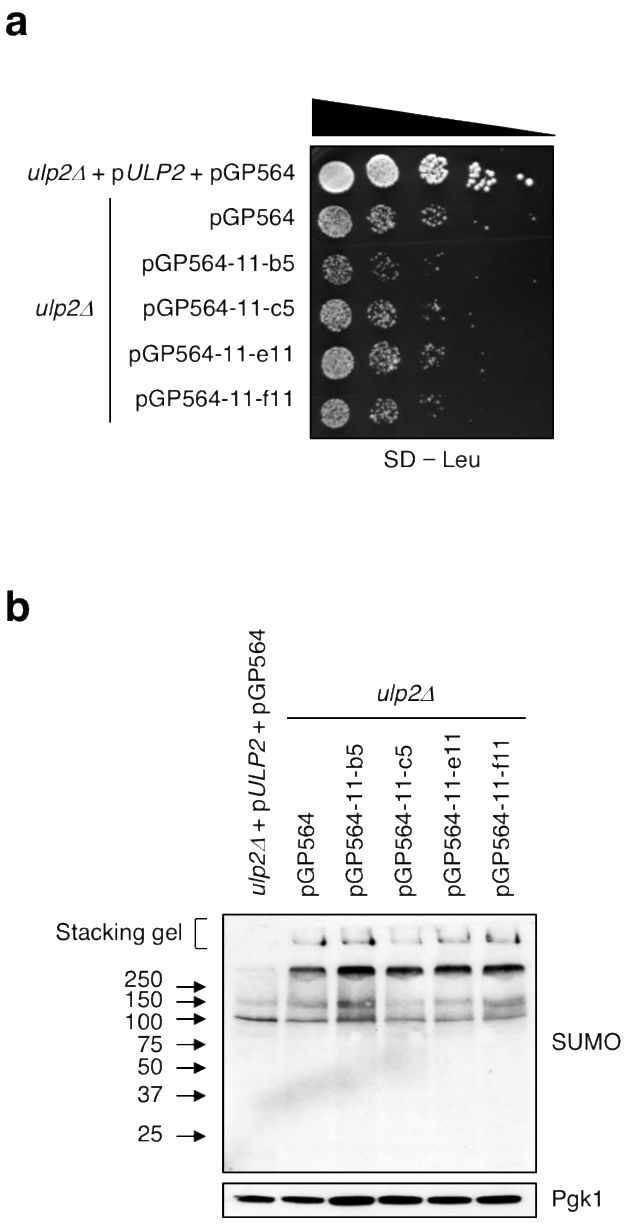
Supplementary Fig. 7



Supplementary Fig. 7 Screening of ChrXII genes for suppression of *ulp2Δ* aneuploidy

a, **b** qPCR ploidy assays were performed with *ulp2Δ* strains containing the indicated 2-μm plasmids. The ratios of ChrI (**a**) and ChrXII (**b**) to ChrIII were both analyzed in duplicate qPCR reactions. The error bars indicate the SD from two experiments. Arrowheads indicate candidate plasmids showing a possible change of *ulp2Δ* aneuploidy.

