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Supplemental Information

Single-Cell Tracing Dissects Regulation of Maintenance and Inheritance of Transcriptional Reinduction Memory

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Figure S1.

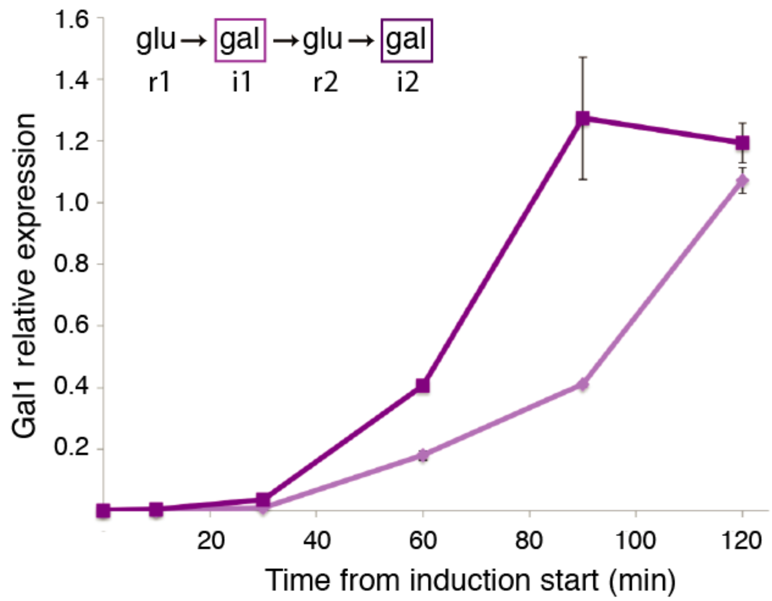

Figure S1. Gal1 memory validated at the RNA level, Related to Figure 1

RT-qPCR analysis of RNA isolated during galactose inductions from WT yeast cultures during a timecourse memory experiment shows higher amounts of Gal1 mRNA at corresponding timepoints during i2 compared to i1, validating that memory is observed in this strain. Error bars are calculated as SD from 2 technical replicates, shown is a representative experiment verified by 4 biological replicates.

Figure S2.

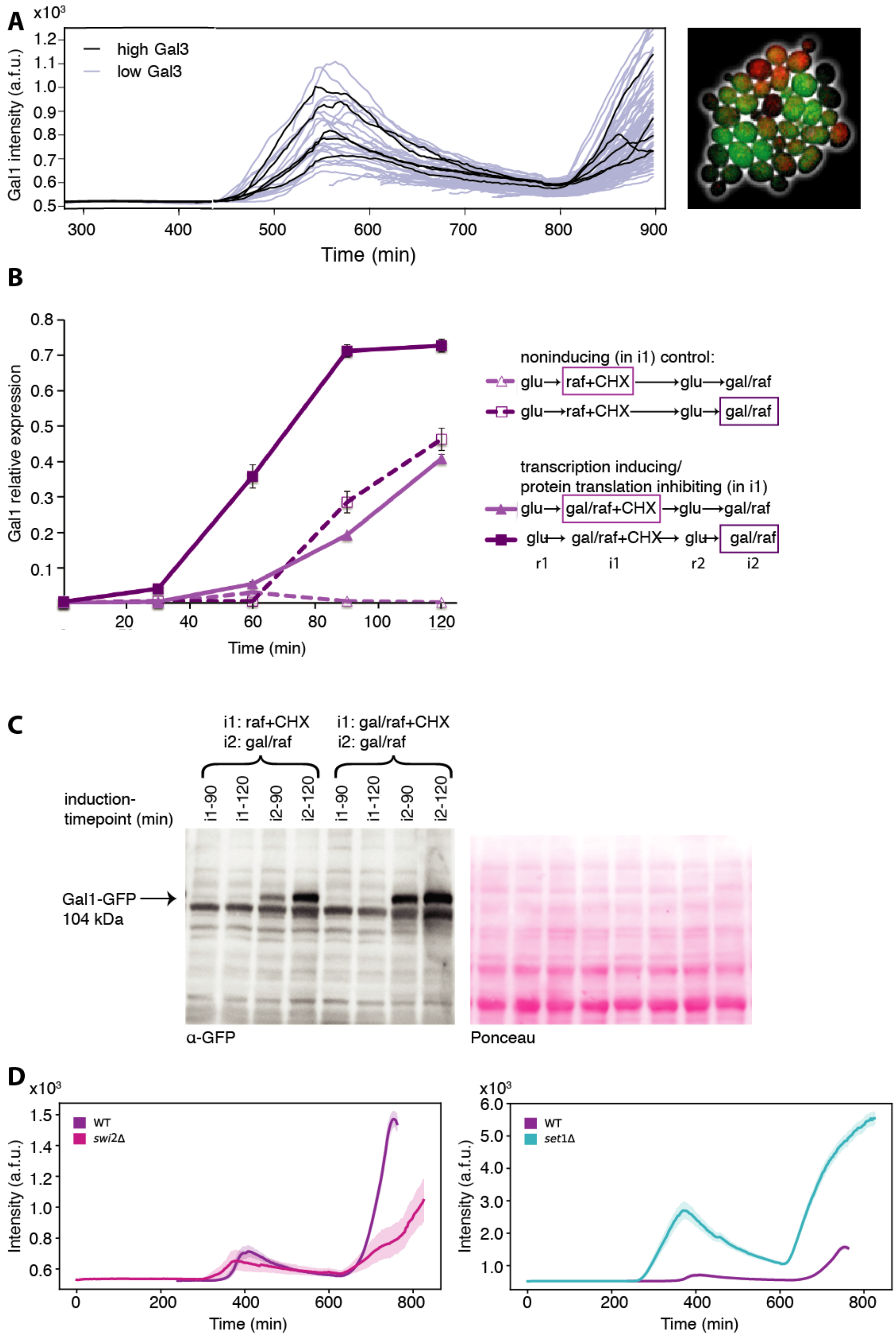
A
x10³
Gal1 intensity (a.f.u.)
high Gal3
low Gal3
Time (min)
B
Gal1 relative expression
Time (min)
noninducing (in i1) control:
glu→ raf+CHX →glu→gal/raf
glu→raf+CHX→glu→ gal/raf
transcription inducing/
protein translation inhibiting (in i1)
glu→ gal/raf+CHX →glu→gal/raf
glu→ gal/raf+CHX→ glu→ gal/raf
r1
i1
r2
i2
C
i1: raf+CHX
i2: gal/raf
i1: gal/raf+CHX
i2: gal/raf
induction-
timepoint (min)
i1-90
i1-120
i2-90
i2-120
Gal1-GFP
104 kDa
α-GFP
Ponceau
D
x10³
Intensity (a.f.u.)
WT
swi2Δ
set1Δ
Time (min)

Figure S2. Protein inheritance and setup validation for Gal1 memory, Related to Figure 2

A, Gal1 and Gal3 proteins are not essential for memory. Gal1 ORF was replaced with GFP and Gal3 was tagged with mCherry. **left**, Single-cell traces of GFP expressed from Gal1 promoter (blue and black). Cells that display faster reinduction of GFP from the Gal1 promoter are not the ones with the highest Gal3 protein levels prior to reinduction (black). **right**, Representative image during reinduction shows cells with highest Gal3-mCherry do not have the most GFP expressed from Gal1 reporter.

B, Protein translation inhibition by cycloheximide (CHX) during an initial induction does not abrogate memory. RT-qPCR of Gal1 mRNA from cultures of WT yeast grown during i1 in either raf with CHX (non-inducing control) or gal/raf with CHX, subsequently grown during r2 in glu, followed by induction in gal/raf shows Gal1 transcriptional memory in i2 even after protein translation inhibition during i1. Error bars indicate SD from 2 technical replicates.

C, Validation of Gal1 reinduction memory by detecting GFP levels. Immunoblot with a GPF-specific antibody of the same cultures as in (B) shows Gal1-GFP protein expression memory in i2 even after protein translation inhibition during i1.

D, Effect of previously identified mutants implicated in Gal1 memory observed by microfluidics. **left**, Swi2 deletion results in loss-of-memory in comparison to WT. **right**, Set1 deletion results in an increase in Gal1 expression in both inductions. Shown is average Gal1-GFP expression (solid line) ±95% confidence intervals (shaded area).

Figure S3.

