Fine-tuning of coumaric acid synthesis to increase naringenin production in yeast

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Figure S1.

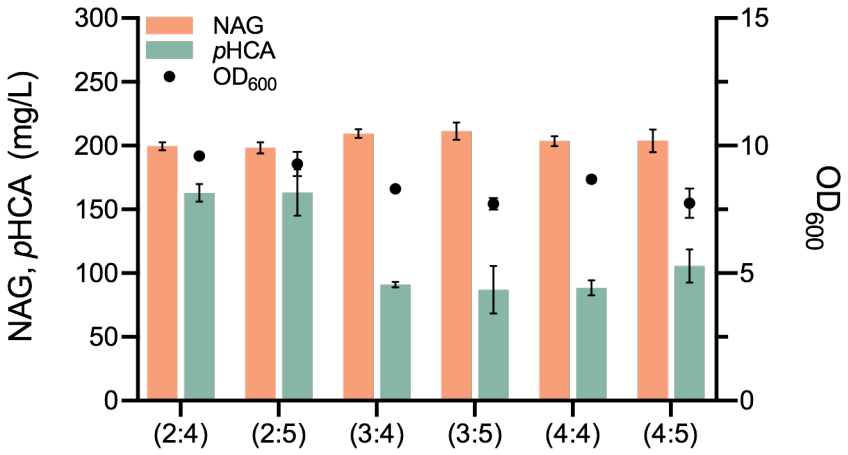

Figure S1. Optimization of the downstream enzymes of *p*-coumaric acid for (2*S*)-naringenin production. The numbers (n : n) indicate the respective gene copy numbers of *4CL* and *CHS*&*CHI*. Cells were grown in a defined minimal medium with 30 g/L glucose as the sole carbon source, and cultures were sampled after 96 h of growth for metabolite analysis. All data represent the mean of n = 3 biologically independent samples and error bars show standard deviation.

Figure S2

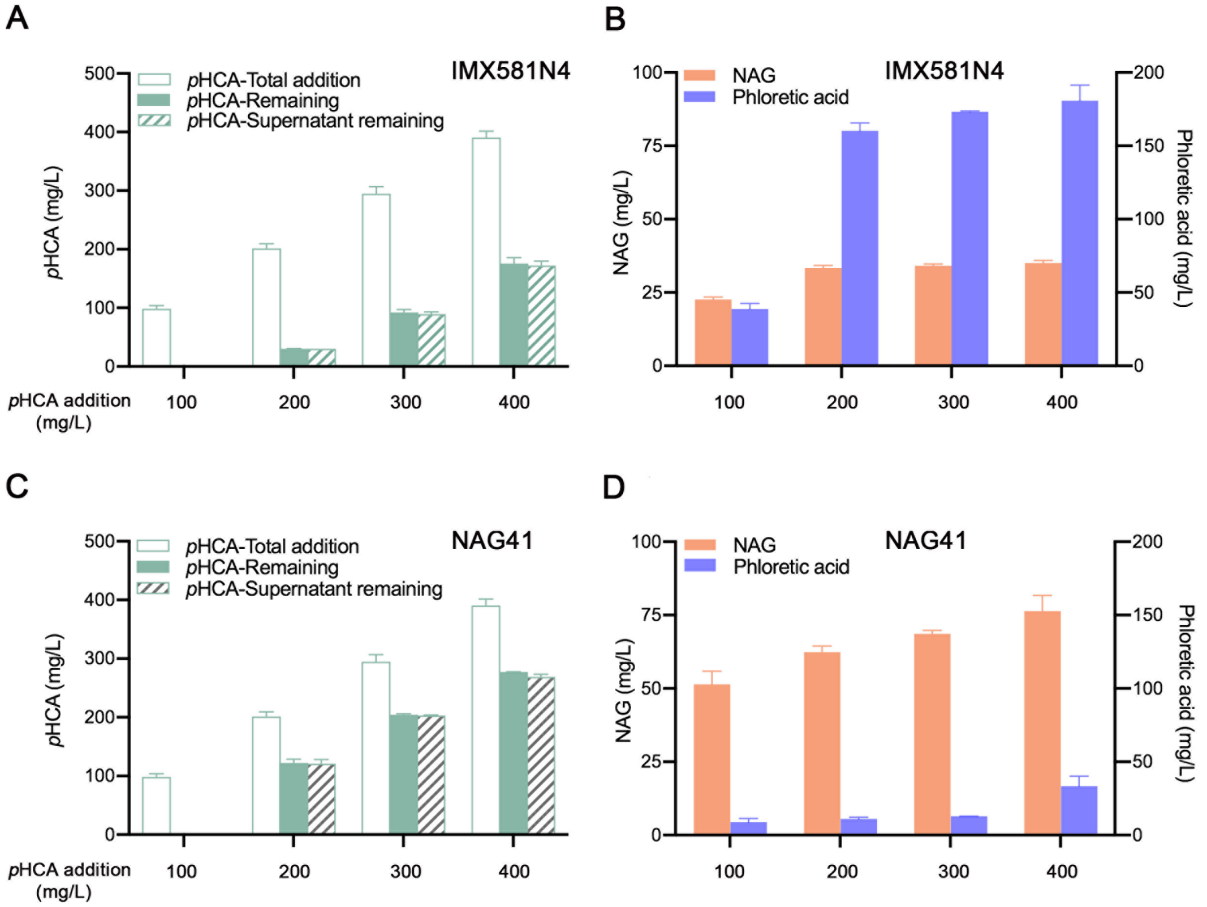

Figure S2. Production of (2*S*)-naringenin in strains supplemented with different concentrations of *p*-coumaric acid. (A) (B) (2*S*)-naringenin production by the IMX581N4 strain expressing one copy of *4CL* and *CHS*&*CHI* with the supplementary of different concentrations of *p*-coumaric acid. Cells were grown in a defined minimal medium with 30 g/L glucose as the sole carbon source and with supplemented *p*-coumaric acid (100, 200, 300, 400 mg/L) as precursor. Cultures were sampled after 96 h of growth for metabolite detection. (C) (D) Production of (2*S*)-naringenin in strain NAG41 supplemented with different concentrations of *p*-coumaric acid. Strain NAG41 harboring three copies of *4CL* and four copies of *CHS*&*CHI*, simultaneously expressing the *ACC1* mutant and the malonate assimilation pathway (*matBC*). Cells were grown in a defined minimal medium with 30 g/L glucose as the sole carbon source and 2 g/L sodium malonate dibasic, and with supplemented *p*-coumaric acid (100, 200, 300, 400 mg/L) as precursor. Cultures were sampled after 96 h of growth for metabolite analysis. All data represent the mean of n ≥ 2 biologically independent samples and error bars show standard deviation.

Supplementary Table 1. *S. cerevisiae* strains used in this study.