Supplementary Fig. 8

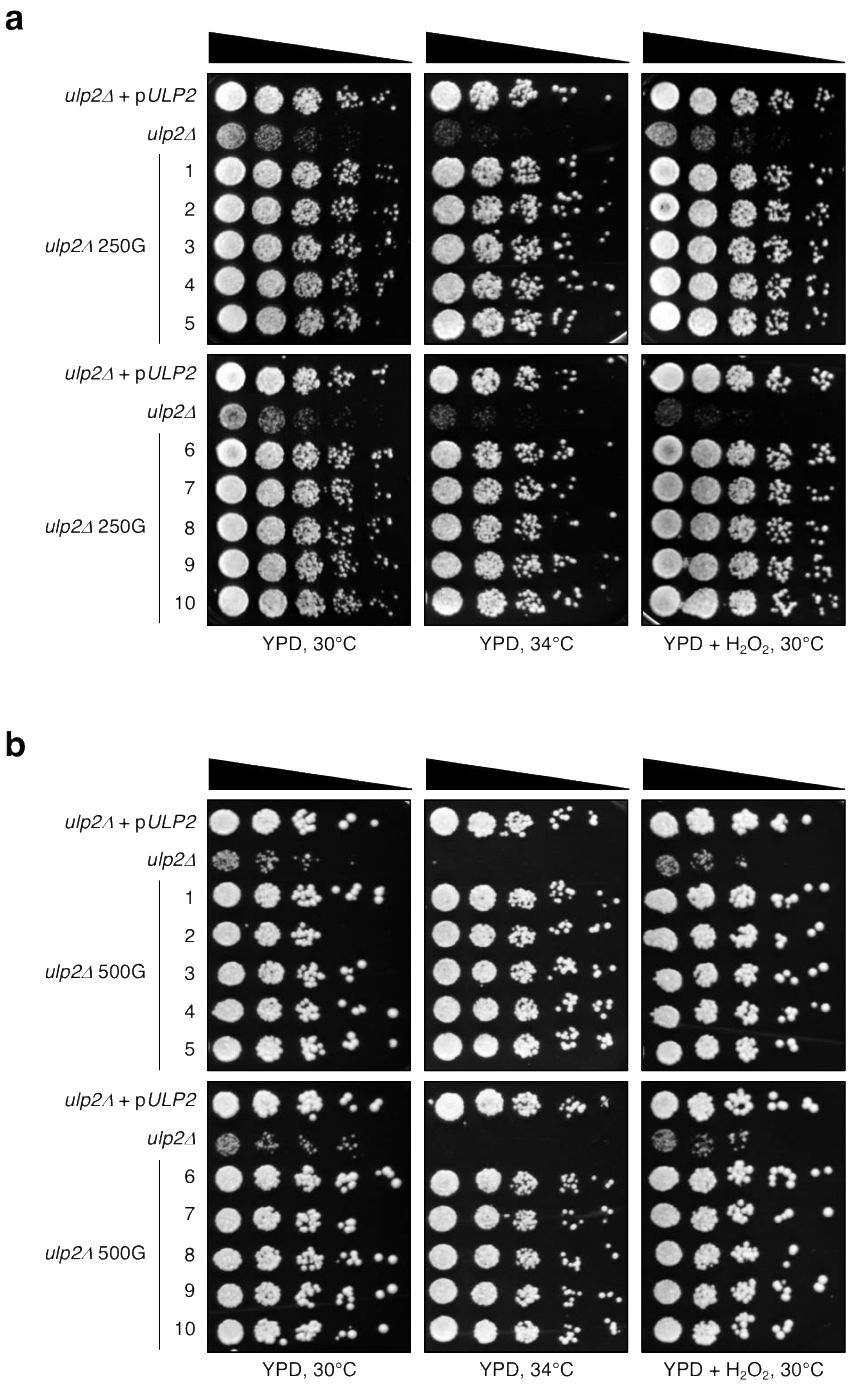


Supplementary Fig. 8 Plasmids identified that suppressed *ulp2Δ* ChrXII disomy did not suppress the growth defect or accumulation of polySUMO conjugates in cells lacking *ULP2*.

a Growth assay of the indicated yeast transformants. After spotting cells in five-fold serial dilutions on an SD – Leu plate, the plate was incubated for 2 days at 30°C.

b Immunoblot analysis of SUMO conjugates in extracts prepared from the indicated strains as in Fig. 1e.

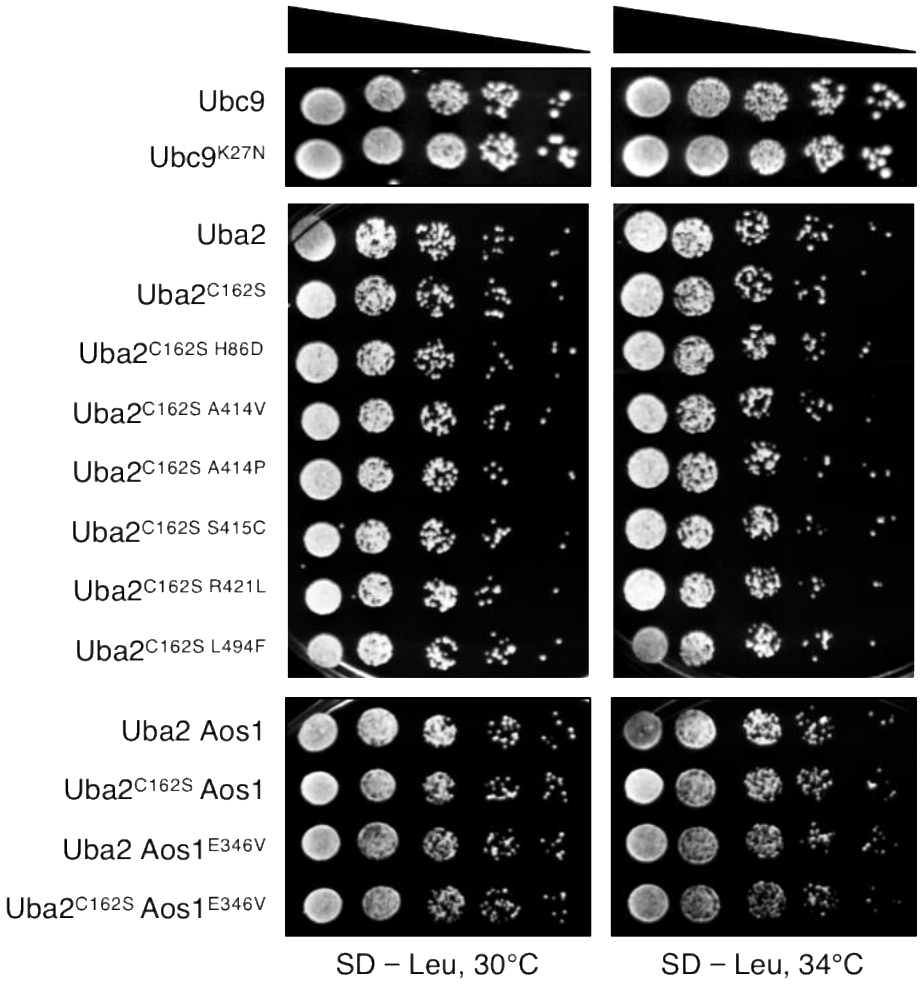
Supplementary Fig. 9



Supplementary Fig. 9 *ulp2Δ* cells become resistant to stress following high passage.

a, **b** Growth assay of the indicated strains passaged for 250 (**a**) or 500 (**b**) generations. After spotting cells in five-fold serial dilutions on the indicated plates, they were incubated for 2-3 days at 30°C or 34°C, as shown.

Supplementary Fig. 10



Supplementary Fig. 10 Identified mutations of Ubc9, Uba2 and Aos1 do not affect cell growth. Growth assay of strains expressing the indicated proteins; the strains have a normal copy of *ULP2*. After spotting cells in five-fold serial dilutions, the SD – Leu plates were incubated for 2 days at 30°C or 34°C.