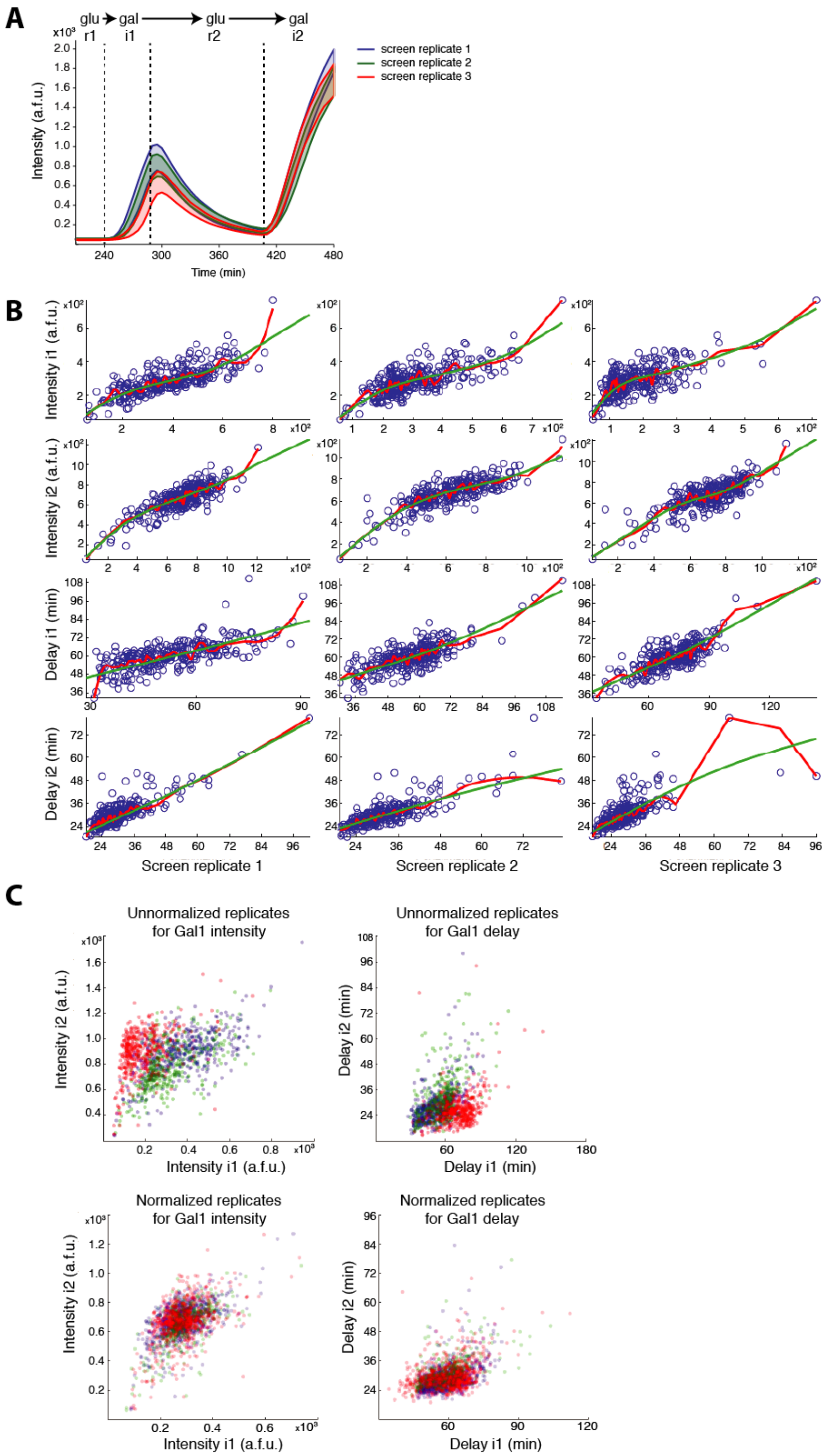
A
glu → gal → glu → gal
r1 i1 r2 i2
screen replicate 1
screen replicate 2
screen replicate 3
Intensity (a.f.u.)
Time (min)
B
Intensity i1 (a.f.u.)
Intensity i2 (a.f.u.)
Delay i1 (min)
Delay i2 (min)
Screen replicate 1
Screen replicate 2
Screen replicate 3
C
Unnormalized replicates for Gal1 intensity
Unnormalized replicates for Gal1 delay
Normalized replicates for Gal1 intensity
Normalized replicates for Gal1 delay
Intensity i1 (a.f.u.)
Intensity i2 (a.f.u.)
Delay i1 (min)
Delay i2 (min)

Figure S3. High-throughput microfluidics screen data normalization, Related to Figure 3

A, Summary of all screen experiments shows reproducibility of the screen. Median and 25 to 75 percentiles of Gal1-GFP intensity for all strains in a single experiment combined is shown for 3 biological screen replicates, each containing technical duplicates.

B, Normalization of screen replicates using LOESS for data reduction. Data collected from 3 independent microfluidics experiments were condensed to a single dataset using LOESS. y-axis shows average values of strains in intensity and delay for both i1 and i2. x-axis shows the respective values in the experimental repeats. Red lines show the result of LOESS, green lines show the final local regression lines used for data normalization.

C, Overlay of screen replicates before and after normalization by LOESS. **top**, raw values for Gal1 intensity and delay. **bottom**, normalized values.

Figure S4.

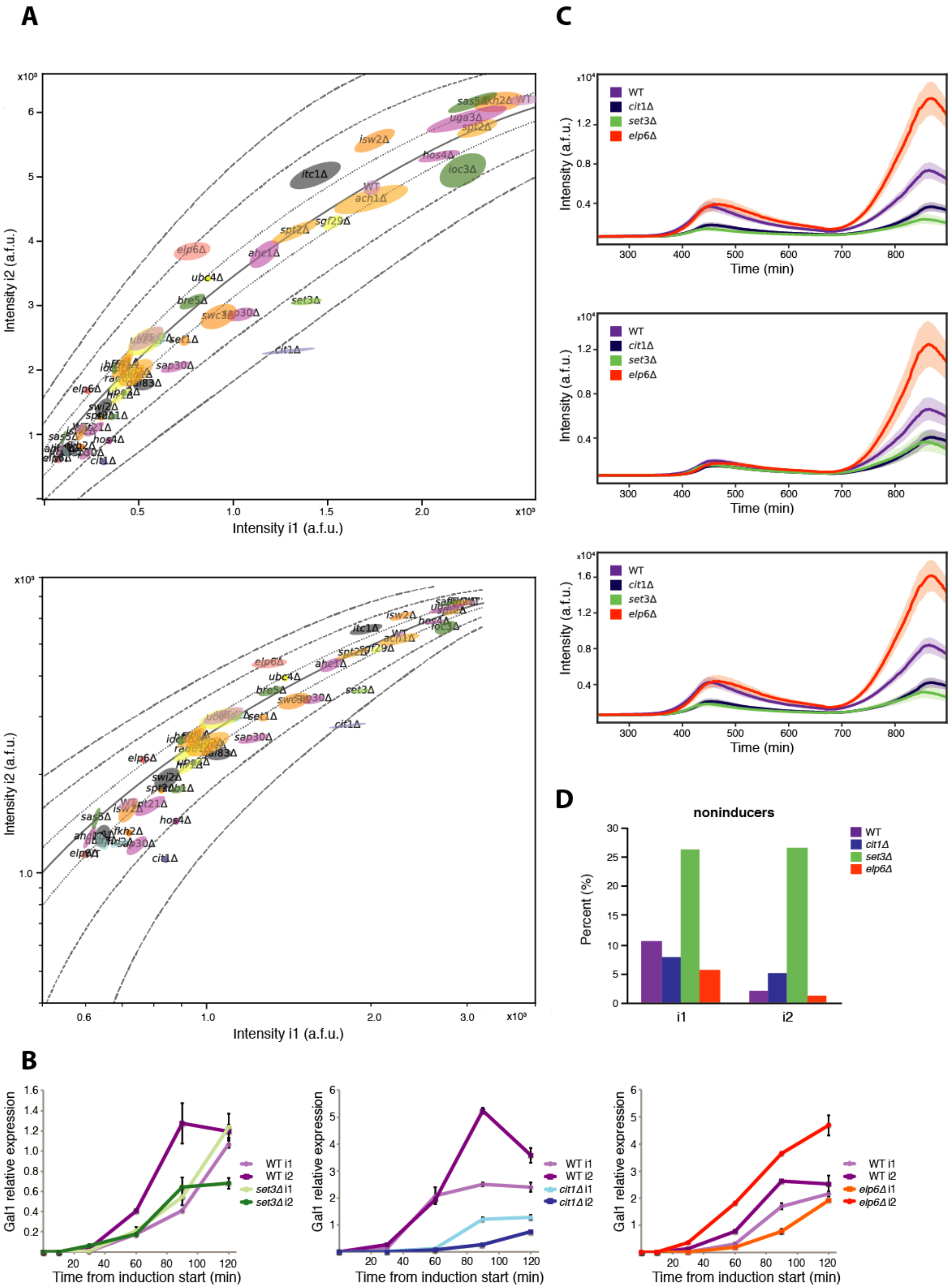
A
Intensity i2 (a.f.u.)
Intensity i1 (a.f.u.)
x10³
C
WT
cit1Δ
set3Δ
elp6Δ
Intensity (a.f.u.)
Time (min)
x10⁴
D
noninducers
Percent (%)
i1
i2
B
Gal1 relative expression
Time from induction start (min)
WT i1
WT i2
set3Δ i1
set3Δ i2
cit1Δ i1
cit1Δ i2
elp6Δ i1
elp6Δ i2

Figure S4. Validation of loss-of-memory and gain-of-memory candidates, Related to Figure 3

A, Summary of candidate validation experiment results using cell-tracking microfluidics. Individual strains are plotted as maximum Gal1 intensity of cells during induction averaged over all cells in a microfluidics channel, taken from 21 experiments with each strain analyzed in a minimum of 8 microchannels. WT and mutant strains were induced for various lengths of time to minimize the effect of a mutation on overall gene induction strength by achieving comparable i1 expression. The interpolated WT response curve for different induction lengths is shown as a solid line. Lines of equal deviation from the WT are also shown at deviation Z-score values ±1, ±3 and ±5 (above and below the WT response curve, respectively). The best candidates were identified based on the difference in distribution using two-sample AD tests comparing WT and mutant Z-scores with >200 cells (see Methods). **top**, linear scale. **bottom**, log scale.

B, Mutant memory effects observed at the protein level by GFP are recapitulated at the Gal1 transcript level. RT-qPCR analysis of RNA isolated from indicated candidate strains during timecourse memory experiments. Each strain was tested with a minimum of 4 biological replicates, shown are representative expression profiles. Error bars calculated as SD from 2 technical replicates.

C, Removal of non-inducers and thresholding candidate mutant cells does not change the loss-of-memory/gain-of-memory phenotype of candidates. **top**, all data included. **middle,** thresholding cells for each strain for similar expression as WT in i1 shows that the loss-of-memory/gain-of-memory phenotypes of candidates in i2 persist. **bottom**, removing non-inducers from mutant data also shows that the loss-of-memory and gain-of-memory phenotypes persist. Shown are Gal1 expression population means (solid lines) in each of the mutants ±95% confidence intervals (shaded areas).