Strain ID	Genotype	Parental strain	Origin
IMX581	*MATa ura3-52 can1Δ :: cas9-natNT2 TRP1 LEU2 HIS3*		(1)
QL01	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t)*	IMX581	(2)
NAG01	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-HaCHS-CCW12p)+(tHXT7p-PhCHI-FBAt)*	QL01	This work
NAG02	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-HaCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	QL01	This work
NAG03	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-HaCHS-CCW12p)+(tHXT7p-SmCHI-FBAt)*	QL01	This work
NAG04	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PhCHI-FBAt)*	QL01	This work
NAG05	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	QL01	This work
NAG06	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-SmCHI-FBAt)*	QL01	This work
NAG07	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4:: (TDH3p-At4CL-ADH1t) + (TDH2t-SmCHS-CCW12p)+(tHXT7p-PhCHI-FBAt)*	QL01	This work
NAG08	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-SmCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	QL01	This work
NAG09	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-SmCHS-CCW12p)+(tHXT7p-SmCHI-FBAt)*	QL01	This work
NAG10	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG05	This work
NAG11	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) X-2::(GPM1p-PHA2-CYC1t) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG010	This work
NAG1-2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-*	NAG010	This work

	CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt)		
NAG1-3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt)*	NAG1-2	This work
NAG1-4	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XII-1::(TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG1-3	This work
NAG2-1	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t)*	NAG010	This work
NAG2-2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4:: (TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG10	This work
NAG2-3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt)*	NAG2-2	This work
NAG2-4	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt)*	NAG2-3	This work
NAG3-1	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) XII-5::(CYC1t-At4CL-TPIp)*	NAG2-1	This work
NAG3-2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(CYC1t-At4CL-TPIp)*	NAG2-2	This work

NAG3-3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp)*	NAG2-2	This work
NAG3-4	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt)*	NAG3-3	This work
NAG4-1	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) XII-5::(CYC1t-At4CL-TPIp) XI-1::(CYC1t-At4CL-TPIp)*	NAG3-1	This work
NAG4-2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(CYC1t-At4CL-TPIp) XI-1::(CYC1t-At4CL-TPIp)*	NAG3-2	This work
NAG4-3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(CYC1t-At4CL-TPIp)*	NAG3-3	This work
NAG4-4	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+(TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp)*	NAG3-3	This work
NAG-CHS*2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(TEF1p-RsCHS-FBAt)*	NAG10	This work
NAG-CHS*3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(TEF1p-RsCHS-FBAt) XI-1: (TEF1p-RsCHS-FBAt)*	NAG-CHS*2	This work

NAG-CHI*2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)*	NAG10	This work
NAG-CHI*3	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp) XI-1:(pYX212t-PsCHI-PGKp)*	NAG-CHI*2	This work
NAG2-5	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-3::(TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG2-4	This work
NAG3-5	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-3::(TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG3-4	This work
NAG4-5	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-3:;(TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	NAG4-4	This work
NAG12	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A} -TDH2t)*	NAG010	This work
NAG13	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t)*	NAG010	This work
NAG14	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t)*	NAG12	This work

NAG37	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2: (TPIp-ACC1^{S659A,S1157A}-TDH2t)*	NAG3-4	This work
NAG38	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t)*	NAG3-4	This work
NAG39	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t)*	NAG37	This work
NAG41	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t)*	NAG39	This work
NAG58	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (GPM1p-AtPAL2-FBA1t)*	NAG39	This work
NAG59	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (CCW12p-AtPAL2-FBA1t)*	NAG39	This work
NAG60	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-*	NAG39	This work

	FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (CCW12_BS2p-AtPAL2-FBA1t)		
NAG61	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (CCW12_BS123p-AtPAL2-FBA1t)*	NAG39	This work
NAG62	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (TDH3p-AtPAL2-FBA1t)*	NAG39	This work
NAG63	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (TDH3_BS23p-AtPAL2-FBA1t)*	NAG39	This work
NAG64	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (TEF1p-AtPAL2-FBA1t)*	NAG39	This work
NAG65	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3:: (TEF1_BS123p-AtPAL2-FBA1t)*	NAG39	This work
NAG39-2	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2::(GPM1p-AtPAL2-FBA1t)+(TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+*	NAG39	This work

	(TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) X-2::(TEF1-NLS_FapR-ADH1t)		
NAG66	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(GPM1p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG58	This work
NAG67	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(CCW12p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG59	This work
NAG68	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(CCW12_BS2p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG60	This work
NAG69	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(CCW12_BS123p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG61	This work
NAG70	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TDH3p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG62	This work
NAG71	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7 ^{G141S}-TEF1p)+(PGK1p-ARO4 ^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1 ^{S659A,S1157A} -TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TDH3_BS23p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG63	This work

NAG72	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TEF1p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG64	This work
NAG73	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TEF1_BS123p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t)*	NAG65	This work
NAG74	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TDH3_BS23p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t) FDC1::(pYX212t-DCR1-TDH3p) + (tHXT7p-AGO1-CYC1t)*	NAG71	This work
NAG75	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TDH3_BS23p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t) FDC1::(pYX212t-DCR1-TDH3p) + (tHXT7p-AGO1-CYC1t) XI-5::(TDH3_BS23p-FAS1_200bpshRNA-TDH2t)*	NAG74	This work
NAG76	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-2:: TDH3p-AtC4H-CYC1t)+(tHXT7p-AtATR2-pYX212t)+(PGK1p-CYB5-ADH1t) X-3::(TPI1p-EcaroL-pYX212t)+(ADH1t-ARO7^{G141S}-TEF1p)+(PGK1p-ARO4^{K229L}-CYC1t) X-4::(CYC1t-ARO1-TPI1p)+(TDH3p-ARO2-ADH1t)+(TDH2t-ARO3-TEF1p) XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-1::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt) XII-5::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) + (CYC1t-At4CL-TPIp) XI-1::(pYX212t-PsCHI-PGKp)+ (TEF1p-RsCHS-FBAt) XI-2::(TPIp-ACC1^{S659A,S1157A}-TDH2t) XII-3::(TDH2t-matB-TDH3p) + (tHXT7p-matC-CYC1t) XI-3::(TDH3_BS23p-AtPAL2-FBA1t) X-2::(TEF1-NLS_FapR-ADH1t) FDC1::(pYX212t-DCR1-TDH3p) + (tHXT7p-AGO1-CYC1t) XI-5::(TDH3_BS23p-FAS1_250bpshRNA-TDH2t)*	NAG74	This work
IMX581-N4	*MATa ura3-52 can1Δ::cas9-natNT2 TRP1 LEU2 HIS3 XII-4::(TDH3p-At4CL-ADH1t) + (TDH2t-RsCHS-CCW12p)+(tHXT7p-PsCHI-FBAt)*	IMX581	This work

Supplementary Table 2. Plasmids used in this study.

Plasmid ID	Relevant characteristics	Origin
pCfB1018	*Template for AtPAL2 and AtC4H*	(3)
pCfB0848	*Template for AtATR2 and CYB5*	(3)
pCfB0854	*Template for At4CL1*	(4)
pCfB0826	*Template for ARO4* ^{K229L} *and ARO7*^{G141S}	(3)
pCfB2747	*Template for EcoroL*	(3)
pAD	*Template for ACC1*$^{S659A,\ S1157A}$	(5)
pFDA8	*Template for NLS-FapR*	(6)
pX&Y19	*Template for pCCW12_BS2*	(7)
pX&Y22	*Template for pCCW12_BS123*	(7)
pX&Y31	*Template for pTDH3_BS23*	(7)
pFDA7	*Template for pTEF1_BS123*	(6)
pGK3	*Template for AGO1 and DCR1*	(8)
pQC007	*2µm ampR KlURA3 gRNA-XII-2.Y*	(2)
pQC010	*2µm ampR KlURA3 gRNA-XII-4.Y*	(2)
pQC005	*2µm ampR KlURA3 gRNA-X-3.Y*	(2)
pQC008	*2µm ampR KlURA3 gRNA-X-4.Y*	(2)
pQC032	*2µm ampR URA3 gRNA-XII-1.Y [2x]*	(2)
pQC033	*2µm ampR URA3 gRNA-XII-5.Y [2x]*	(2)
pQC030	*2µm ampR URA3 gRNA-XI-1.Y [2x]*	(2)
pQC130	*2µm ampR URA3 gRNA-XI-2.Y [2x]*	(2)
pQC133	*2µm ampR URA3 gRNA-XII-3.Y [2x]*	(2)
pQC029	*2µm ampR URA3 gRNA-X-2.Y [2x]*	(2)
pQC006	*2µm ampR KlURA3 gRNA-XI-3.Y*	(2)
pQC009	*2µm ampR KlURA3 gRNA-XI-5.Y*	(2)
pMEL10	*2µm ampR KlURA3 gRNA-CAN1.Y*	(2)
pMC005	*2µm ampR URA3 gRNA-AtPAL2.Y*	This work

Supplementary Table 3. Primers used in this study.