Supplementary Fig. 11 Original WB Figures**.**

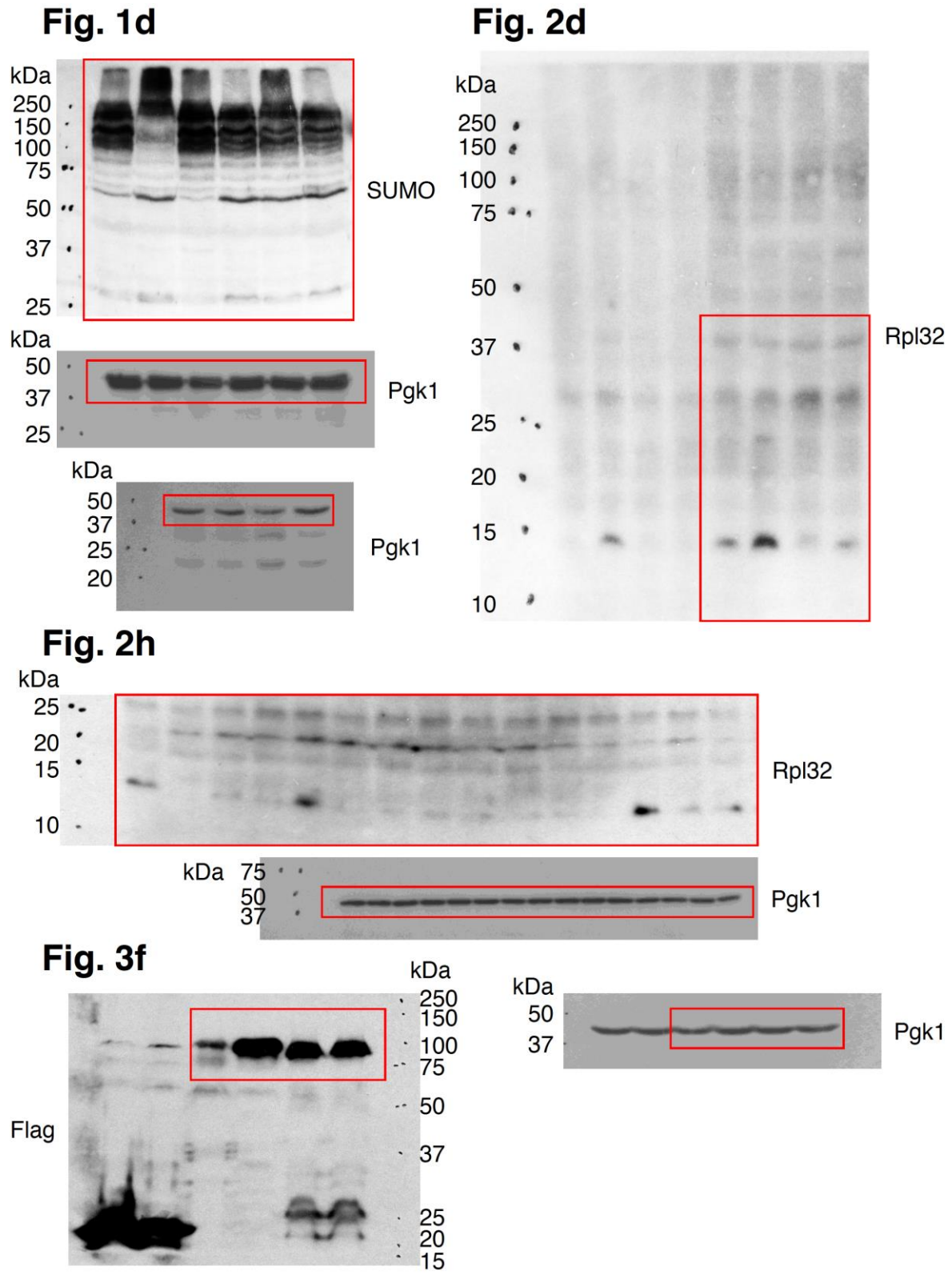


Fig. 5e

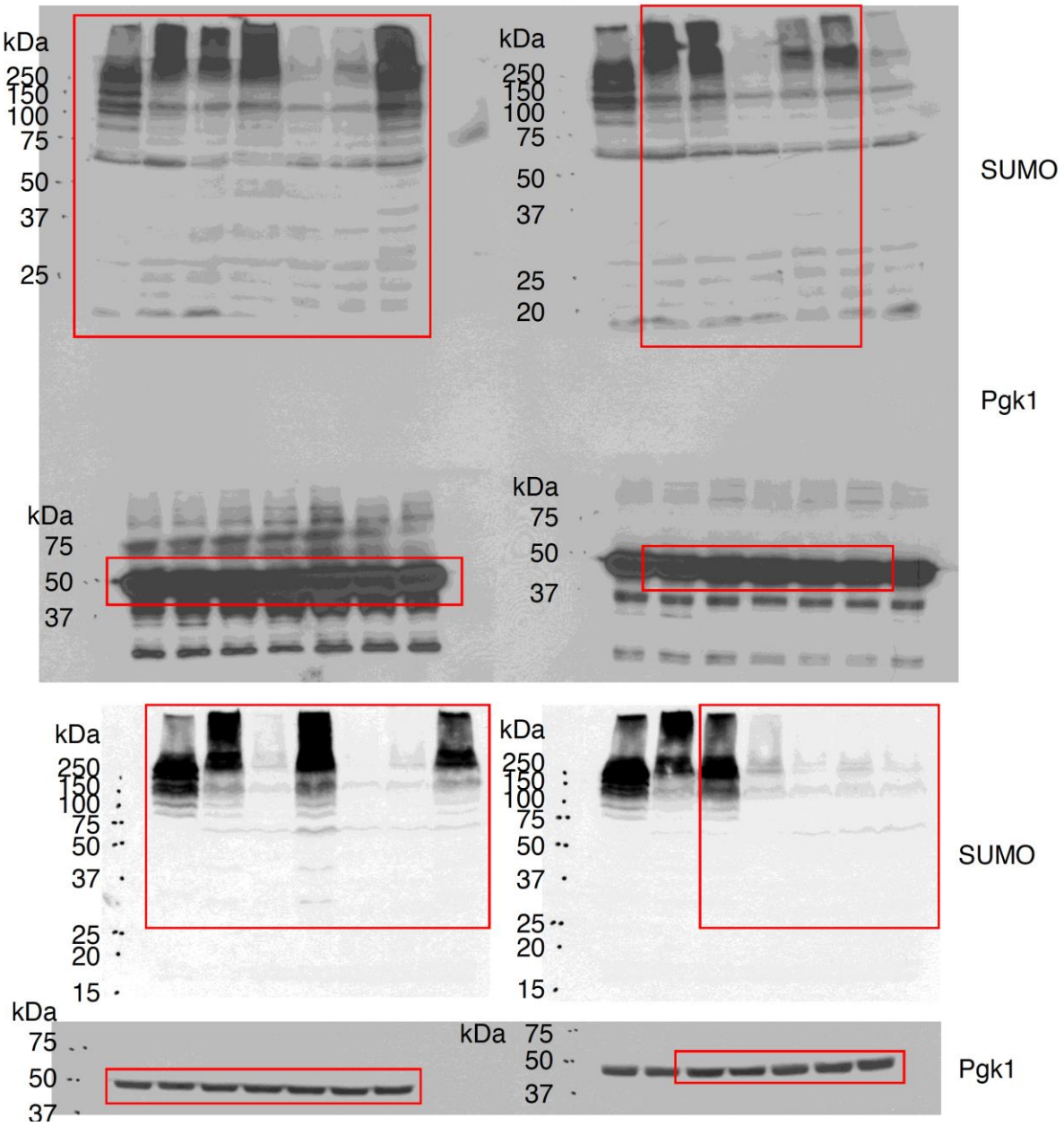

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Fig. 5g

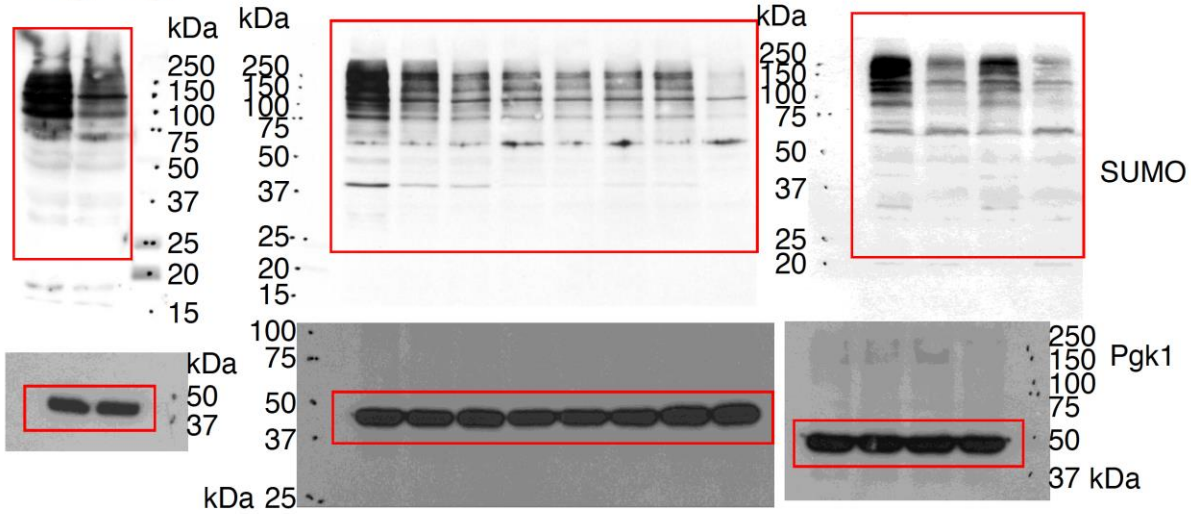