D, Loss-of-memory mutant *set3Δ* has a high percentage of non-inducers in the population. Box plot of percentage of non-inducer cells for each strain in i1 and i2.

Figure S5.

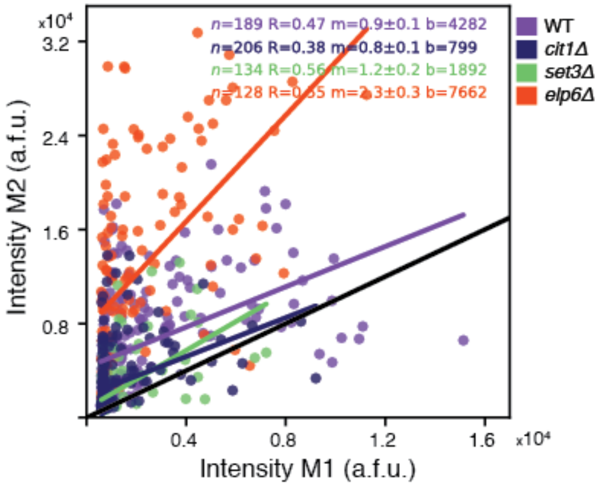

Figure S5. Gal1 memory maintenance effects in mothers, Related to Figure 4

Scatter plots of Gal1 intensity with linear regressions M2=m*M1+b. Shorter delays of activation manifest as a non-zero offset b (>0) in WT, with no effect on the slope m (~1), which is dominated by changes in expression rates. The gain-of-memory mutant *elp6Δ* reveals an increase in offset and slope compared to WT, likely affecting both activation and expression. Loss-of-memory mutants *set3Δ* and *cit1Δ* have lower offsets compared to WT, demonstrating an impact on activation and resulting in loss-of-memory. This suggests that different steps leading to Gal1 expression are affected in the mutants.

Figure S6.

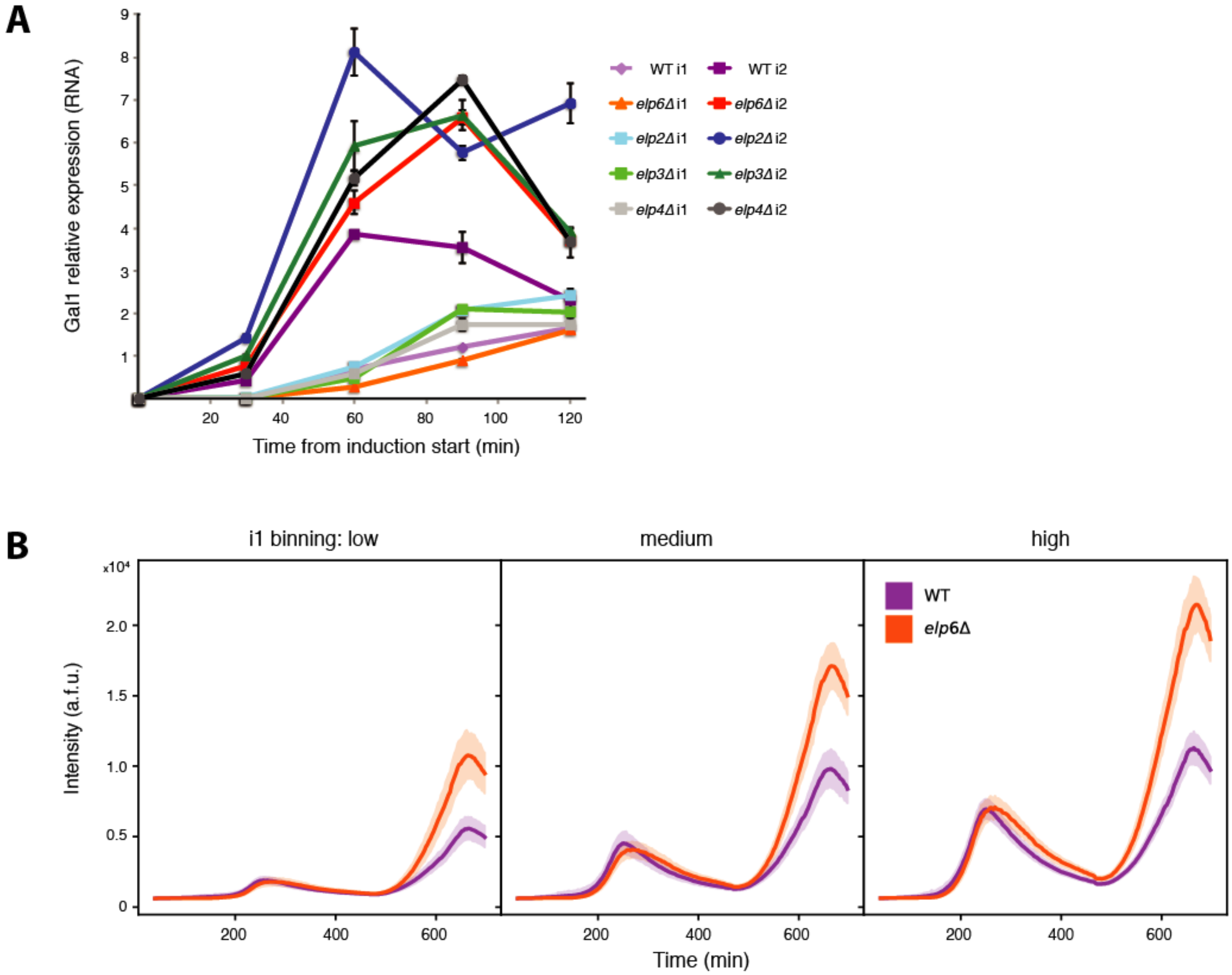

Figure S6. Effect of individual Elp complex members and i1 induction levels on gain-of-memory, Related to Figure 5

A, RT-qPCR analysis from strains with deletions of non-essential Elp complex members. The *elp6Δ* gain-of-memory phenotype is representative of other complex members. Error bars calculated as SD from 2 technical replicates, shown is a representative experiment from 2 biological replicates.

B, Higher induction in i1 leads to stronger *elp6Δ* gain-of-memory in i2. WT and *elp6Δ* cells were binned into equivalent low (left), medium (middle), or high (right) i1 expression bins to compare the effect of increasing i1 expression on the gain-of-memory phenotype in *elp6Δ*. Shown is average Gal1-GFP expression (solid line) ±95% confidence intervals (shaded area).

Table S1. Yeast strains, Related to Figure 1 and Star Methods

ID	Name/Description	Genotype	Reference
Y7092	SGA query strain	*MATα; can1Δ::STE2pr-Sp_his5 lyp1Δ his3Δ1 leu2Δ0 ura3Δ0 met15Δ0*	Tong and Boone (2007)
RSY14	Gal1 ORF replaced with GFP, precursor to RSY16	Y7092; *gal1Δ::GFP-kanMX*	This study
RSY15	Precursor to SGA reporter strain RSY17	Y7092; *Gal1-GFP::kanMX*	This study
RSY16	Gal1 ORF replaced with GFP, precursor to RSY19	Y7092; *gal1Δ::GFP-natMX*	This study
RSY17	SGA reporter strain	Y7092; *Gal1-GFP::natMX*	This study
RSY19	Gal1 ORF replaced with GFP, Gal3 tagged with mCherry	Y7092; *gal1Δ::GFP-natMX Gal3-mCherry-His5*	This study
RSY208	WT	RSY17*; Nab2NLS-2mCherry::Ura3*	This study
BY4741	YKO collection parent strain	*MATa; his3Δ1 leu2Δ0 ura3Δ0 met15Δ0*	Brachmann CB, *et al.* (1998)
AK453	SGA WT	*MATa; his3Δ1 leu2Δ0::KanMX ura3Δ0 met15Δ0*	This study
RSY209	*set1Δ*	RSY208; *set1Δ::kanMX*	This study
RSY213	*jhd2Δ*	RSY208; *jhd2Δ::kanMX*	This study
RSY215	*swi2Δ*	RSY208; *swi2Δ::kanMX*	This study
RSY1461	*ach1Δ*	RSY208; *ach1Δ::kanMX*	This study
RSY1462	*bre5Δ*	RSY208; *bre5Δ::kanMX*	This study
RSY1463	*cit1Δ*	RSY208; *cit1Δ::kanMX*	This study
RSY1467	*set3Δ*	RSY208; *set3Δ::kanMX*	This study
RSY1468	*spt2Δ*	RSY208; *spt2Δ::kanMX*	This study
RSY1469	*swc3Δ*	RSY208; *swc3Δ::kanMX*	This study
RSY1470	*ubc4Δ*	RSY208; *ubc4Δ::kanMX*	This study
RSY1471	*hir1Δ*	RSY208; *hir1Δ::kanMX*	This study
RSY1474	*elp6Δ*	RSY208; *elp6Δ::kanMX*	This study
RSY1475	*hos4Δ*	RSY208; *hos4Δ::kanMX*	This study
RSY1480	*rrd1Δ*	RSY208; *rrd1Δ::kanMX*	This study
RSY1481	*sap30Δ*	RSY208; *sap30Δ::kanMX*	This study
RSY1482	*rad61Δ*	RSY208; *rad61Δ::kanMX*	This study
RSY1484	*sub1Δ*	RSY208; *sub1Δ::kanMX*	This study
RSY1485	*uba3Δ*	RSY208; *uba3Δ::kanMX*	This study
RSY1486	*ufd2Δ*	RSY208; *ufd2Δ::kanMX*	This study
RSY1487	*fkh2Δ*	RSY208; *fkh2Δ::kanMX*	This study
RSY1488	*hmt1Δ*	RSY208; *hmt1Δ::kanMX*	This study
RSY1490	*ahc1Δ*	RSY208; *ahc1Δ::kanMX*	This study
RSY1492	*ioc3Δ*	RSY208; *ioc3Δ::kanMX*	This study
RSY1493	*isw2Δ*	RSY208; *isw2Δ::kanMX*	This study
RSY1494	*sas5Δ*	RSY208; *sas5Δ::kanMX*	This study
RSY1496	*sgf29Δ*	RSY208; *sgf29Δ::kanMX*	This study
RSY1497	*spt21Δ*	RSY208; *spt21Δ::kanMX*	This study
RSY1499	*uga3Δ*	RSY208; *uga3Δ::kanMX*	This study
RSY1500	*itc1Δ*	RSY208; *itc1Δ::kanMX*	This study
RSY1522	*elp2Δ*	RSY208; *elp2Δ::kanMX*	This study
RSY1523	*elp3Δ*	RSY208; *elp3Δ::kanMX*	This study
RSY1524	*elp4Δ*	RSY208; *elp4Δ::kanMX*	This study