Plasmid ID	Name	Sequence (5'-3')
Primers for homologous regions for expression module integration		
P001	*XII-4 up-F*	GTATCCGGCTGTTCCTTCATAG
P002	*XII-4 up-R (with TDH3p-F)*[a]	CTTTGAAATGGCAGTATTGATAATGATAAACTCGATGCCATAGTATGTGTGATGG
P003	*XII-4 dn-F (with FBA1t-R)*	CGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACTATTCCCCATTAGAGTCAAATAAAAG
P004	*XII-4 dn-R*	TTTCTGCCGTACCTGGATGGTCATTTC
P005	*XII-1 up-F*	GTTGAGCTCTGTCCTTCATGG
P006	*XII-1 up-R1 (with TDH3p-F)*	CTTTGAAATGGCAGTATTGATAATGATAAACTCGAGAAAGAACCGAACCGATGCC
P007	*XII-1 dn-F1 (with ADH1t-R)*	AAATCGCTCCCCATTTCACCCAATTGTAGATATGCCTTCCCGTGAATCAACTGCAC
P008	*XII-1 dn-R*	CAATCCTCGCATTTCAGCTTC
P009	*XII-1 up-R2 (with pYX212t-R)*	GCTCCCTTTAGGGTTCCGATTTAGTGGTTTACGGCGAAAGAACCGAACCGATGC
P010	*XII-1 dn-F2 (with FBA1t-R)*	CGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACTGTTCAGTTTAGTGCTCTGTCTGAG
P011	*XII-5 up-F*	GTAGTGATCATTGGCTTAAC
P012	*XII-5 up-R1 (with pYX212t-R)*	GCTCCCTTTAGGGTTCCGATTTAGTGGTTTACGGCGTGACAATAAATTCAAACCGGT
P013	*XII-5 dn-F1 (with TPI1p-F)*	ATTCTAAGTAAGTTAAATATCCGTAATCTTTAAACCAACTCAGAAGTTTGACAGC
P014	*XII-5 dn-R*	CTCTTTTGCCTTTCAAAAAAG
P015	*XII-5 up-R2 (with CYC1t-R)*	GGACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCGTGACAATAAATTCAAACCGGT
P016	*XII-5 dn-F2 (with FBA1t-R)*	CGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACTCAACTCAGAAGTTTGACAGC
P017	*XII-5 dn-F3 (with PGK1p-F)*	ATGCCTATTGTGCAGATGTTATAATATCTGTGCGTCAACTCAGAAGTTTGACAGC
P018	*XII-5 up-R3 (with TEF1p-F)*	AGAGTAAAAAAGGAGTAGAAACATTTTGAAGCTATGTGACAATAAATTCAAACCGGT
P019	*XI-1 up-F*	ATTTGTGTGAAGGAATAGTGACG
P020	*XI-1 up-R1 (with pYX212t-R)*	GCTCCCTTTAGGGTTCCGATTTAGTGGTTTACGGCCAATGGGCTTGGTATTCCG
P021	*XI-1 dn-F1 (with TPI1p-F)*	ATTCTAAGTAAGTTAAATATCCGTAATCTTTAAACTTTCTTGGCATTGGCAAATC
P022	*XI-1 dn-R*	AAGAGCCGAGTCCCCATCAG
P023	*XI-1 up-R2 (with CYC1t-R)*	GGACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCCAATGGGCTTGGTATTCCG
P024	*XI-1 dn-F2 (with FBA1t-R)*	CGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACTTTTCTTGGCATTGGCAAATC
P025	*XI-1 dn-F3 (with PGK1p-F)*	ATGCCTATTGTGCAGATGTTATAATATCTGTGCGTTTTCTTGGCATTGGCAAATC
P026	*XI-1 up-R3 (with TEF1p-F)*	AGAGTAAAAAAGGAGTAGAAACATTTTGAAGCTATCAATGGGCTTGGTATTCCG
P027	*XII-2 up-F*	CGGCATGCAAACATCTACAC
P028	*XII-2 up-R (with GPM1p-F)*	GCTCACAAATCTTAAAGTCATACATTGCACGACTACATAACGCGTTACACGGAAG
P029	*XII-2 dn-F (with PGK1p-F)*	GCAAATGCCTATTGTGCAGATGTTTATAATATCTGTGCGTCTACTATCGGCGACTCTCTC
P030	*XII-2 dn-R*	GAGCGAACGTAAGAGAGGTTAATG
P031	*X-3 up-F*	CGAGATCTTTGTGTTCGGTTACC
P032	*X-3 up-R (with TPI1p-F)*	CTAAGTAAGTTAAATATCCGTAATCTTTAAACGTCTCGTATGTCGGCTCTCGC
P033	*X-3 dn-F (with CYC1t-R)*	GACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCTGTGTCCGCGTTTTCTAAGGC
P034	*X-3 dn-R*	GAGGTGGTTATTGATCACCGGA
P035	*X-4 up-F*	CCCAAAGCTAAGAGTCCCATT
P036	*X-4 up-R (with CYC1t-R)*	GACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCCTGCTCTTGAATGGCGACAG
P037	*X-4 dn-F (with TEF1p-F)*	GAAGAGTAAAAAAGGAGTAGAAACATTTTGAAGCTATAACAGGCATGGGAAGATTCG
P038	*X-4 dn-R*	CTGGTGAGGATTTACGGTATGA
P039	*X-2 up-F*	CGTCTATGAGGAGACTGTTAGTTG
P040	*X-2 up-R (with GPM1p-F)*	GCTCACAAATCTTAAAGTCATACATTGCACGACTAGACCACTTCGAGAGCAAGTTG
P041	*X-2 dn-F (with CYC1t-R)*	GACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCCCTGCATAATCGGCCTCAC
P042	*X-2 dn-R*	CTCGCCAAGGCATTACCATC
P043	*XI-2 up-F*	TAACTCTTCGTATGAGGATTTTC
P044	*XI-2 up-R*	TTCTATGGCACATTTTTCTGTTG
P127	*XI-2 dn-F*	CCACAAGTAAAGCTCGTTGAC
P128	*XI-2 dn-R*	ATGGTTGAAAAGGTTACAGAGG
P129	*XII-3 up-F*	TGTGCCCCTTAAAATTCATATAC
P130	*XII-3 up-R (with TDH2t-R)*	TAAAGCACTTAGTATCACACTAATTGGCTTTTCGCGAATGAGCAGGTACCCCTTA
P131	*XII-3 dn-F (with CYC1t-R)*	GGACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCGCATAGAGCTAATTAGGTTTGAG