Fig. 6d

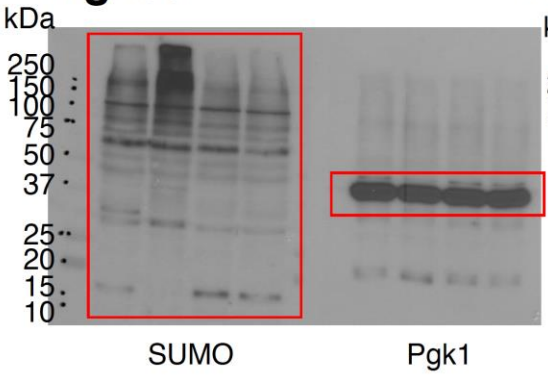


Fig. 6l

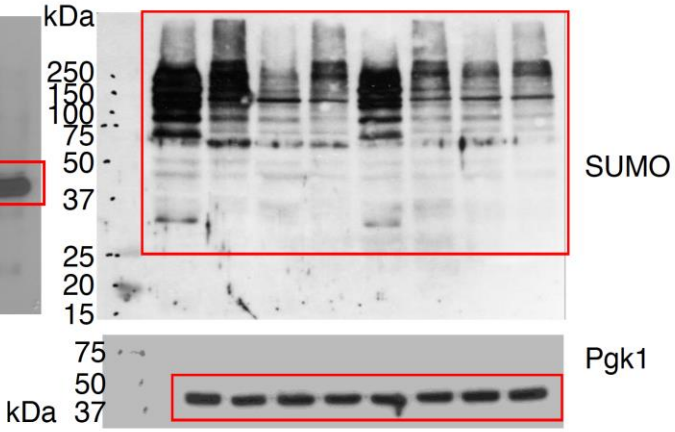
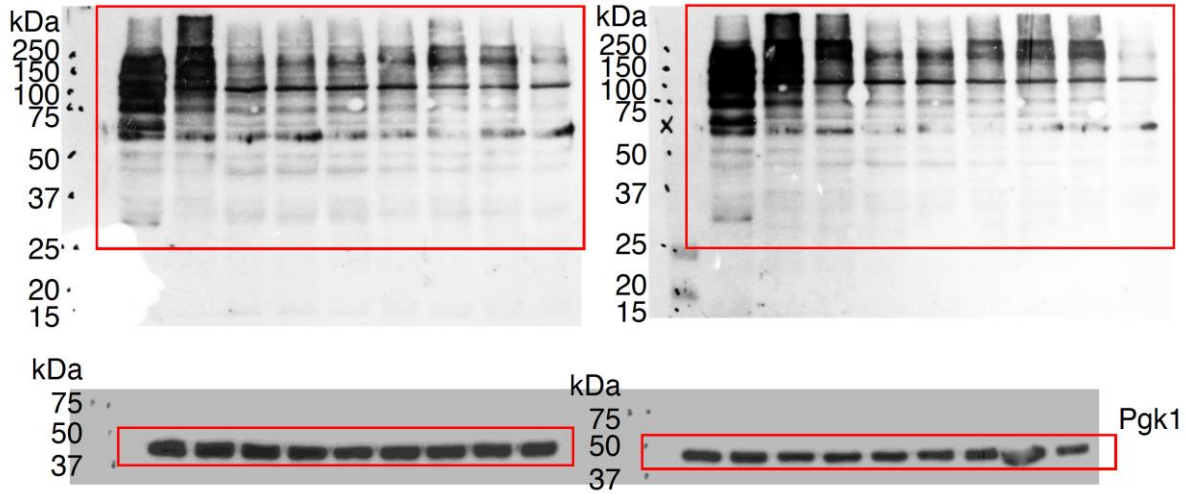
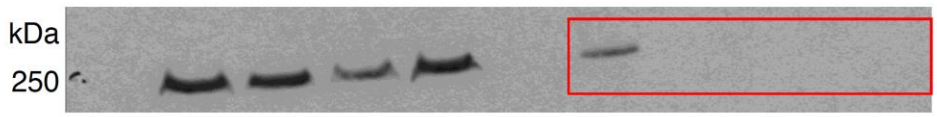
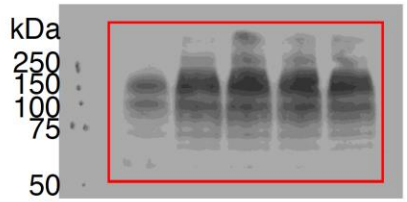