Table S2. Oligonucleotides, Related to Figure 1 and Star Methods

ID	Name	Sequence 5' to 3'	Function
OL2078	Gal1ORF-sfGFP (f)	GCAGCTGTCTATATGAATTAATGTCCAAGGGTGAAGAGC	to generate PCR product used to transform Y7092 to make RSY15, C-terminal fusion of superfolderGFP to GAL1 with the kanMX marker PCR from plasmid pMaM4
OL2079	TEFt-Gal1downstream (r)	AACAAAGTAAAAAAAAGAAGTATACCAGTATAGCGACCAGCATTC	to generate PCR product used to transform Y7092 to make RSY15, C-terminal fusion of superfolderGFP to GAL1 with the kanMX marker PCR from plasmid pMaM4, and subsequently to replace KanMX marker in RSY15 with the NatMX marker to make RSY17
OL2080	TEFp-natMX (f)	CACATCACATCCGAACATAAACAACCATGACCACTCTTGACGACAC	to replace KanMX marker in RSY15 with the NatMX marker to make RSY17
OL2081	Gal1 271 bp upstream (f)	GCCCCACAAACCTTCAAAT	genotyping of superfolder GFP insertion as a fusion to GAL1
OL2082	sfGFP_A (r)	TTCTCTCTTGCACGTAGCCTT	genotyping of superfolder GFP insertion as a fusion to GAL1
OL2083	Gal1_A (f)	TGGATCATATGGTTCCCGTT	genotyping of superfolder GFP insertion as a fusion to GAL1
OL2084	Gal1_B (r)	AAACGCAGCGGTTGAAAGCAT	genotyping of superfolder GFP insertion as a fusion to GAL1
OL2085	kanB	CTGCAGCGAGGAGCCGTAAT	genotyping KanMX replacements
OL2086	kanC	TGATTTTGATGACGAGCGTAAT	genotyping KanMX replacements
OL2087	natB	TAAGCCGTGTCGTCAAGA	genotyping NatMX replacements
OL2088	natC	TCTGGCTGGAGGTCACCAA	genotyping NatMX replacements
OL2089	PfoI Ura3pr 1110 bp up (f)	CGATAGTCCCGGATTGACAAATGAGAACTTCATGTGGG	to clone in ~1kb Ura3 promoter to create plasmid PL1603 for homology at Ura3 locus in RSY17
OL2090	NdeI Ura3 pr 88 bp up (r)	ACACCACATATGCGTATATATACCAATCTAAGTCTGTGC	to clone in ~1kb Ura3 promoter to create Plasmid PL1603 for homology at Ura3 locus in RSY17
OL2091	Gal1 RT-qPCR (f)	ACACCCTGGAACGGCGATATTGAA	Gal1 RT-qPCR primer
OL2092	Gal1 RT-qPCR(r)	TGAGACTCGTTCATCAAGGCACCA	Gal1 RT-qPCR primer
OL2093	Tcm1 (f)	ACCTCCATTAACCACAAGATTTACA	Tcm1/Rpl3 qPCR primer
OL2094	Tcm1 (r)	AGTCGTTCTTAATTTCACCGTAGTG	Tcm1/Rpl3 qPCR primer
OL2095	*leu2Δ* F	ATATTATAGCTTCTAACGACAATGGAATTCTAACAATTATCAAATTGTCCGCCAGTACATGGAGGCCCAGAATACCCT	to generate PCR fragment to insert KanMX at the Leu2 locus in BY4741 to construct a control strain for SGA
OL2096	*leu2Δ* R	AATCCTCCAATATATAAATTAGGAATCATAGTTTCATGATTTTCTGTTACACCTAACAGTATAGCGACCAGCATTCAC	to generate PCR fragment to insert KanMX at the Leu2 locus in BY4741 to construct a control strain for SGA
OL2097	*leu2Δ* (Fcheck)	CATCAAAATCCACGTTCTTTTCATATGGATTCCT	genotyping KanMX insertion at Leu2 locus
OL2098	*leu2Δ* (Rcheck)	AAACTCCATCAAATGGTCAGGTCATTGAGTGTTT	genotyping KanMX insertion at Leu2 locus
OL2099	*set1Δ::KanMX* (f)	TATTTGTTGAATCTTTATAAGAGGTCTCTGCGTTTAGAGAACATGGAGGCCCAGAATACCC	replacing set1 with KanMX in RSY208
OL2100	*set1Δ::KanMX* (r)	TGTTAAATCAGGAAGCTCCAAACAAATCAATGTATCATCGCAGTATAGCGACCAGCATTCA	replacing set1 with KanMX in RSY208
OL2101	Set1 395 bp upstream (f)	GTTTTGGCCAATTTTATTTACTG	genotyping of *set1Δ::KanMX*
OL2102	Set1 378 bp downstream (r)	TTTTGGTTGAGCGGTATCAG	genotyping of *set1Δ::KanMX*
OL2103	*jhd2Δ::KanMX* (f)	ATTAACTAATCTCATCTTGCACAAAAAACGTATCACTATCACATGGAGGCCCAGAATACCC	replacing jhd2 with KanMX in RSY208
OL2104	*jhd2Δ::KanMX* (r)	TATTCTAAAAAATCATTACGCCATACACAAATATTGAAGACAGTATAGCGACCAGCATTCA	replacing jhd2 with KanMX in RSY208
OL2105	Jhd2 392 bp upstream (f)	ATCCGTATGCTCATCTCGTGA	genotyping of *jhd2Δ::KanMX*
OL2106	Jhd2 390 bp downstream (r)	GCGAAAAGACCCAATTGACCA	genotyping of *jhd2Δ::KanMX*
OL2107	*hir1Δ::KanMX* (f)	AGCATAATAAAATTGCCAGTAACCAAAGGTCTCTGATAACACATGGAGGCCCAGAATACCC	replacing hir1 with KanMX in RSY208
OL2108	*hir1Δ::KanMX* (r)	TGAGGGAAAAAACTTGTCCAAAGGAAGGGGTATAAGCTTACAGTATAGCGACCAGCATTCA	replacing hir1 with KanMX in RSY208
OL2109	Hir1 283 bp upstream (f)	CCCCACAAACTGAAAGCACAT	genotyping of *hir1Δ::KanMX*
OL2110	Hir1 376 bp downstream (r)	CGTGAAAATGGCAAATTTCTC	genotyping of *hir1Δ::KanMX*
OL2111	*swi2Δ::KanMX* (f)	ACTTTCTGCTATTTTCACGACTTTCGATTAATTATCTGCCACATGGAGGCCCAGAATACCC	replacing swi2 with KanMX in RSY208
OL2112	*swi2Δ::KanMX* (r)	CGTATAAACGAATAAGTACTTATATTGCTTTAGGAAGGTACAGTATAGCGACCAGCATTCA	replacing swi2 with KanMX in RSY208
OL2113	Swi2 295 bp upstream (f)	AGGAAAAATAGCCGCCGGTAAA	genotyping of *swi2Δ::KanMX*
OL2114	Swi2 291 bp downstream (r)	GGTCCAAGAACAAGTTCACTATG	genotyping of *swi2Δ::KanMX*
OL2115	*ach1Δ::KanMX* (f)	CAACACATTTCTTTTTTTCTTTTTCACATATTGCACTAAAACATGGAGGCCCAGAATACCC	replacing ach1 with KanMX in RSY208
OL2116	*ach1Δ::KanMX* (r)	TTTTTTGTTAAATACTCATCTCTCGGTTTGCGCACAAACACAGTATAGCGACCAGCATTCA	replacing ach1 with KanMX in RSY208
OL2117	Ach1 289 bp upstream (f)	ACAACGCCCTCAACCACAT	genotyping of *ach1Δ::KanMX*
OL2118	Ach1 298 bp downstream (r)	CGTCATCAGCGAAATTCGTT	genotyping of *ach1Δ::KanMX*
OL2119	*bre5Δ::KanMX* (f)	TGAAGTCATACCCTCGAATAGAAGTATCAAATAAAAGAAAACATGGAGGCCCAGAATACCC	replacing bre5 with KanMX in RSY208
OL2120	*bre5Δ::KanMX* (r)	TTATTTTTTCAATTTTTCTTTTTAAAAGGCTTGTGGTTGACAGTATAGCGACCAGCATTCA	replacing bre5 with KanMX in RSY208
OL2121	Bre5 359 bp upstream (f)	TCACCTACCACAAGCTTTCGT	genotyping of *bre5Δ::KanMX*
OL2122	Bre5 320 bp downstream (r)	TCAAGCTTGCTATCCCCTTC	genotyping of *bre5Δ::KanMX*
OL2123	*cit1Δ::KanMX* (f)	ATAAGGCAAAACATATAGCAATATAATACTATTTACGAAGACATGGAGGCCCAGAATACCC	replacing cit1 with KanMX in RSY208
OL2124	*cit1Δ::KanMX* (r)	TTGAATAGTCGCATACCCTGAATCAAAAATCAAATTTTCCCAGTATAGCGACCAGCATTCA	replacing cit1 with KanMX in RSY208
OL2125	Cit1 299 bp upstream (f)	TGTGTTATTGGAGGATCGCA	genotyping of *cit1Δ::KanMX*
OL2126	Cit1 268 bp downstream (r)	TTACTGCTAAATCAGCGCGCC	genotyping of *cit1Δ::KanMX*
OL2131	*set3Δ::KanMX* (f)	CAGTTTTAGATCGTACTTCACAAAATACGAGAACTGAATCACATGGAGGCCCAGAATACCC	replacing set3 with KanMX in RSY208
OL2132	*set3Δ::KanMX* (r)	TACTTAAGTTTATATAGGTGTAAGAAGGAAATGTCCATGTCAGTATAGCGACCAGCATTCA	replacing set3 with KanMX in RSY208
OL2133	Set3 394 bp upstream (f)	TTCTTTCTGGCTTTTTGCAGT	genotyping of *set3Δ::KanMX*
OL2134	Set3 397 bp downstream (r)	CGCATTGGATAATAATGGCG	genotyping of *set3Δ::KanMX*
OL2135	*spt2Δ::KanMX* (f)	ACAGGGACTTGAGTCCTATTCAAAGTGAAATATTTTAGTTACATGGAGGCCCAGAATACCC	replacing spt2 with KanMX in RSY208
OL2136	*spt2Δ::KanMX* (r)	TCATTTCACGTCCATATATCAAAACATATATCAATATTCCCAGTATAGCGACCAGCATTCA	replacing spt2 with KanMX in RSY208
OL2137	Spt2 378 bp upstream (f)	TGTTGACAAAGCGGAGGAAAG	genotyping of *spt2Δ::KanMX*
OL2138	Spt2 386 bp downstream (r)	GCCGCGAATCTTGTTGAAAA	genotyping of *spt2Δ::KanMX*
OL2139	*swc3Δ::KanMX* (f):	CATGCGATTTGGAAGTAACGCTCGCCGTAGACAAGTAAGAACATGGAGGCCCAGAATACCC	replacing swc3 with KanMX in RSY208
OL2140	*swc3Δ::KanMX* (r)	ATCATAATGGCGTTAAAGCAGAATAAAGTAACCGAACACCCAGTATAGCGACCAGCATTCA	replacing swc3 with KanMX in RSY208
OL2141	Swc3 282 bp upstream (f)	CGGTATTGAAGACACTGACGA	genotyping of *swc3Δ::KanMX*
OL2142	Swc3 293 bp downstream (r)	GGCAAATGGAGGGGATTTTT	genotyping of *swc3Δ::KanMX*
OL2143	*ubc4Δ::KanMX* (f)	TGACTATAGAGTACATACATAAACAAGCATCCAAAAAAACACATGGAGGCCCAGAATACCC	replacing ubc4 with KanMX in RSY208
OL2144	*ubc4Δ::KanMX* (r)	AAATCTTGCTTCTCTTTTTCAGCTGAGTAAGGACTTCTGTCAGTATAGCGACCAGCATTCA	replacing ubc4 with KanMX in RSY208
OL2145	Ubc4 255 bp upstream (f)	ATGGTCTGCGAGATTTTTCC	genotyping of *ubc4Δ::KanMX*
OL2146	Ubc4 256 bp downstream (r)	AATGTTCATGAATCTCCCCTG	genotyping of *ubc4Δ::KanMX*
OL2151	*elp6Δ::KanMX* (f)	ACCGTCCAGAACCTCCACAAAAATAACTAAATACACATTTACATGGAGGCCCAGAATACCC	replacing elp6 with KanMX in RSY208
OL2152	*elp6Δ::KanMX* (r)	TACGAGAATCAATGTGCCTCGTATATAATCTTATCATTATCAGTATAGCGACCAGCATTCA	replacing elp6 with KanMX in RSY208
OL2153	Elp6 274 bp upstream(f)	TGCTGTTGGAAAATTCCTGC	genotyping of *elp6Δ::KanMX*
OL2154	Elp6 263 bp downstream(r)	TGGATAAAATCTGGTGAACGA	genotyping of *elp6Δ::KanMX*
OL2155	*hos4Δ::KanMX* (f)	TATGTGACAGAGAAGAATTGCTGTAGAGATTCATGACAATACATGGAGGCCCAGAATACCC	replacing hos4 with KanMX in RSY208
OL2156	*hos4Δ::KanMX* (r)	AACTATGTATGAGCATATGCCAACGGACCGATGAATTGTTCAGTATAGCGACCAGCATTCA	replacing hos4 with KanMX in RSY208
OL2157	Hos4 250 bp upstream(f)	AAATCAAGGCTCAGGAAGTGA	genotyping of *hos4Δ::KanMX*
OL2158	Hos4 250 bp downstream(r)	CTTTTTTCGTCTTTTGCACGG	genotyping of *hos4Δ::KanMX*
OL2159	*rrd1Δ::KanMX* (f)	AAAGAACGCACATATGAACAAGCATTAAACGAGCAAAGAAACATGGAGGCCCAGAATACCC	replacing rrd1 with KanMX in RSY208
OL2160	*rrd1Δ::KanMX* (r)	TCATAATGCTTGTCATACACATTTATATGTTTAATTAATACAGTATAGCGACCAGCATTCA	replacing rrd1 with KanMX in RSY208
OL2161	Rrd1 287 bp upstream(f)	CCTTTCCATCTGCTCCGAGT	genotyping of *rrd1Δ::KanMX*
OL2162	Rrd1 224 bp downstream(r)	TGTTGTTGTTGCTGCTTCTG	genotyping of *rrd1Δ::KanMX*
OL2163	*sap30Δ::KanMX* (f)	TAGTTTAGCAAATCGAAGGATAGGTATATACTGAGTAGTAACATGGAGGCCCAGAATACCC	replacing sap30 with KanMX in RSY208