P132	*XII-3 dn-R*	GAACTTACAAGCTGATTTTGGT
P133	*X-2 up-R (with TEF1p-F)*	AGAGTAAAAAAGGAGTAGAAACATTTTGAAGCTATGACCACTTCGAGAGCAAGTTG
P134	*X-2 dn-F (with ADH1t-R)*	AAATCGCTCCCCATTTCACCCAATTGTAGATATGCCCTGCATAATCGGCCTCAC
P135	*XI-3 up-F*	AGTTACTTGCTCTATGCGTTTGC
P136	*XI-3 up-R1 (with GPM1p-F)*	GCTCACAAATCTTAAAGTCATACATTGCACGACTAAATCAGACGCACGCTTGGC
P137	*XI-3 dn-F (with FBA1t-R)*	CGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACTTTACGTGGATTGAGCCAGCA
P138	*XI-3 dn-R*	TGAGAATCCGGACCAGCAGAT
P139	*XI-3 up-R2 (with CCW12p-F)*	GCCCCTTTTGGACTAACCGTGTGGTTCATGGGTGGAATCAGACGCACGCTTGGC
P140	*XI-3 up-R3 (with TDH3p-F)*	CTTTGAAATGGCAGTATTGATAATGATAAACTCGAAATCAGACGCACGCTTGGC
P141	*XI-3 up-R4 (with TEF1p-F)*	AGAGTAAAAAAGGAGTAGAAACATTTTGAAGCTATAATCAGACGCACGCTTGGC
P142	*FDC1 up-F*	CTGAGCATTTTATTACGTTACTCAAC
P143	*FDC1 up-R (with pYX212t-R)*	CCCTTTAGGGTTCCGATTTAGTGGTTTACGGCTTGAATATATAAATTGACAATTCTTTTG
P144	*FDC1 dn-F (with CYC1t-R)*	GGACGCTCGAAGGCTTTAATTTGCGGCCGGTACCCTTGCCATAGACTTTCTACGG
P145	*FDC1 dn-R*	GTCCATTTATTTTTTATGTGCTGTC
P146	*XI-5 up-F*	GCGGAGAAGTCGTTGATAGC
P147	*XI-5 up-R1 (with TDH3p-F)*	CTTTGAAATGGCAGTATTGATAATGATAAACTCGATGGTGCACGGAGTTTATGG
P148	*XI-5 dn-F (with TDH2t-R)*	TAAAGCACTTAGTATCACACTAATTGGCTTTTCGCTTGTAAAACAGGTATTGGCTGC
P149	*XI-5 dn-R*	GATCATAGATCCGGCACTTAGAG
Primers for amplification of promoters and terminators		
P045	*TDH3p-F*	TCGAGTTTATCATTATCAATACTGCC
P046	*TDH3p-R*	CATTTTGTTTGTTTATGTGTGTTTATTCGA
P047	*ADH1t-F*	GCGAATTTCTTATGATTTATGATTTTT
P048	*ADH1t-R*	GCATATCTACAATTGGGTGAAATGG
P049	*TDH2t-F1*	ATTTAACTCCTTAAGTTACTTTAATGATTTAG
P050	*TDH2t-R1 (with ADH1t-R)*	AAATCGCTCCCCATTTCACCCAATTGTAGATATGCGCGAAAAGCCAATTAGTGTGATAC
P051	*CCW12p-F*	CCACCCATGAACCACACGG
P052	*CCW12p-R*	CATTTTGTTTATTGATATAGTGTTTAAGCGAATG
P053	*tHXT7p-F1 (with CCW12p-F)*	GCCCCTTTTGGACTAACCGTGTGGTTCATGGGTGGCTCGTAGGAACAATTTCGGG
P054	*tHXT7p-R*	CATTTTTTGATTAAAATTAAAAAAACTTTTTG
P055	*FBA1t-F*	GTTAATTCAAATTAATTGATATAGTTTTTT
P056	*FBA1t-R*	GATACCGTCGACCTCGAGTC
P057	*GPM1p-F*	TAGTCGTGCAATGTATGACTTTAAGA
P058	*GPM1p-R*	CATTGTTTTTATTGTAATATGTGTGTTTGTT
P059	*CYC1t-F*	GATACCGTCGACCTCGAGTC
P060	*CYC1t-R1*	GGGTACCGGCCGCAAATTAA
P061	*pYX212t-F*	TAGGGCCCACAAGCTTACG
P062	*pYX212t-R1 (with ADH1t-R)*	CAAATCGCTCCCCATTTCACCCAATTGTAGATATGCGCCGTAAACCACTAAATCGGA
P063	*ADH1t-F*	GCGAATTTCTTATGATTTATGATTTTT
P064	*ADH1t-R*	GCATATCTACAATTGGGTGAAATGG
P065	*PGK1p-F*	ACGCACAGATATTATAACATCTGC
P066	*PGK1p-R*	CATTTTGTTATATTTGTTGTAAAAAGTAGATAA
P067	*TPI1p-F*	GTTTAAAGATTACGGATATTTAACTTAC
P068	*TPI1p-R*	CATTTTTAGTTTATGTATGTGTTTTTTGTAG
P069	*TEF1p-F1*	ATAGCTTCAAAATGTTTCTACTCCT
P070	*TEF1p-R*	CATTTTGTAATTAAAACTTAGATTAGATTGC
P071	*TEF1p-F2 (with PGK1p-F)*	ATGCCTATTGTGCAGATGTTATAATATCTGTGCGTATAGCTTCAAAATGTTTCTACTCCT
P072	*PGK1p-F*	ACGCACAGATATTATAACATCTGC
P073	*PGK1p-R*	CATTTTGTTATATTTGTTGTAAAAAGTAGATAA
P074	*pYX212t-R2*	GCCGTAAACCACTAAATCGGA
P075	*TDH2t-R2*	GCGAAAAGCCAATTAGTGTGATAC
P076	*tHXT7p-F2*	CTCGTAGGAACAATTTCGGG
P077	*tHXT7p-F3 (with TDH3p-F)*	CTTTGAAATGGCAGTATTGATAATGATAAACTCGACTCGTAGGAACAATTTCGGG
P078	*CYC1t-R2 (with FBA1t-R)*	TCGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTACGGGTACCGGCCGCAAATTAA