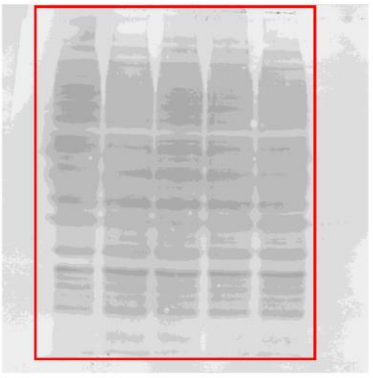
Fig. 6h



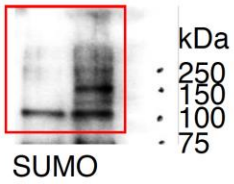
Supplementary Fig. 1b

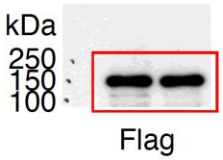


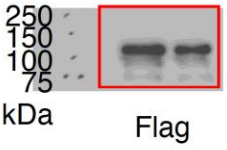


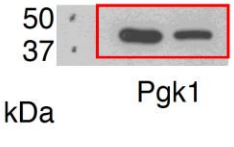


Supplementary Fig. 5a

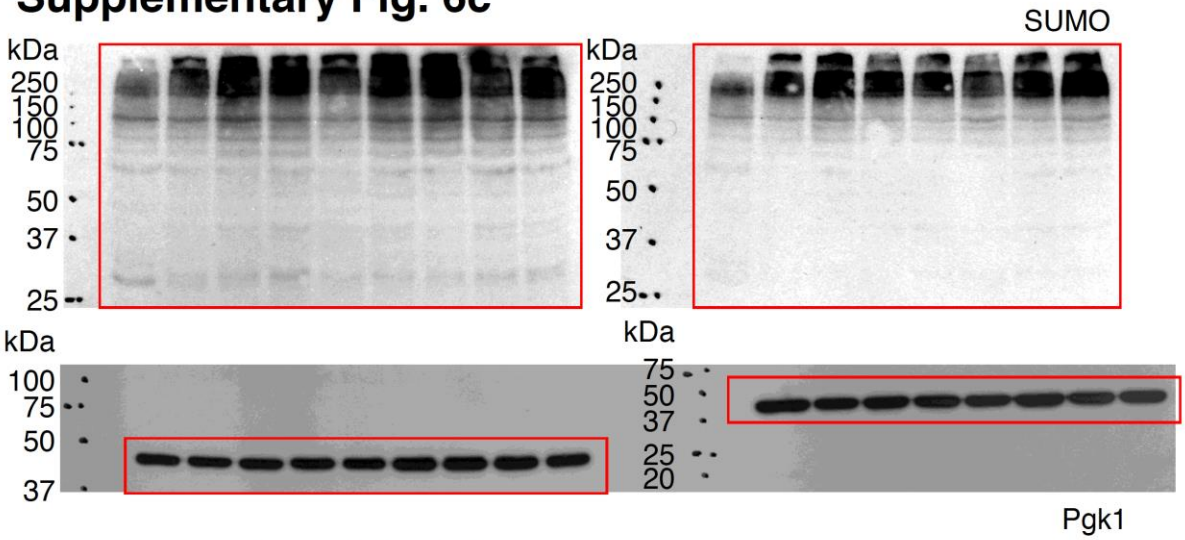




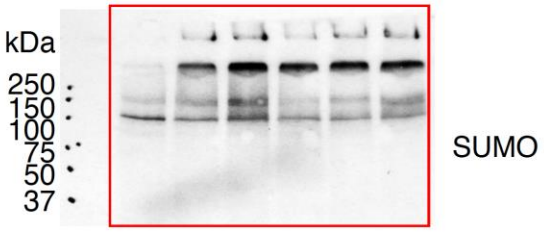


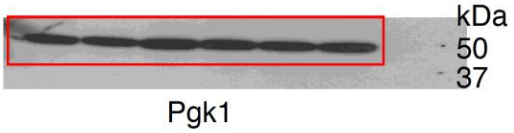


Supplementary Fig. 6c



Supplementary Fig. 8b





Supplementary Tables

Supplementary Table 1. Yeast strains

Strain	Genotype	Source
MHY500	*MATa his3-200 leu2-3,112 lys2-801 trp1-1 ura3-52*	[1]
MHY606	*MATa/MATα his3-Δ200/his3-Δ200 leu2-3,112/leu2-3,112 lys2-801/lys2-801 trp1-1/trp1-1 ura3-52/ura3-52*	[2]
MHY1328	*MATa/MATα his3-Δ200/his3-Δ200 leu2-3,112/leu2-3,112 lys2-801/lys2-801 trp1-1/trp1-1 ura3-52/ura3-52 ULP2/ulp2Δ::HIS3*	[3]
MHY1379	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3* [YCplac33-*ULP2*]	[3]
MHY1538	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 smt3Δ::HIS3 ulp1Δ::HIS3* [pVT102U-*SMT3gg*, YCp50-*ULP1*]	[4]
MHY1620	*MATa his3-Δ200 leu2-3,112::LEU2::ubc9-1 ura3-52 lys2-801 trp1-1 ubc9Δ::TRP1*	[5]
MHY4027 (JR5-2A)	*MATa ade2-1 ura3-1 his3-11, -15 trp1-1 leu2-3,112 can1-100 ssd1 htb1-1 htb2*-1 [YCp50-*HTB1*]	[6]
MHY4659	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 doa10-Δ1::HIS3 uba2Δ::KanMX6 [pIS-uba2ts]*	[5]
MHY5033	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::KanMX6*	[7]
MHY5339	*MATα ade2-1 ura3-1 his3-11, -15 trp1-1 leu2-3,112 can1-100 GAL-His6-SMT3::kanMX6*	[8]
MHY7863	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ULP2-6xGly-3xFlag::HIS3MX6*	[7]
MHY9388	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ccr4Δ::kanMX6*	[7]
MHY9389	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 ccr4Δ::kanMX6*	[7]
MHY9393	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 CCR4-6xGly-3xFlag::kanMX6* [YCplac33-*ULP2*]	This study
MHY9494 (Y911)	*MATa leu2Δ0 met15Δ0 ura3Δ0 HIS3::pRS303-ADH-AFB2 ULP2-AIDstar-6FLAG* (+*neo-HHR-B2* in 3'UTR)	This study
MHY9610	*MATa his3Δ1 leu2Δ0 met15Δ0 ura3Δ0 RAP1-TAP::HIS3MX6*	TAP tag library
MHY9611	*MATa his3Δ1 leu2Δ0 met15Δ0 ura3Δ0 HST3-TAP::HIS3MX6*	TAP tag library