OL2164	*sap30Δ::KanMX* (r)	TTACATAACTTATACACAAAAGGGCTGCCTCATCGTTTGACAGTATAGCGACCAGCATTCA	replacing sap30 with KanMX in RSY208
OL2165	Sap30 238 bp upstream(f)	TGGCAGCATAGCACTGTAATG	genotyping of *sap30Δ::KanMX*
OL2166	Sap30 247 bp downstream(r)	TGTAATGCTTTATGGCGCCT	genotyping of *sap30Δ::KanMX*
OL2167	*rad61Δ::KanMX* (f)	AAACCATCTTCTTACCCTAAAGCATCCTGTTTCTGAAAAAACATGGAGGCCCAGAATACCC	replacing rad61 with KanMX in RSY208
OL2168	*rad61Δ::KanMX* (r)	GGTGAAGATGAAGCCAGGCTATGTTCAATGTATGCTTTCTCAGTATAGCGACCAGCATTCA	replacing rad61 with KanMX in RSY208
OL2169	Rad61 257 bp upstream(f)	TGCTTTCAAGCTGGTCTTCA	genotyping of *rad61Δ::KanMX*
OL2170	Rad61 202 bp downstream(r)	AGCGCCATAAGGCATACAAA	genotyping of *rad61Δ::KanMX*
OL2171	*sub1Δ::KanMX* (f)	TACACATCAATTTTTCGACATATATACAAACACAAGCGCTACATGGAGGCCCAGAATACCC	replacing sub1 with KanMX in RSY208
OL2172	*sub1Δ::KanMX* (r)	TGGAAGACGTTGACATAAGCAAGCTCAACTTCCAGGACTACAGTATAGCGACCAGCATTCA	replacing sub1 with KanMX in RSY208
OL2173	Sub1 216 bp upstream(f)	TTTCTCTCTTGGCTTGCCTT	genotyping of *sub1Δ::KanMX*
OL2174	Sub1 239 bp downstream(r)	GTTGTACGGGGAAAATGCTT	genotyping of *sub1Δ::KanMX*
OL2175	*uba3Δ::KanMX* (f)	GATATTGTATACCTATATTATCGATAATAAAGCGACGAGGACATGGAGGCCCAGAATACCC	replacing uba3 with KanMX in RSY208
OL2176	*uba3Δ::KanMX* (r)	AACAAGTGACACCGGCGGATGGTATTATTCATTAGTAATACAGTATAGCGACCAGCATTCA	replacing uba3 with KanMX in RSY208
OL2177	Uba3 350 bp upstream(f)	TTTATGCATTTGGCTCCTGT	genotyping of *uba3Δ::KanMX*
OL2178	Uba3 245 bp downstream(r)	TGTGATCAACGGCTCCTTAGT	genotyping of *uba3Δ::KanMX*
OL2179	*ufd2Δ::KanMX* (f)	AAAAGTTAACTTTGAAAGTAGAACCCTCATTCCATAGATCACATGGAGGCCCAGAATACCC	replacing ufd2 with KanMX in RSY208
OL2180	*ufd2Δ::KanMX* (r)	ATTAGGGTCAATTTTGCAATTTATTCTATCACTTATTCATCAGTATAGCGACCAGCATTCA	replacing ufd2 with KanMX in RSY208
OL2181	Ufd2 226 bp upstream(f)	TTCTAACCATTGGCAACAAAA	genotyping of *ufd2Δ::KanMX*
OL2182	Ufd2 236 bp downstream(r)	AGAAGCAAATCGCTTTCCCA	genotyping of *ufd2Δ::KanMX*
OL2183	*fkh2Δ::KanMX* (f)	CCTCCGTTTCCTTTATTGAAACTTTATCAATGCGCAAGAAACATGGAGGCCCAGAATACCC	replacing fkh2 with KanMX in RSY208
OL2184	*fkh2Δ::KanMX* (r)	TTCATTTCTTTAGTCTTAGTGATTCACCTTGTTTCTTGTCCAGTATAGCGACCAGCATTCA	replacing fkh2 with KanMX in RSY208
OL2185	Fkh2 287 bp upstream (f)	ATGGTTCCGCATTTCTAAAGG	genotyping of *fkh2Δ::KanMX*
OL2186	Fkh2 287 bp downstream(r)	TCAAGGATGCAAACACAGCA	genotyping of *fkh2Δ::KanMX*
OL2187	*hmt1Δ::KanMX* (f)	AAAAAAGAGTTAGAACCGACAAATTCATCCAAAGAAAATAACATGGAGGCCCAGAATACCC	replacing hmt1 with KanMX in RSY208
OL2188	*hmt1Δ::KanMX* (r)	TGCTTTTCAAATTTTTTTCTTTCTCCAGCAAACAAAAGTCCAGTATAGCGACCAGCATTCA	replacing hmt1 with KanMX in RSY208
OL2189	Hmt1 299 bp upstream (f)	CCCATGAGGGACTGTTAATGA	genotyping of *hmt1Δ::KanMX*
OL2190	Hmt1 294 bp downstream(r)	TTGCCGACATAGGTTGGAAA	genotyping of *hmt1Δ::KanMX*
OL2191	*ahc1Δ::KanMX* (f)	CGCTTCTCATCCAACACTTTGTGTATATGTCCATCTCCTCACATGGAGGCCCAGAATACCC	replacing ahc1 with KanMX in RSY208
OL2192	*ahc1Δ::KanMX* (r)	GAATATTATATTACGTAATTTACTTATTTATATGTGTGTACAGTATAGCGACCAGCATTCA	replacing ahc1 with KanMX in RSY208
OL2193	Ahc1 199 bp upstream(f)	AGGAAGAGCAGACAGCAAGAA	genotyping of *ahc1Δ::KanMX*
OL2194	Ahc1 200 bp down(r)	TAAAACGAGTGCTGGAGGGAA	genotyping of *ahc1Δ::KanMX*
OL2199	*ioc3Δ::KanMX* (f)	ACCAAGTACTTCAAGCAAAGTTTGCAATCCCCTATTGTTTACATGGAGGCCCAGAATACCC	replacing ioc3 with KanMX in RSY208
OL2200	*ioc3Δ::KanMX* (r)	AGGAGTTTCACAATCTTCACGTTCGTTGAAAGCTAGTTGTCAGTATAGCGACCAGCATTCA	replacing ioc3 with KanMX in RSY208
OL2201	Ioc3 250 bp upstream(f)	TGGCGGTATTTGTTAACATTG	genotyping of *ioc3Δ::KanMX*
OL2202	Ioc3 240 bp down(r)	CGTTTTACCACACTGGCGAAT	genotyping of *ioc3Δ::KanMX*
OL2203	*isw2Δ::KanMX* (f)	TGGTTTAAGTCGTAACAAAAGGAAAACTTACAATCAGATCACATGGAGGCCCAGAATACCC	replacing isw2Δ with KanMX in RSY208
OL2204	*isw2Δ::KanMX* (r)	ATATCTCTCACGTCACTTATTTTAATGCACAATACATGATCAGTATAGCGACCAGCATTCA	replacing isw2Δ with KanMX in RSY208
OL2205	Isw2 229 bp upstream(f)	CGTAACGTACGTACAATGGCT	genotyping of *isw2Δ::KanMX*
OL2206	Isw2 229 bp down(r)	CATTCACCATTTTTGCAGCG	genotyping of *isw2Δ::KanMX*
OL2207	*sas5Δ::KanMX* (f)	CTTTTTTTTTTTTTTGGTGCCATATAATAGACGCTCTTTTACATGGAGGCCCAGAATACCC	replacing sas5 with KanMX in RSY208
OL2208	*sas5Δ::KanMX* (r)	CTATGTTTTCAGGCATTGTTTAATTTCATGATGGCTGTCCCAGTATAGCGACCAGCATTCA	replacing sas5 with KanMX in RSY208
OL2209	Sas5 229 bp upstream(f)	TTAGTGACGTTTACAGCTGGC	genotyping of *sas5Δ::KanMX*
OL2210	Sas5 246 bp down(r)	GTTCTGTGGAAGCGCAAAAA	genotyping of *sas5Δ::KanMX*
OL2215	*sgf29Δ::KanMX* (f)	GGAGTTTTTCACAGCAAAACACACGGTCACCTTTCTTATTACATGGAGGCCCAGAATACCC	replacing sgf29 with KanMX in RSY208
OL2216	*sgf29Δ::KanMX* (r)	AGAAGATCTTATGATATGTAGTAAATGTTAACCACCATTGCAGTATAGCGACCAGCATTCA	replacing sgf29 with KanMX in RSY208
OL2217	Sgf29 244 bp upstream(f)	CCCTCGGGACTCTCCTCTATA	genotyping of *sgf29Δ::KanMX*
OL2218	Sgf29 220 bp down(r)	CTCTCCATCTTGGCGAAAAA	genotyping of *sgf29Δ::KanMX*
OL2219	*spt21Δ::KanMX* (f)	ATTGGAATTGGTATTCACTTGAACAAAAGACTCTGGTAAAACATGGAGGCCCAGAATACCC	replacing spt21 with KanMX in RSY208
OL2220	*spt21Δ::KanMX* (r)	TATATACATGCTGTGCTAGGAATAAGTTCATGTAATATTTCAGTATAGCGACCAGCATTCA	replacing spt21 with KanMX in RSY208
OL2221	Spt21 236 bp upstream(f)	AAACGCGTCGCGTTAGAAAA	genotyping of *spt21Δ::KanMX*
OL2222	Spt21 235 bp down(r)	TCAAGGAGACAATTTCCGCT	genotyping of *spt21Δ::KanMX*
OL2223	*uga3Δ::KanMX* (f)	TGTATGGATGCCAAGAAAACAAAGTTTTTTAAAGTGAGGTACATGGAGGCCCAGAATACCC	replacing uga3 with KanMX in RSY208
OL2224	*uga3Δ::KanMX* (r)	TTAAGACACCCAGGGGGCGGGGAAAGAAAATATATGCTGCCAGTATAGCGACCAGCATTCA	replacing uga3 with KanMX in RSY208
OL2225	Uga3 249 bp upstream(f)	CATCACGTTCGTCGTGACATA	genotyping of *uga3Δ::KanMX*
OL2226	Uga3 247 bp down(r)	TTACAGGTATCAAACCGGGCA	genotyping of *uga3Δ::KanMX*
OL2227	*itc1Δ::KanMX* (f)_2	AAAAAAAGAAAATAACAATAGGAGGAAGTAAAGAAAGCCGTTAATAAACAACATGGAGGCC CAGAATACCC	replacing itc1 with KanMX in RSY208
OL2228	*itc1Δ::KanMX* (r)_2	TTTATGAATACTACAATTTACCATCAGTTACAAAGGAAGTTTTTTATATACAGTATAGCGACCA GCATTCA	replacing itc1 with KanMX in RSY208
OL2229	Itc1 358 bp upstream (f)	TTAACGTGGTGAGAAAACCCG	genotyping of *itc1Δ::KanMX*
OL2230	Itc1 389 bp downstream (r)	TGCCCACATTGTGGTACAAA	genotyping of *itc1Δ::KanMX*
OL2231	*elp2Δ::KanMX* (f)	AGTTCCTGCAAAAACTTTATATAGTTAACGTTCCATAATCACATGGAGGCCCAGAATACCC	replacing elp2 with KanMX in RSY208
OL2232	*elp2Δ::KanMX* (r)	TATCCTCTTCTTTTCACATGAGAAATGATATAGATATTGCCAGTATAGCGACCAGCATTCA	replacing elp2 with KanMX in RSY208
OL2233	Elp2 276 bp upstream (f)	GAGACTGAGATGCAACCCATT	genotyping of *elp2Δ::KanMX*
OL2234	Elp2 280 bp down (r)	GAGTCCATTGGATGGTCAAA	genotyping of *elp2Δ::KanMX*
OL2235	*elp3Δ::KanMX* (f)	TAAAAGCACCTAAGGAAAATCGAAGAACACCCTGACAAAGACATGGAGGCCCAGAATACCC	replacing elp3 with KanMX in RSY208
OL2236	*elp3Δ::KanMX* (r)	AACCGGCCATGTCGGCGGCACATAAAAGTTCTATTTACCTCAGTATAGCGACCAGCATTCA	replacing elp3 with KanMX in RSY208
OL2237	Elp3 190 bp upstream (f)	TCTGCCGCTTTCATTGTTT	genotyping of *elp3Δ::KanMX*
OL2238	Elp3 225 bp down (r)	TTCGTTCCTTCCCTTCTGTT	genotyping of *elp3Δ::KanMX*
OL2239	*elp4Δ::KanMX* (f)	CATTGTATAACAAATTCGGCTCCCAAATATCGCATGTACCACATGGAGGCCCAGAATACCC	replacing elp4 with KanMX in RSY208
OL2240	*elp4Δ::KanMX* (r)	AAAAGCATGCCGTATATTTCCCATAAATTGAACCATATTCCAGTATAGCGACCAGCATTCA	replacing elp4 with KanMX in RSY208
OL2241	Elp4 282 bp upstream (f)	TTGCACAAGCATTTTGCTGG	genotyping of *elp4Δ::KanMX*
OL2242	Elp4 271 bp down (r)	TCAAATCCAAAGGAGTGGAA	genotyping of *elp4Δ::KanMX*
OL2243	Gal1 ChIP (f)	GGAAAAGCTGCATAACCACTTTAAC	Gal1 promoter ChIP-qPCR primer
OL2244	Gal1 ChIP (r)	CAATCACTTCTTCTGAATGAGATTT	Gal1 promoter ChIP-qPCR primer
OL2282	Gal1MN1401 (f)	AAATTAACGAATCAAATTAACAACCATAG	Gal1 promoter MNase-qPCR primer
OL2283	Gal1MN1401 (r)	CCAGAAATAAGGCTAAAAAACTAATC	Gal1 promoter MNase-qPCR primer
OL2306	Gal1promoter-sfGFP (f)	TTAACGTCAAGGAGAAAAAACTATAATGTCCAAGGGTGAAGAGC	to generate PCR product used to transform Y7092 to make RSY14, replacement of GAL1 with superfolderGFP and the kanMX marker PCR from plasmid pMaM4
OL2307	Gal3ORF-mCherry (f)	AGTTTCGAAGCCTGCCTTGGGTACTTGTTTGTACGAACAAATGGTGAGCAAGGGCGAGGA	to generate PCR product used to transform Y16 to make RSY19, replacement of GAL1 with superfolderGFP and a C-terminal fusion of mCherry to GAL3 with the His5 marker PCR from plasmid pKT355
OL2308	Gal3ORF-mCherry (r)	CTTTTAATATTTAAAGGTTGTTCCAAGAAGGTGTTTAGTGTTACAACACTCCCTTCGTGC	to generate PCR product used to transform Y16 to make RSY19, replacement of GAL1 with superfolderGFP and a C-terminal fusion of mCherry to GAL3 with the His5 marker PCR from plasmid pKT355