P079	*TEF1p-F3 (with XI-2_up)*	CGGGGTGTAACTCAACAGAAAAATGTGCCATAGAAATAGCTTCAAAATGTTTCTACTCCT
P080	*TEF1p-R (with mACC1_up)*	GAGAAGACTCGAATAAGCTTTCTTCGCTCATTTTGTAATTAAAACTTAGATTAGATTGC
P081	*TDH2t-F2 (with mACC1_dn)*	AAGAAAAATTGTTGAAGACTTTGAAATAAATTTAACTCCTTAAGTTACTTTAATGATTTAG
P082	*TDH2t-R3 (with XI-2_dn)*	CAACTGATCAACTGGTCAACGAGCTTTACTTGTGGGCGAAAAGCCAATTAGTGTGATAC
Primers for amplification of genes		
P164	*At4CL1-F (with TDH3p-R)*	ACTTAGTTTCGAATAAACACACATAAACAAACAAAATGGCTCCACAAGAACAAG
P165	*At4CL1-R (with ADH1t-F)*	TTAATAATAAAAATCATAAATCATAAGAAATTCGCTCACAAACCGTTAGCCAAC
P166	*RsCHS-F (with CCW12p-R)*	CTGTCATTCGCTTAAACACTATATCAATAAACAAAATGGTTACTGTTGAAGATGTTAG
P167	*RsCHS-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATTTAAGTACACAATGAATGCAAAAC
P168	*PsCHI-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGGCAAAACCACCATCTG
P169	*PsCHI-R (with FBA1t-F)*	TCATTAAAAAACTATATCAATTAATTTGAATTAACTTATTTTAACAATTCAGAAATTCTTGC
P170	*HaCHS-F (with CCW12p-R)*	CTGTCATTCGCTTAAACACTATATCAATAAACAAAATGGTTACTGTTGAAGAAG
P171	*HaCHS-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATTTAATTAATAGCAACTGAATG
P172	*SmCHS-F (with CCW12p-R)*	CTGTCATTCGCTTAAACACTATATCAATAAACAAAATGGTTACTGTTGAAGAATAC
P173	*SmCHS-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATTTAAGCTGCAACAGAATGC
P174	*PhCHI-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGTCTCCACCAGTTTCAG
P175	*PsCHI-R (with FBA1t-F)*	TCATTAAAAAACTATATCAATTAATTTGAATTAACTTAAACACCAATAACTGGG
P176	*SmCHI-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGGCTGCTGTTACTAAATTG
P177	*SmCHI-R (with FBA1t-F)*	TCATTAAAAAACTATATCAATTAATTTGAATTAACATGGCTGCTGTTACTAAATTG
P178	*AtPAL2-F (with GPM1p-R)*	CCAAACAAACACACATATTACAATAAAAACAATGGATCAAATCGAAGCTATGTTG
P179	*AtPAL2-R (with FBA1t-F)*	CTCATTAAAAAACTATATCAATTAATTTGAATTAACTCAGCAGATAGGAATAGGAGCACC
P180	*AtC4H-F (with TDH3p-R)*	GTTTCGAATAAACACACATAAACAAACAAAATGGACTTGTTGTTGTTGGAAAAG
P181	*AtC4H-R (with CYC1t-F)*	CATAACTAATTACATGACTCGAGGTCGACGGTATCTCAACAGTTTCTTGGCTTCATAAC
P182	*AtATR2-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGTCCTCCTCTTCTTCATCATC
P183	*AtATR2-R (with pYX212t-F)*	CCCGGGTCGACGCGTAAGCTTGTGGGCCCTATCACCAGACATCTCTCAAGTATCTAC
P184	*CYB5-F (with PGK1p-R)*	GTAATTATCTACTTTTTACAACAAATATAACAAAATGCCTAAAGTTTACAGTTACCAAG
P185	*CYB5-R (with ADH1t-F)*	TTTAATAATAAAAATCATAAATCATAAGAAATTCGCTCATTCGTTCAACAAATAATAAGC
P186	*EcoroL-F (with TPI1p-R)*	CTATAACTACAAAAAACACATACATAAACTAAAAATGACACAACCTCTTTTTCTGATC
P187	*EcoroL-R (with pYX212t-F)*	GATACCCGGGTCGACGCGTAAGCTTGTGGGCCCTATCAACAATTGATCGTCTGTGCC
P188	*ARO7*-F (with TEF1p-R)*	CATAGCAATCTAATCTAAGTTTTAATTACAAAATGGATTTCACAAAACCAGA
P189	*ARO7*-R (with ADH1t-F)*	TATTTAATAATAAAAATCATAAATCATAAGAAATTCGCTTACTCTTCCAACCTTCTTAGC
P190	*ARO4*-F (with PGK1p-R)*	GTAATTATCTACTTTTTACAACAAATATAACAAAATGAGTGAATCTCCAATGTTCG
P191	*ARO4*-R (with CYC1t-F)*	CATAACTAATTACATGACTCGAGGTCGACGGTATCCTATTTCTTGTTAACTTCTCTTCTT
P192	*ARO1-F (with TPI1p-R)*	CTATAACTACAAAAAACACATACATAAACTAAAAATGGTGCAGTTAGCCAAAGTC
P193	*ARO1-R (with CYC1t-F)*	CATAACTAATTACATGACTCGAGGTCGACGGTATCCTACTCTTTCGTAACGGCATCA
P194	*ARO2-F (with TDH3p-R)*	GTTTCGAATAAACACACATAAACAAACAAAATGTCAACGTTTGGGAAACTG
P195	*ARO2-R (with ADH1t-F)*	CTTATTTAATAATAAAAATCATAAATCATAAGAAATTCGCTTAATGAACCACGGATCTGGA
P196	*ARO3-F (with TEF1p-R)*	CATAGCAATCTAATCTAAGTTTTAATTACAAAATGTTCATTAAAAACGATCACGC
P197	*ARO3-R (with TDH2t-F)*	CTAAATCATTAAAGTAACTTAAGGAGTTAAATCTATTTTTTCAAGGCCTTTCTTC
P198	*PHA2-F (with GPM1p-R)*	CCAAACAAACACACATATTACAATAAAAACAATGGCCAGCAAGACTTTGAGG
P199	*PHA2-R (with CYC1t-F)*	ACTAATTACATGACTCGAGGTCGACGGTATCTTATTTGTGATAATATCTCTCATTTCTG
P200	*At4CL1-F (with TPI1p-R)*	TCTATAACTACAAAAAACACATACATAAACTAAAAATGGCTCCACAAGAACAAG
P201	*At4CL1-R (with CYC1t-F)*	CATAACTAATTACATGACTCGAGGTCGACGGTATCTCACAAACCGTTAGCCAAC
P202	*RsCHS-F (with TEF1p-R)*	AAGCATAGCAATCTAATCTAAGTTTTAATTACAAAATGGTTACTGTTGAAGATGTTAG
P203	*RsCHS-R (with FBA1t-F)*	TCATTAAAAAACTATATCAATTAATTTGAATTAACTTAAGTACACAATGAATGCAAAAC
P204	*PsCHI-F (with PGK1p-R)*	AGTAATTATCTACTTTTTACAACAAATATAACAAAATGGCAAAACCACCATCTG
P205	*PsCHI-R (with pYX212t-F)*	ACCCGGGTCGACGCGTAAGCTTGTGGGCCCTATTATTTTAACAATTCAGAAATTCTTG
P206	*mACC1_up 500bp-F*	ATGAGCGAAGAAAGCTTATTCG
P207	*mACC1_up 500bp-R*	CAATAGTGGATTCTCGGAGGC
P208	*mACC1_dn 500bp-F*	ATCGTGAGAGAGAACTATTGCC
P209	*mACC1_dn 500bp-R*	TTATTTCAAAGTCTTCAACAATTTTTCTTTATC
P210	*matB-F (with TDH3p-R)*	CTTAGTTTCGAATAAACACACATAAACAAACAAAATGTCTAATCATTTGTTTGATGCAATG
P211	*matB-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATTTAAGTTCTTGTGTACAAATCAGC