MHY9612	*MATa his3Δ1 leu2Δ0 met15Δ0 ura3Δ0 NRG2-TAP::HIS3MX6*	TAP tag library
MHY9613	*MATa ade2-1 ura3-1 his3-11, -15 trp1-1 leu2-3,112 can1-100 ssd1 htb1-1 htb2-1 smt3Δ::HIS3* [pRS314-*FLAG-H2B*, pRS425-*GPD-HIS6-SMT3*]	This study
MHY9618	*MATa ade2-1 ura3-1 his3-11, -15 trp1-1 leu2-3,112 can1-100 ssd1 htb1-1 htb2-1 smt3Δ::HIS3 ulp2Δ::kanMX6*	This study

	[pRS314-*FLAG-H2B*, pRS425-*GPD-HIS6-SMT3*]	
MHY9619	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 ubc9Δ::TRP1* [YCplac33-*ULP2*, pRS315-*UBC9*]	This study
MHY9620	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 ubc9Δ::TRP1* [YCplac33-*ULP2*, pRS315-*ubc9K27N*]	This study
MHY9621	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*UBA2*]	This study
MHY9622	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S*]	This study
MHY9623	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S H86D*]	This study
MHY9624	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S,A414V*]	This study
MHY9676	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S,A414P*]	This study
MHY9625	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::KanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S S415C*]	This study
MHY9626	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S,R421L*]	This study
MHY9627	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::KanMX6* [YCplac33-*ULP2*, pRS315-*uba2C162S L494F*]	This study
MHY9637	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ubc9Δ::TRP1* [pRS315-*UBC9*]	This study
MHY9638	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ubc9Δ::TRP1* [pRS315-*ubc9K27N*]	This study
MHY9639	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*UBA2*]	This study
MHY9640	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*uba2C162S*]	This study
MHY9641	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*uba2C162S,H86D*]	This study
MHY9642	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*uba2C162S,A414V*]	This study
MHY9675	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*uba2C162S,A414P*]	This study
MHY9643	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::KanMX6* [pRS315-*uba2C162S S415C*]	This study
MHY9644	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52*	This study