Table S3. Statistical tests and exact *P*-values, Related to Figures 1-5

Figure	Comparison	Statistical test	paired	one-sided or two-sided	Multiple testing correction	*P*-value	test statistic
1D, left	WT M1 vs. M2 intensity	Mann-Whitney U	yes	two	none	1.7E-27	8.0E+02
1D, middle	WT M1 vs. M2 delay	Mann-Whitney U	yes	two	none	3.5E-28	0.0E+00
1D, right	WT M1 vs. M2 expression rate	Mann-Whitney U	yes	two	none	1.2E-01	4.7E+03
2B	D2 vs. M1	Kolmogorov-Smirnov	no	two	none	1.5E-48	7.8E-01
2B	D2 vs. M2	Kolmogorov-Smirnov	no	two	none	1.6E-01	1.1E-01
2C	M2-D2 vs. U M2-D2	Mann-Whitney U	no	two	none	7.8E-30	1.7E+04
2D	1 vs. 1+2+3	Mann-Whitney U	no	two	none	3.7E-01	2.9E+03
2D	2 vs. 1+2+3	Mann-Whitney U	no	two	none	9.4E-01	5.6E+03
2D	3 vs. 1+2+3	Mann-Whitney U	no	two	none	3.3E-01	2.5E+03
2E	WT raf+CHX vs. gal/raf+CHX	Kolmogorov-Smirnov	no	two	none	2.1E-27	5.6E-01
3D	*cit1Δ* vs. WT	Anderson-Darling	no	two	none	9.1E-06	1.8E+01
3D	*set3Δ* vs. WT	Anderson-Darling	no	two	none	1.0E-05	2.4E+01
3D	*elp6Δ* vs. WT	Anderson-Darling	no	two	none	7.5E-04	7.2E+00
4A	*cit1Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	6.6E-06	1.6E+04
4A	*set3Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	3.0E-01	5.3E+03
4A	*elp6Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	7.6E-04	7.3E+03
4B, left	*cit1Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	1.1E-08	1.7E+04
4B, left	*set3Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	4.5E-02	5.6E+03
4B, left	*elp6Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.0E-01	1.1E+04
4B, right	*cit1Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.0E-10	1.8E+04
4B, right	*set3Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.4E-02	5.7E+03
4B, right	*elp6Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.8E-02	8.0E+03
4D	*cit1Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	1.2E-04	4.5E+04
4D	*set3Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	7.4E-01	2.2E+04
4D	*elp6Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.0E+00	3.8E+04
4E	*cit1Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	4.7E-02	5.0E+04
4E	*set3Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	1.0E+00	1.0E+04
4E	*elp6Δ* vs. WT	Mann-Whitney U	no	two	Bonferroni	2.9E-02	3.8E+04
5E	*cit1Δ* vs. WT in r1	t-test	no	two	Bonferroni	2.6E-01	
5E	*set3Δ* vs. WT in r1	t-test	no	two	Bonferroni	1.9E-01	
5E	*elp6Δ* vs. WT in r1	t-test	no	two	Bonferroni	5.7E-01	
5E	*cit1Δ* vs. WT in r2	t-test	no	two	Bonferroni	7.2E-02	
5E	*set3Δ* vs. WT in r2	t-test	no	two	Bonferroni	2.3E-01	
5E	*elp6Δ* vs. WT in r2	t-test	no	two	Bonferroni	5.1E-04	

Table S4. Gene list of deletion mutants used for library construction, Related to Figure 3 and Star Methods