P212	*matC-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGGGTATCGAATTGTTGTCTATC
P213	*matC-R (with CYC1t-F)*	TAACTAATTACATGACTCGAGGTCGACGGTATCTTAAACTAAACCTGGAACAACAAAAAC
P223	*AtPAL2-F (with CCW12p-R)*	CTGTCATTCGCTTAAACACTATATCAATAAACAAAATGGATCAAATCGAAGCTATG
P224	*AtPAL2-F (with TEF1p-R)*	TAGCAATCTAATCTAAGTTTTAATTACAAAATGGATCAAATCGAAGCTATG
P225	*AtPAL2-F (with TDH3p-R)*	TTTCGAATAAACACACATAAACAAACAAAATGGATCAAATCGAAGCTATG
P226	*NLS_FapR-F (with TEF1p-R)*	GCAATCTAATCTAAGTTTTAATTACAAAATGCCAAAGAAGAAGAGAAAGGTTAG
P227	*NLS_FapR-R (with ADH1t-F)*	TTAATAATAAAAATCATAAATCATAAGAAATTCGCTTATGAATGTTTTGAACGATACATG
P228	*DCR1-F (with TDH3p-R)*	GATACCCGGGTCGACGCGTAAGCTTGTGGGCCCTATCACAGATTGTTGCAATGCC
P229	*DCR1-R (with pYX212t-F)*	ACTTAGTTTCGAATAAACACACATAAACAAACAAAATGAATAGAGAAAAAAGCGCC
P230	*AGO1-F (with tHXT7p-R)*	CAAAAACAAAAAGTTTTTTTAATTTTAATCAAAAAATGTCATCCAATTCGGAGGAG
P231	*AGO1-R (with CYC1t-F)*	CATAACTAATTACATGACTCGAGGTCGACGGTATCTCATATGTAGTACATGATGTCAG
P232	*FAS1_sense 200bp-F (with TDH3p-R)*	TTTCGAATAAACACACATAAACAAACAAAATGGACGCTTACTCCACAAG
P233	*FAS1_ sense 200bp-R (with rad9_intron1-F)*	GAAAAAAGTTCCAACACACCTGCTGCAGCAAACCCTTCAG
P234	*rad9_intron1-F*	CAGGTGTGTTGGAACTTTTTTCAAACCTTACTAAACATTGAAACTAATTGGTAAAGATA
P235	*rad9_intron1-R*	TATCTTTACCAATTAGTTTCAATGTTTAGTAAGGTTTGAAAAAAGTTCCAACACACCTG
P236	*FAS1_antisense 200bp-F (with rad9_intron1-R)*	AACATTGAAACTAATTGGTAAAGATACTGCAGCAAACCCTTCAG
P237	*FAS1_antisense 200bp-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATATGGACGCTTACTCCACAAG
P238	*FAS1_ sense 250bp-F (with TDH3p-R)*	TTTCGAATAAACACACATAAACAAACAAAATGGACGCTTACTCCACAAG
P239	*FAS1_ sense 250bp-R (with rad9_intron1-F)*	GAAAAAAGTTCCAACACACCTGAGACCTGATCGAATTGACC
P240	*FAS1_antisense 250bp-F (with rad9_intron1-R)*	AACATTGAAACTAATTGGTAAAGATAAGACCTGATCGAATTGACC
P241	*FAS1_antisense 250bp-R (with TDH2t-F)*	AAACTAAATCATTAAAGTAACTTAAGGAGTTAAATATGGACGCTTACTCCACAAG
Primers for *AtPAL2* gene deletion and repair oligos		
P214	*Vector backbone-F*	GATCATTTATCTTTCACTGCGGAGAAG
P215	*Vector backbone-R*	GTTTTAGAGCTAGAAATAGCAAGTTAAAATAAGGCTAGTC
P216	*Sequencing-F*	CACCTTTCGAGAGGACGATG
P217	*Sequencing-R*	GCTGGCCTTTTGCTCACATG
P218	*AtPAL2_gRNA*	TGCGCATGTTTCGGCGTTCGAAACTTCTCCGCAGTGAAAGATAAATGATCAATGGTACA GCTGTTGGTTCGTTTTAGAGCTAGAAATAGCAAGTTAAAATAAGGCTAGTCCGTTATCAA C
P219	*Repair Fragment 1-F*	GCCATTTTTTTTTCTGTATCGGGCCCTCCTTACTGCTCTCCTTCCGTGTAACGCGTTATG AATTTTTATTTCATTCTGGAACTCTTCGAGTTCTTTGTAAAGTCTTTCATAGTAGCTTAC
P220	*Repair Fragment 1-R*	GTAAGCTACTATGAAAGACTTTACAAAGAACTCGAAGAGTTCCAGAATGAAATAAAAATT CATAACGCGTTACACGGAAGGAGAGCAGTAAGGAGGGCCCGATACAGAAAAAAAAATG GC
P221	*Repair Fragment 2-F*	GCCATTTTTTTTTCTGTATCGGGCCCTCCTTACTGCTCTCCTTCCGTGTAACGCGTTATG CTACTATCGGCGACTCTCTCGAAATTTTTCTTAACGCGTCCTTGTACTGCGTCTAACGCT
P222	*Repair Fragment 2-R*	AGCGTTAGACGCAGTACAAGGACGCGTTAAGAAAAATTTCGAGAGAGTCGCCGATAGT AGCATAACGCGTTACACGGAAGGAGAGCAGTAAGGAGGGCCCGATACAGAAAAAAAAA TGGC

[a] short overlap to the fragments in the parentheses were included in corresponding primers.

Supplementary Table 4. Codon optimized genes used in this study.