	uba2Δ::kanMX6 [pRS315-*uba2C162S,R421L*]	
MHY9645	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6* [pRS315-*uba2C162S,L494F*]	This study
MHY9677	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6 aos1Δ::NatMX4* [YCplac33-*ULP2*, pRS315-*UBA2-AOS1*]	This study
MHY9678	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6 aos1Δ::natMX4* [YCplac33-*ULP2*, pRS315- *uba2C162S-AOS1*]	This study
MHY9679	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6 aos1Δ::natMX4* [YCplac33-*ULP2*, pRS315- *UBA2-aos1E346V*]	This study
MHY9680	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 uba2Δ::kanMX6 aos1Δ::natMX4* [YCplac33-*ULP2*, pRS315- *uba2C162S-aos1E346V*]	This study
MHY9681	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6 aos1Δ::natMX4* [pRS315-*UBA2-AOS1*]	This study
MHY9682	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6 aos1Δ::natMX4* [pRS315- *uba2C162S-AOS1*]	This study
MHY9683	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6 aos1Δ::natMX4* [pRS315-*UBA2-aos1E346V*]	This study
MHY9684	*MATα his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 uba2Δ::kanMX6 aos1Δ::natMX4* [pRS315- *uba2C162S-aos1E346V*]	This study
MHY10229	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 NOT5-6xGly-3xFlag::kanMX6* [YCplac33-*ULP2*]	This study
MHY10230	*MATa his3-Δ200 leu2-3,112 lys2-801 trp1-1 ura3-52 ulp2Δ::HIS3 RAP1-6xGly-3xFlag::kanMX6* [YCplac33-*ULP2*]	This study

Supplementary Table 2. Plasmids

Plasmid	Description	Source
YCplac33	*CEN*, *URA3*	[9]
YCplac33-ULP2	*CEN*, *URA3*, *ULP2*	[3]
YCplac33-UBC9	*CEN*, *URA3*, *UBC9*	Alaron Lewis
YCplac33-UBA2	*CEN*, *URA3*, *UBA2*	Alaron Lewis
YCplac33-UBA2 AOS1	*CEN*, *URA3*, *UBA2*, *AOS1*	This study
pGP564	*2μ*, *LEU2*	[10]
pGP564-REX3+snR6+YLR108C	*2μ*, *LEU2*, *REX3*, *snR6*, *YLR108C*	This study
pGP564-AHP1	*2μ*, *LEU2*, *AHP1*	This study
pGP564-CCW12	*2μ*, *LEU2*, *CCW12*	This study
pGP564-YLR111W	*2μ*, *LEU2*, *YLR111W*	This study
pGP564-YLR112W+HOG1	*2μ*, *LEU2*, *YLR112W*, *HOG1*	This study
pGP564-tR(ACG)L+AVL9	*2μ*, *LEU2*, *tR(ACG)L*, *AVL9*	This study
pGP564-REC102	*2μ*, *LEU2*, *REC102*	This study
pGP564-CHS5	*2μ*, *LEU2*, *CHS5*	This study
pGP564-JIP3+MID2	*2μ*, *LEU2*, *JIP3*, *MID2*	This study
pGP564-tD(GUC)L2+snoRNAs	*2μ*, *LEU2*, *tD(GUC)L2*, *snR61*, *snR55*, *snR57*	This study
pGP564-snoRNAs	*2μ*, *LEU2*, *snR61*, *snR55*, *snR57*	This study
pGP564-RPS25B	*2μ*, *LEU2*, *RPS25B*	This study
pGP564-YLR334C+tE(UUC)L+NUP2	*2μ*, *LEU2*, *YLR334C*, *tE(UUC)L*, *NUP2*	This study
pGP564-SGD1	*2μ*, *LEU2*, *SGD1*	This study
pGP564-VRP1+OPI9	*2μ*, *LEU2*, *VRP1*, *OPI9*	This study
pGP564-YLR339C+RPP0+SPO77	*2μ*, *LEU2*, *YLR339C*, *RPP0*, *SPO77*	This study
pRS315	*CEN*, *LEU2*	[11]
pRS315-UBC9	*CEN*, *LEU2*, *UBC9*	This study
pRS315-UBC9K27N	*CEN*, *LEU2*, *ubc9K27N*	This study
pRS315-UBA2	*CEN*, *LEU2*, *UBA2*	This study
pRS315-UBA2C162S	*CEN*, *LEU2*, *uba2C162S*	This study
pRS315-UBA2C162S H86D	*CEN*, *LEU2*, *uba2C162S,H86D*	This study
pRS315-UBA2C162S A414V	*CEN*, *LEU2*, *uba2C162S,A414V*	This study
pRS315-UBA2C162S A414P	*CEN*, *LEU2*, *uba2C162S,A414P*	This study
pRS315-UBA2C162S S415C	*CEN*, *LEU2*, *uba2C162S,S415C*	This study
pRS315-UBA2C162S R421L	*CEN*, *LEU2*, *uba2C162S,R421L*	This study
pRS315-UBA2C162S L494F	*CEN*, *LEU2*, *uba2C162S,L494F*	This study
pRS315-UBA2-AOS1	*CEN*, *LEU2*, *UBA2*, *AOS1*	This study
pRS315-UBA2C162S-AOS1	*CEN*, *LEU2*, *uba2C162S*, *AOS1*	This study
pRS315-UBA2-AOS1E346V	*CEN*, *LEU2*, *UBA2*, *aos1E346V*	This study
pRS315-UBA2C162S-AOS1E346V	*CEN*, *LEU2*, *uba2C162S*, *aos1E346V*	This study
p425-GPD	*2μ*, *LEU2*, P_{GPD}, T_{CYC1}	[12]
p425-GPD-CLN3	*2μ*, *LEU2*, P_{GPD}, T_{CYC1}, *CLN3*	[7]
p425-GPD-CCR4	*2μ*, *LEU2*, P_{GPD}, T_{CYC1}, *CCR4*	[7]
p425-GPD-NOT5	*2μ*, *LEU2*, P_{GPD}, T_{CYC1}, *NOT5*	[7]

p425-GPD-HIS6-SMT3	*2μ*, *LEU2*, P_{GPD}, T_{CYC1}, *HIS6-SMT3*	This study
pRS314-FLAG-H2B	*CEN*, *TRP1*, *FLAG-HTB1*	[13]