Systematic name	Standard name	Systematic name	Standard name	Systematic name	Standard name	Systematic name	Standard name	Systematic name	Standard name	Systematic name	Standard name
YAL011W	SWC3	YDL059C	RAD59	YER116C	SLX8	YIL110W	HPM1	YLR306W	UBC12	YNL330C	RPD3
YAL013W	DEP1	YDL070W	BDF2	YER123W	YCK3	YIL112W	HOS4	YLR307W	CDA1	YNR001C	CIT1
YAL017W	PSK1	YDL074C	BRE1	YER142C	MAG1	YIL122W	POG1	YLR308W	CDA2	YNR010W	CSE2
YAL019W	FUN30	YDL076C	RXT3	YER144C	UBP5	YIL128W	MET18	YLR320W	MMS22	YNR024W	HXT17
YAL029C	MYO4	YDL090C	RAM1	YER151C	UBP3	YIL131C	FKH1	YLR335W	NUP2	YNR051C	BRE5
YAL036C	RBG1	YDL102W	STE20	YER161C	SPT2	YIL153W	RRD1	YLR377C	GAL80	YNR072W	RTS2
YAL049C	AIM2	YDL112W	TRM3	YER162C	RAD4	YIL156W	UBP7	YLR381W	CTF3	YOL001W	PHO80
YAL051W	OAF1	YDL115C	NVJ1	YER164W	CHD1	YIL160C	POT1	YLR384C	IKI3	YOL004W	SIN3
YAL054C	ACS1	YDL122W	UBP1	YER167W	BCK2	YIL162W	MIG1	YLR385C	SWC7	YOL006C	TOP1
YAR002W	NUP60	YDL131W	LYS21	YER177W	BMH1	YIR001C	SNT2	YLR394W	CST9	YOL012C	HTZ1
YAR003W	SWD1	YDL134C	PPH21	YER178W	PDA1	YIR002C	MPH1	YLR418C	CDC73	YOL017W	ESC8
YAR015W	ADE1	YDL160C-A	SUC2	YER179W	DMC1	YIR005W	IST3	YLR421C	RPN13	YOL054W	PSH1
YAR020C	PAU7	YDL170W	UGA3	YFL001W	DEG1	YIR009W	MSL1	YLR449W	FPR4	YOL067C	RTG1
YAR050W	FLO1	YDL175C	AIR2	YFL007W	BLM3	YIR023W	DAL81	YLR453C	RIF2	YOL068C	HST1
YBL001C	ECM15	YDL182W	LYS20	YFL013C	IES1	YIR025W	MND2	YML005W	TRM12	YOL086W-A	PIP2
YBL003C	HTA2	YDL185W	TFP1	YFL023W	BUD27	YJL030W	MAD2	YML028W	TSA1	YOL090W	MSH2
YBL008W	HIR1	YDL188C	PPH22	YFL049W	SWP82	YJL047C	RTT101	YML032C	RAD52	YOL104C	NDJ1
YBL015W	ACH1	YDL190C	UFD2	YFR010W	UBP6	YJL065C	DLS1	YML034W	SRC1	YOL108C	INO4
YBL016W	FUS3	YDL194W	SNF3	YFR013W	IOC3	YJL092W	HPR5	YML041C	VPS71	YOR001W	RRP6
YBL031W	SHE1	YDL213C	NOP6	YFR034C	PHO4	YJL105W	SET4	YML042W	CAT2	YOR005C	DNL4
YBL037W	APL3	YDL224C	WHI4	YFR038W	IRC5	YJL115W	ASF1	YML051W	ERG13	YOR014W	RTS1
YBL046W	PSY4	YDL227C	HO	YGL004C	RPN14	YJL124C	LSM1	YML060W	OGG1	YOR021C	SFM1
YBL052C	SAS3	YDR004W	RAD57	YGL019W	CKB1	YJL148W	RPA34	YML062C	MFT1	YOR023C	AHC1
YBL054W	TOD6	YDR009W	SGN1	YGL035C	MSN4	YJL168C	SET2	YML074C	FPR3	YOR025W	HST3
YBL067C	UBP13	YDR014W	RAD61	YGL043W	DST1	YJL173C	MPT5	YML094W	GIM5	YOR033C	EXO1
YBL088C	TEL1	YDR059C	UBC5	YGL058W	RAD6	YJL176C	SWI3	YML095C	RAD10	YOR038C	HIR2
YBL089W	AVT5	YDR073W	SNF11	YGL060W	YBP2	YJL187C	SWE1	YML102W	CAC2	YOR039W	CKB2
YBL091C-A	SCS22	YDR075W	PPH3	YGL066W	SGF73	YJL197W	UBP12	YML109W	ZDS2	YOR061W	CKA2
YBL103C	RTG3	YDR076W	RAD55	YGL087C	MMS2	YJR021C	REC107	YML111W	BUL2	YOR064C	YNG1
YBR005W	RCR1	YDR083W	RRP8	YGL090W	LIF1	YJR032W	CPR7	YML121W	GTR1	YOR077W	ERG10
YBR006W	UGA2	YDR092W	UBC13	YGL096W	TOS8	YJR035W	RAD26	YML126C	MSN2	YOR100C	CRC1
YBR007C	DSF2	YDR096W	GIS1	YGL115W	SNF4	YJR036C	HUL4	YMR021C	MAC1	YOR123C	LEO1
YBR009C	HHF1	YDR097C	MSH6	YGL127C	SOH1	YJR043C	POL32	YMR022W	QRI8	YOR124C	UBP2
YBR010W	HHT1	YDR121W	DPB4	YGL131C	RSM22	YJR052W	RAD7	YMR036C	MIH1	YOR144C	ELG1
YBR014C	GRX7	YDR139C	RUB1	YGL133W	ITC1	YJR082C	EAF6	YMR037C	NAM7	YOR156C	NFI1
YBR030W	RKM3	YDR143C	SAN1	YGL136C	MRM2	YJR090C	RFA3	YMR039C	SUB1	YOR162C	YRR1
YBR031W	RPL4a	YDR146C	SWI5	YGL151W	NUT1	YJR099W	YUH1	YMR044W	IOC4	YOR172W	YRM1
YBR034C	HMT1	YDR155C	CPR1	YGL163C	RAD54	YJR119C	JHD2	YMR048W	CSM3	YOR189W	IES4
YBR046C	ZTA1	YDR156W	RPA14	YGL168W	HUR1	YJR135C	MCM22	YMR075W	RCO1	YOR191W	RIS1
YBR057C	MUM2	YDR159W	SAC3	YGL173C	KEM1	YJR140C	HIR3	YMR078C	CTF18	YOR195W	SLK19
YBR058C	UBP14	YDR174W	HMO1	YGL174W	BUD13	YKL010C	UFD4	YMR080C	MPP6	YOR202W	HIS3
YBR061C	TRM7	YDR181C	SAS4	YGL175C	SAE2	YKL020C	SPT23	YMR100W	MUB1	YOR213C	SAS5
YBR072W	HSP26	YDR191W	HST4	YGL178W	POL3	YKL023W	SKA1	YMR106C	YKU80	YOR239W	ABP140
YBR073W	RDH54	YDR198C	RKM2	YGL194C	HOS2	YKL033W	TTI1	YMR127C	SAS2	YOR279C	RFM1
YBR082C	UBC4	YDR207C	UME6	YGL213C	SKI8	YKL062W	GRR1	YMR133W	REC114	YOR304W	ISW2
YBR083W	TEC1	YDR214W	AHA1	YGL222C	EDC1	YKL101W	HSL1	YMR135C	GID8	YOR308C	SNU66