Gene	Sequence (5'-3')
HaCHS	ATGGTTACTGTTGAAGAAGTTAGAAAAGCACAAAGAGCTGAAGGTCCAGCAACTGTTATGGCTATTGGTACAGCAGTT CCACCAAATTGTGTTGATCAAGCTACTTACCCAGATTACTACTTCAGAATTACAAATTCTGAACATAAGGCAGAATTAA AGGAAAAGTTCCAAAGAATGTGTGATAAATCACAAATTAAGAAAAGATATATGTACTTGAATGAAGAAGTTTTAAAAGA AAATCCAAATATGTGTGCATACATGGCTCCATCTTTAGATGCTAGACAAGATATCGTTGTTGTTGAAGTTCCAAAATTG GGTAAAGAAGCTGCTGTTAAAGCAATTAAAGAATGGGGTCAACCAAAGTCTAAGATCACTCATTTGGTTTTCTGTACT ACATCAGGTGTTGATATGCCAGGTGCTGATTACCAATTGACAAAATTGTTGGGTTTAAGACCATCAGTTAAGAGATTG ATGATGTACCAACAAGGTTGTTTTGCAGGTGGTACAGTTTTGAGATTGGCTAAAGATTTGGCAGAAAACAATAAGGGT GCTAGAGTTTTGGTTGTTTGTTCTGAAATCACTGCTGTTACTTTTAGAGGTCCAACTGATACACATTTGGATTCATTAG TTGGTCAAGCATTGTTTGGTGACGGTGCTGCTGCTATTATTATTGGTTCTGATCCAATTCCAGAAGTTGAAAAGCCATT GTTCGAATTGGTTTCTGCTGCTCAAACTATTTTACCAGATTCAGAAGGTGCTATTGATGGTCATTTGAGAGAAGTTGGT TTAACATTCCATTTGTTGAAGGATGTTCCAGGTTTGATCTCTAAAAATGTTGAAAAATCATTGACTGAAGCCTTTAAAC CATTGGGTATCTCTGATTGGAACTCTTTATTTTGGATTGCTCATCCAGGTGGTCCAGCAATTTTGGATCAAGTTGAAG CTAAATTGTCTTTAAAGCCAGAAAAATTGAGAGCAACAAGACATGTTTTGTCAGAATACGGTAACATGTCTTCAGCTTG TGTTTTGTTTATTTTAGATGAAATGAGAAGAAAGTCTAAGGAAGATGGTTTGAAGACTACAGGTGAAGGTATTGAATG GGGTGTTTTGTTTGGTTTTGGTCCAGGTTTAACTGTTGAAACAGTTGTTTTGCATTCAGTTGCTATTAATTAA
RsCHS	ATGGTTACTGTTGAAGATGTTAGAAGAGCACAAAGAGCTGAAGGTCCAGCAACAGTTATGGCTATTGGTACTGCAAC ACCATCTAATTGTGTTGATCAATCAACTTACCCAGATTTCTACTTTAGAATTACAAATTCTGAACATAAGGCTGAATTAA AGGAAAAGTTCCAAAGAATGTGTGATAAATCAATGATTAAGAAAAGATATATGTACTTAACTGAAGAAATTTTGAAGGA AAACCCATCTGTTTGTGAATATATGGCTCCATCATTAGATGCAAGACAAGATATGGTTGTTGTTGAAGTTCCAAAATTG GGTAAAGAAGCTGCAACTAAAGCTATTAAAGAATGGGGTCAACCAAAGTCTAAGATCACACATTTGGTTTTCTGTACT ACATCAGGTGTTGATATGCCAGGTGCAGATTACCAATTGACTAAATTGTTGGGTTTAAGACCATCTGTTAAGAGATTG ATGATGTACCAACAAGGTTGTTTTGCTGGTGGTACAGTTTTGAGATTGGCTAAAGATTTGGCAGAAAACAATAAGGGT GCTAGAGTTTTGGTTGTTTGTTCAGAAATCACTGCTGTTACTTTTAGAGGTCCATCTGATACACATTTGGATTCATTGG TTGGTCAAGCATTGTTTGGTGACGGTGCTGCTGCTATTATTGTTGGTGCAGATCCAGTTCCAGAAGTTGAAAAGCCAT TGTTCGAATTGGTTTCTGCTGCTCAAACTATTTTACCAGATTCAGATGGTGCTATTGATGGTCATTTGAGAGAAGTTGG TTTGACATTCCATTTGTTGAAGGATGTTCCAGGTTTGATCTCTAAAAATATCGAAAAAGCATTGACTGAAGCATTTCAA CCATTGGGTATTTCTGATTGGAACTCTATTTTCTGGATTGCTCATCCAGGTGGTCCAGCAATTTTGGATCAAGTTGAAT TGAAATTATCTTTGAAGCCAGAAAAATTGAGAGCTACAAGACATGTTTTGTCAGAATACGGTAACATGTCTTCAGCATG TGTTTTGTTTATTTTGGATGAAATGAGAAGAAAATCTGCTGAAGAAGGTTTAAAAACTACAGGTGAAGGTTTAGAATGG GGTGTTTTGTTTGGTTTTGGTCCAGGTTTGACTGTTGAAACAGTTGTTTTGCATTCATTGTGTACTTAA
SmCHS	ATGGTTACTGTTGAAGAATACAGAAAGGCACAAAGAGCTGAAGGTCCAGCAACAGTTATGGCTATTGGTACTTCTACA CCATCAAATTGTGTTGATCAATCTGCTTACCCAGATTATTACTTTAGAATTACTAAATCAGAACATAAGACAGAATTAAA GGAAAAGTTTAAAAGAATGTGTGAAAAATCTATGATTAAGAAAAGATATATGTACTTAACTGAAGAAATTTTGAAAGAA AAATCTAATATGTGTGCATATATGGCTCCATCATTAGATGCAAGACAAGATATCGTTGTTGTTGAAGTTCCAAAATTGG GTAAAGAAGCTGCACAAAAAGCTATTAAAGAATGGGGTCAACCAAAGTCTAAGATCACTCATTTGGTTTTCTGTACTA CATCAGGTGTTGATATGCCAGGTTGTGATTACCAATTGACAAAATTGTTGGGTTTAAGACCATCTGTTAAGAGATTGAT GATGTACCAACAAGGTTGTTTTGCTGGTGGTACAGTTTTGAGATTGGCAAAAGATTTGGCTGAAAACAATAAGGGTGC AAGAGTTTTGGTTGTTTGTTCTGAAATCACTGCTGTTACTTTTAGAGGTCCATCTGAATCACATTTGGATTCATTGGTT GGTCAAGCATTGTTTGGTGACGGTGCTGCTGCTGTTATTATTGGTTCTGATCCAATTTCAGGTGTTGAAAGACCATTA TTTGAATTGGTTTCTGCTGCTCAAACTTTGTTACCAGATTCAGAAGGTGCAATTGATGGTCATTTGAGAGAAGTTGGTT TGACATTCCATTTGTTGAAAGATGTTCCAGGTATCATCTCTAAAAATATCGATAAATCATTAGTTGAAGCATTTCAACCA TTGGGTATCTCTGATTGGAACTCTTTATTTTGGATTGCACATCCAGGTGGTCCAGCTATTTTGGATCAAGTTGAATTGA AATTGGGTTTGAACCCAGAAAAATTGAGAGCAACTAGAGAAGTTTTGTCTAACTACGGTAACATGTCTTCAGCTTGTG TTTTGTTTATTTTGGATGAAATGAGAAAAGCATCAGCTAAACAAGGTTTACCAACTACAGGTGAAGGTTTACAATGGG GTGTTTTGTTTGGTTTTGGTCCAGGTTTGACTGTTGAAACATTAGTTTTGCATTCTGTTGCAGCTTAA
PhCHI	ATGTCTCCACCAGTTTCAGTTACTAAGATGCAAGTTGAAAACTATGCTTTTGCACCAACAGTTAATCCAGCAGGTTCTA CTAATACATTGTTTTTAGCTGGTGCAGGTCATAGAGGTTTGGAAATCGAGGGTAAATTCGTTAAGTTTACTGCTATCG GTGTTTACTTGGAAGAATCTGCTATCCCATTTTTAGCAGAAAAGTGGAAGGGTAAAACTCCACAAGAATTAACAGATT CAGTTGAATTTTTCAGAGATGTTGTTACTGGTCCATTCGAAAAGTTTACTAGAGTTACAATGATCTTGCCATTGACAGG TAAACAATACTCTGAAAAGGTTGCTGAAAATTGTGTTGCACATTGGAAAGGTATTGGTACTTACACAGATGATGAAGG TAGAGCTATCGAAAAGTTTTTGGATGTTTTTAGATCAGAAACATTTCCACCAGGTGCATCTATCATGTTCACTCAATCA CCATTAGGTTTGTTGACAATTTCTTTTGCTAAAGATGATTCAGTTACTGGTACAGCTAACGCAGTTATTGAAAATAAGC AATTGTCTGAAGCTGTTTTAGAATCAATCATCGGTAAACATGGTGTTTCTCCAGCTGCAAAATGTTCAGTTGCTGAAAG AGTTGCAGAATTGTTGAAGAAATCTTATGCTGAAGAAGCATCAGTTTTCGGTAAACCAGAAACTGAAAAATCTACAATC CCAGTTATTGGTGTTTAA
PsCHI	ATGGCAAAACCACCATCTGTTTCAGGTGTTAACATCGAATCTTATGCTTTTCCACCAACTGTTAAACCACCAGGTTCTA CTAAAACATTGTTTTTAGGTGGTGCAGGTGTTAGAGGTTTGGAAGTTCCAACTGGTCAATTCGTTAAGTTTACTGCTAT CGGTGTTTACTTGGAAGATAACGCAATCACTTCATTAGCTGTTAAGTGGAAAGGTAAAACTGCTGAAGAATTAACAGA ATCTGATGATTTCTTTAGAGATATCGTTACAGGTCCATTCGAAAAGTTTACTCAAGTTACAATGATCTTGCCATTGACT