Supplementary Table 3. Oligonucleotides

Name	Sequence
ChrI_Left_FWD	ACAGCTTCTAAACGTTCCGTGTGC
ChrI_Left_REV	GCGGTGTGTGGATGATGGTTTCAT
ChrI_Right_FWD	GCACTTGATCCATGTAGCCATACTCG
ChrI_Right_REV	TTCGGGTGACCCTTATGGCATTCT
ChrV_Left_FWD	TCCGCCGGCAACTGTAACTGTAAA
ChrV_Left_REV	ATAGTAACCAACGAGAGCGCGCAA
ChrV_Right_FWD	CAAGCCACTGTTGGCGTTTCAACT
ChrV_Right_REV	TTTATGTGCGGCTTTGTCAGCAGG
ChrVIII_Left_FWD	TTGTCGGTCTAGCCGAAAGGTGTT
ChrVIII_Left_REV	AGTTCTGCGGCAGTAATGTAGGGT
ChrVIII_Right_FWD	TGGAAAGGGCCTCGAAAGACGTTA
ChrVIII_Right_REV	TCGGGACTCCACCTGGAATATTGT
ChrX_Left_FWD	ATTTACCGGTTAGTGTCAGCGCCA
ChrX_Left_REV	CGACAGAGTAGTTTATGCCGAGGGTT
ChrX_Right_FWD	AGGCGAGTACCCTTAGCATTTCCT
ChrX_Right_REV	ACGAGGCAAGTGTAGGTCCTTTGT
ChrXII_Left_FWD	TGGAGATGAAGGGTTGTCGTTGGT
ChrXII_Left_REV	ACGTGTAGCGTTTCTGCTGGTCTT
ChrXII_Right_FWD	ATGGCAGGCAGGTGAATGAGATGA
ChrXII_Right_REV	AGAGTAGACCATGGGACGTCGTTT
RPL12B pro For (777-800)	GCTCTAGGCCGAGAAAATGTTAAT
RPL12B pro Rev (884-910)	TCATACTAGTAATGTACCGCCAAAGAA
RPL12B CDS For (1178-1199)	ACAGAGATCCGTTTGCGTGACT
RPL12B CDS Rev (1248-1267)	AAAGCGGCTAGAGGGGACTG
RPS18B pro For (793-812)	GTCTCCGCAGGCCTCTTGTT
RPS18B pro Rev (869-893)	CCAGTTAGGATAGCAAAGGTGTCAG
RPS18B CDS For (1508-1529)	AGGGTGTTGGTCGTCGTTACTC
RPS18B CDS Rev (1609-1629)	TGGGTTTTGCATGATTTGGAC
RPS20 pro For (767-792)	AAACATAAGAGAAAAAATGCCACAAC
RPS20 pro Rev (887-918)	CTTTACTATTATTTTGAATTCAATACGGTCTA
RPS20 CDS For (1202-1225)	AGAAAGACTCCAAATGGTGAAGGT
RPS20 CDS Rev (1242-1265)	TCTTGTGGATTCTCATTTCGTAGG
snR30 pro For (807-828)	AGTAACCCTAAACCATCAGCGG
snR30 pro Rev (924-947)	CCATAGAAGTTAAATGCACGACGA
snR30 CDS For (1361-1379)	CAGAAGTGGCCCCGTTGAC
snR30 CDS Rev (1457-1480)	ACATCCCGCAATCTCTTCGTAATA
snR40 pro For (773-779)	TTCTTCTTAAAGTATAAAAGGCGGACA
snR40 pro Rev (875-896)	ACCGGTTCGCACTACGATACTT
snR40 CDS For (1006-1027)	TGACGAGAAAAAAGCTGTGCAC
snR40 CDS Rev (1068-1095)	TCAGAAATTTGGGTATACTTAATGCTTC
snR60 pro For (759-779)	ACTTCGTCGCTTTCTCCTCCA
snR60 pro Rev (877-899)	AGGCATACGGCAAATTGACTACA
snR60 CDS For (1002-1030)	GTTAATGATGATAACCAAAGATGCATAGT
snR60 CDS Rev (1077-1103)	TTCAGATAGGAGCGAAAGACTAATTTC

SNR57 Pro For (650-675)	ATTGAACCCTAACAAATGCTACAGTG
SNR57 Pro Rev (752-781)	CATCCAACTCAATTAAGAAAGTTAGAAGAT
SNR57 ORF For (1076-1100)	TTCGTTTATGATCTGGCCTCTTTAT
SNR57 ORF Rev (1139-1164)	TTGAACCGGATATTTTAATCAGTGTC
18S For	GCTTGCGTTGATTACGTCCC
18S Rev	CACTAAGCCATTCAATCGGT
25S For	CGTTCATAGCGACATTGCTT
25S Rev	GGGTGAACAATCCAACGCTT
SPT15 For	TAAAAAGAGCTGCCCCAGAA
SPT15 Rev	ATGATGACAGCAGCAAAACG
ACT1_qRT-PCR_FWD	GACGCTCCTCGTGCTGTCTTC
ACT1_qRT-PCR_REV	GAGCTTCATCACCAACGTAGGAGTC
Int IV For (1516109-1516129)	CGCATTACCAGACGGAGATGT
Int IV Rev (1516212-1516234)	CAAGCAAGCCTTGTGCATAAGA

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