YBR094W	PBY1	YDR217C	RAD9	YGL227W	VID30	YKL110C	KTI12	YMR138W	CIN4	YOR338W	YOR338W
YBR095C	RXT2	YDR225W	HTA1	YGL244W	RTF1	YKL113C	RAD27	YMR167W	MLH1	YOR339C	UBC11
YBR098W	MMS4	YDR254W	CHL4	YGL249W	ZIP2	YKL117W	SBA1	YMR176W	ECM5	YOR346W	REV1
YBR103W	SIF2	YDR255C	RMD5	YGL252C	RTG2	YKL149C	DBR1	YMR179W	SPT21	YOR349W	CIN1
YBR107C	IML3	YDR257C	SET7	YGR078C	PAC10	YKL155C	BRE2	YMR190C	SGS1	YOR351C	MEK1
YBR111C	YSA1	YDR260C	SWM1	YGR086C	PIL1	YKL160W	ELF1	YMR207C	HFA1	YOR363C	MHF1
YBR114W	RAD16	YDR266C	HEL2	YGR097W	ASK10	YKL213C	DOA1	YMR209C	YMR209C	YPL001W	HAT1
YBR119W	MUD1	YDR289C	RTT103	YGR121C	MEP1	YKR010C	TOF2	YMR216C	SKY1	YPL008W	CHL1
YBR141C	BMT2	YDR310C	SUM1	YGR134W	CAF130	YKR017C	HEL1	YMR219W	ESC1	YPL015C	HST2
YBR162W-A	YSY6	YDR316W	OMS1	YGR135W	PRE9	YKR028W	SAP190	YMR223W	UBP8	YPL018W	CTF19
YBR169C	SSE2	YDR318W	MCM21	YGR163W	GTR2	YKR029C	SET3	YMR224C	MRE11	YPL022W	RAD1
YBR175W	SWD3	YDR334W	SWR1	YGR184C	UBR1	YKR048C	NAP1	YMR247C	RKR1	YPL024W	NCE4
YBR194W	SOY1	YDR359C	VID21	YGR188C	BUB1	YKR056W	TRM2	YMR263W	SAP30	YPL028W	MHF2
YBR195C	MSI1	YDR363W	ESC2	YGR200C	ELP2	YKR069W	MET1	YMR272C	SCS7	YPL046C	ELC1
YBR208C	DUR1,2	YDR363W-A	SEM1	YGR208W	SER2	YKR072C	SIS2	YMR273C	ZDS1	YPL047W	SGF11
YBR215W	HPC2	YDR369C	XRS2	YGR212W	SLI1	YKR077W	MSA2	YMR275C	BUL1	YPL055C	LGE1
YBR228W	SLX1	YDR378C	LSM6	YGR270W	YTA7	YKR082W	NUP133	YMR284W	YKU70	YPL086C	ELP3
YBR231C	SWC5	YDR386W	MUS81	YGR275W	RTT102	YKR098C	UBP11	YMR304W	UBP15	YPL101W	ELP4
YBR245C	ISW1	YDR392W	SPT3	YHL007C	IWR1	YKR101W	SIR1	YMR312W	ELP6	YPL116W	HOS3
YBR258C	SHG1	YDR409W	SIZ1	YHL022C	SPO11	YLL002W	RTT109	YNL004W	HRB1	YPL127C	HHO1
YBR261C	TAE1	YDR419W	RAD30	YHL039W	EFM1	YLL039C	UBI4	YNL021W	HDA1	YPL138C	SPP1
YBR271W	EFM2	YDR423C	CAD1	YHR031C	RRM3	YLL062C	MHT1	YNL022C	RCM1	YPL139C	UME1
YBR274W	CHK1	YDR435C	PPM1	YHR034C	PIH1	YLR015W	GAL2	YNL030W	HHF2	YPL152W	RRD2
YBR275C	RIF1	YDR440W	DOT1	YHR041C	SRB2	YLR024C	UBR2	YNL031C	HHT2	YPL165C	SET6
YBR278W	DPB3	YDR451C	YHP1	YHR081W	LRP1	YLR032W	RAD5	YNL063W	MTQ1	YPL167C	REV3
YCL010C	SGF29	YDR465C	RMT2	YHR109W	CTM1	YLR039C	RIC1	YNL068C	FKH2	YPL181W	CTI6
YCL011C	GBP2	YDR469W	SDC1	YHR115C	DMA1	YLR044C	PDC1	YNL071W	LAT1	YPL184C	MRN1
YCL016C	DCC1	YDR477W	SNF1	YHR129C	ARP1	YLR055C	SPT8	YNL092W	YNL092W	YPL208W	RKM1
YCL032W	STE50	YDR482C	CWC21	YHR154W	RTT107	YLR056W	ERG3	YNL097C	PHO23	YPL226W	NEW1
YCL037C	SRO9	YDR485C	VPS72	YHR157W	REC104	YLR063W	BMT6	YNL098C	RAS2	YPL248C	GAL4
YCL061C	MRC1	YDR501W	PLM2	YHR167W	THP2	YLR081W	FBP1	YNL107W	YAF9	YPL273W	SAM4
YCR005C	CIT2	YDR519W	FPR2	YHR178W	STB5	YLR085C	ARP6	YNL135C	FPR1	YPR001W	CIT3
YCR028C-A	RIM1	YEL003W	GIM4	YHR191C	CTF8	YLR095C	IOC2	YNL136W	EAF7	YPR007C	REC8
YCR033W	SNT1	YEL012W	UBC8	YHR195W	GAL3	YLR102C	APC9	YNL147W	LSM7	YPR018W	RLF2
YCR060W	TAH1	YEL037C	RAD23	YHR200W	RPN10	YLR135W	SLX4	YNL153C	GIM3	YPR023C	EAF3
YCR065W	HCM1	YEL056W	HAT2	YHR207C	SET5	YLR137W	RKM5	YNL199C	GCR2	YPR031W	NTO1
YCR075C	ERS1	YEL066W	HPA1	YHR209W	CRG1	YLR172C	DPH5	YNL201C	PSY2	YPR046W	MCM16
YCR076C	FUB1	YER007W	PAC2	YIL010W	DOT5	YLR180W	SAM1	YNL206C	RTT106	YPR052C	NHP6A
YCR077C	PAT1	YER027C	GAL83	YIL017C	VID28	YLR182W	SWI6	YNL215W	IES2	YPR066W	UBA3
YCR081W	SRB8	YER030W	CHZ1	YIL035C	CKA1	YLR183C	TOS4	YNL218W	MGS1	YPR068C	HOS1
YCR082W	AHC5	YER035W	EDC2	YIL036W	CST6	YLR200W	YKE2	YNL224C	SQS1	YPR070W	MED1
YCR086W	CSM1	YER051W	JHD1	YIL040W	APQ12	YLR216C	CPR6	YNL246W	VPS75	YPR093C	ASR1
YCR092C	MSH3	YER063W	THO1	YIL064W	SEE1	YLR233C	EST1	YNL253W	TEX1	YPR119W	CLB2
YDL002C	NHP10	YER088C	DOT6	YIL066C	RNR3	YLR234W	TOP3	YNL273W	TOF1	YPR135W	CTF4
YDL013W	HEX3	YER092W	IES5	YIL079C	AIR1	YLR247C	IRC20	YNL288W	CAF40	YPR164W	MMS1
YDL020C	RPN4	YER095W	RAD51	YIL084C	SDS3	YLR263W	RED1	YNL298W	CLA4	YPR179C	HDA3
YDL051W	LHP1	YER098W	UBP9	YIL096C	BMT5	YLR278C	YLR278C	YNL299W	TRF5	YPR193C	HPA2
YDL056W	MBP1	YER111C	SWI4	YIL097W	FYV10	YLR285W	NNT1	YNL307C	MCK1		