	GGTCAACAATACTCAGAAAAGGTTACAGAAAACTGTGTTGCTTACTGGAAAGCAGTTGGTGCTTACACTGATGCTGAA GCATCTGCTATTGAAAAGTTTATTGAAGTTTTTAAAGATGAAAAGTTTCCACCAGGTTCTTCAATTTTGTTTACTCAAAC ACCAGAAGGTTCTTTAACAATCGGTTTTTCAAAGGATGGTGTTTTGCCAGAAGTTGGTAATGCAGTTGTTGAAAATAA GCAATTGTCTGAAGCTGTTTTAGAATCAATCATCGGTAAACATGGTGTTTCTCCAGAAGCTAAACAATCATTAGCTGCA AGAATTTCTGAATTGTTAAAATAA
SmCHI	ATGGCTGCTGTTACTAAATTGCAAATCGAAAACTACGTTTTTCCACCAACTATGGTTAAGCCAGTTGGTTCTAACAACA CTTTCTTTTTGGCTGGTGCAGGTTCAAGAGGTTTAGAAATCGAAGGTAGATTCGTTAAGTTTACTGCTATCGCAGTTTA CTTGGAAGAATCTGCTATTCCATTTTTAGCTGCAAAGTGGAAGGGTAAATCTTCAGAAGAATTAACTGATTCAGTTGAA TTTTTCAAGGATATCGTTACAGGTCCATTCGAAAAGTTTACTCAAGTTACAATGATCTTGCCATTGACTGGTAAACAAT ACTCTGAAAAGGTTGCTGAAAACTGTGTTGCTAACTGGAAAGCAATTGGTACTTACTCTGATGCTGAATCACAAGCAA TCGAAAAGTTCTTGAACGTTTTCCAATCTGAAACATTCCCACATGGTGCATCAATTTTGTTTACTCAATCTCCATTGGG TTCATTAACAATTTCTTTTTCAAAGGATGATTCTGTTCCATCAATCGGTAACGCTGTTATTGAAAATAAGCAATTGTCTG AAGCAGTTTTAGATTCAATCATCGGTAAACATGGTGTTTCTCCAGCTGCAAAGTGTTCAATCGCTAAGAGAGTTTCTG AATTGTTAGAAAAATCAAATGCTGAAGCAGTTGTTAATGAAAAACCAGGTTCTGGTTTGTCAACAATTCAATAA
RtmatB	ATGTCTAATCATTTGTTTGATGCAATGAGAGCTGCAGCTCCTGGTAATGCTCCTTTTATTAGAATCGATAACACTAGAA CATGGACTTACGATGATGCATTTGCTTTATCTGGTAGAATTGCATCAGCTATGGATGCATTGGGTATTAGACCAGGTG ACAGAGTTGCTGTTCAAGTTGAAAAATCTGCAGAAGCTTTGATCTTGTATTTGGCATGTTTGAGATCAGGTGCTGTTTA TTTGCCATTGAATACAGCATACACTTTGGCTGAATTGGATTACTTCATCGGTGACGCAGAACCAAGATTGGTTGTTGT TGCTTCTTCAGCAAGAGCTGGTGTTGAAACTATTGCAAAACCAAGAGGTGCTATTGTTGAAACATTAGATGCAGCTGG TTCTGGTTCATTGTTAGATTTGGCAAGAGATGAACCAGCTGATTTTGTTGATGCATCTAGATCAGCTGATGATTTGGCA GCTATTTTGTACACTTCTGGTACTACAGGTAGATCAAAAGGTGCAATGTTGACACATGGTAATTTGTTGTCAAACGCTT TGACTTTGAGAGATTTTTGGAGAGTTACAGCAGGTGACAGATTGATCCATGCTTTGCCAATCTTCCATACTCATGGTTT ATTCGTTGCTACAAACGTTACTTTGTTAGCAGGTGCTTCTATGTTTTTGTTGTCAAAGTTCGATCCAGAAGAAATCTTG TCTTTGATGCCACAAGCTACTATGTTGATGGGTGTTCCAACATTCTACGTTAGATTGTTGCAATCACCAAGATTGGATA AGCAAGCAGTTGCTAACATCAGATTGTTTATTTCTGGTTCAGCACCATTGTTAGCTGAAACACATACTGAATTTCAAGC AAGAACTGGTCATGCTATTTTAGAAAGATACGGTATGACAGAAACTAACATGAACACTTCTAACCCATACGAAGGTAA AAGAATTGCTGGTACAGTTGGTTTTCCATTGCCAGATGTTACAGTTAGAGTTACTGATCCAGCAACAGGTTTAGCTTT GCCACCAGAACAAACTGGTATGATCGAAATTAAAGGTCCAAACGTTTTTAAAGGTTACTGGAGAATGCCAGAAAAGAC TGCAGCTGAATTCACTGCTGATGGTTTCTTTATTTCTGGTGACTTGGGTAAAATCGATAGAGATGGTTACGTTCATATT GTTGGTCGTGGTAAAGATTTGGTTATTTCTGGTGGTTACAACATCTATCCAAAGGAAGTTGAAGGTGAAATCGATCAA ATCGAAGGTGTTGTTGAATCAGCTGTTATTGGTGTTCCACATCCAGATTTTGGTGAAGGTGTTACTGCTGTTGTTGTTA GAAAACCAGGTGCAGCTTTGGATGAAAAGGCAATCGTTTCTGCTTTGCAAGATAGATTGGCAAGATACAAGCAACCA AAGAGAATCATCTTCGCTGAAGATTTGCCAAGAAATACAATGGGTAAAGTTCAAAAGAATATCTTGAGACAACAATATG CTGATTTGTACACAAGAACTTAA
RtmatC	ATGGGTATCGAATTGTTGTCTATCGGTTTGTTGATTGCTATGTTCATCATCGCAACTATCCAACCAATTAATATGGGTG CTTTGGCATTTGCTGGTGCATTTGTTTTAGGTTCTATGATCATCGGTATGAAGACAAACGAAATCTTCGCTGGTTTCCC ATCAGATTTGTTTTTGACTTTGGTTGCAGTTACATATTTGTTCGCTATCGCACAAATTAATGGTACTATCGATTGGTTG GTTGAATGTGCTGTTAGATTAGTTAGAGGTAGAATTGGTTTGATTCCATGGGTTATGTTCTTGGTTGCTGCAATCATCA CAGGTTTCGGTGCTTTGGGTCCAGCTGCAGTTGCTATTTTGGCACCAGTTGCTTTGTCTTTCGCAGTTCAATACAGAA TCCATCCAGTTATGATGGGTTTAATGGTTATTCATGGTGCTCAAGCAGGTGGTTTTTCTCCAATCTCAATCTATGGTGG TATCACTAACCAAATCGTTGCTAAAGCAGGTTTACCATTTGCTCCAACATCTTTGTTTTTATCTTCATTTTTCTTTAATTT GGCTATCGCAGTTTTGGTTTTCTTTGTTTTCGGTGGTGCTAGAGTTATGAAACATGATCCAGCATCATTGGGTCCATTA CCAGAATTGCATCCAGAAGGTGTTTCTGCTTCAATTAGAGGTCATGGTGGTACTCCAGCTAAACCAATTAGAGAACAT GCATACGGTACTGCTGCAGATACAGCTACTACATTGAGATTGAACAACGAAAGAATCACTACATTGATCGGTTTGACA GCTTTAGGTATCGGTGCATTGGTTTTTAAGTTTAATGTTGGTTTAGTTGCAATGACTGTTGCTGTTGTTTTGGCATTGT TATCTCCAAAGACACAAAAGGCTGCAATCGATAAAGTTTCTTGGTCAACTGTTTTGTTGATCGCTGGTATCATCACATA CGTTGGTGTTATGGAAAAAGCTGGTACTGTTGATTACGTTGCAAATGGTATTTCTTCATTGGGTATGCCATTGTTGGTT GCTTTGTTGTTGTGTTTCACTGGTGCAATTGTTTCAGCTTTTGCATCTTCAACAGCTTTATTGGGTGCAATCATCCCAT TGGCTGTTCCATTTTTATTGCAAGGTCATATCTCTGCTATTGGTGTTGTTGCTGCAATCGCAATCTCAACTACAATCGT TGATACTTCTCCATTTTCAACAAATGGTGCTTTAGTTGTTGCTAATGCACCAGATGATTCTAGAGAACAAGTTTTGAGA CAATTGTTGATCTATTCAGCATTGATCGCTATCATCGGTCCAATTGTTGCTTGGTTGGTTTTTGTTGTTCCAGGTTTAG TTTAA

Supplementary Table 5. Expression modules in the integration constructs used in this study

ID	DNA fragment[a]
M1	*XII-4 up-TDH3p-**At4CL1**-ADH1t +TDH2t*
M2	*ADH1t +TDH2t-**HaCHS**-CCW12p+tHXT7p-**PhCHI**-FBAt- XII-4 dn*
M3	*ADH1t +TDH2t-**HaCHS**-CCW12p+tHXT7p-**PsCHI**-FBAt- XII-4 dn*
M4	*ADH1t +TDH2t-**HaCHS**-CCW12p+tHXT7p-**SmCHI**-FBAt- XII-4 dn*
M5	*ADH1t +TDH2t-**RsCHS**-CCW12p+tHXT7p-**PhCHI**-FBAt- XII-4 dn*
M6	*ADH1t +TDH2t-**RsCHS**-CCW12p+tHXT7p-**PsCHI**-FBAt- XII-4 dn*
M7	*ADH1t +TDH2t-**RsCHS**-CCW12p+tHXT7p-**SmCHI**-FBAt- XII-4 dn*
M8	*ADH1t +TDH2t-**SmCHS**-CCW12p+tHXT7p-**PhCHI**-FBAt- XII-4 dn*
M9	*ADH1t +TDH2t-**SmCHS**-CCW12p+tHXT7p-**PsCHI**-FBAt- XII-4 dn*
M10	*ADH1t +TDH2t-**SmCHS**-CCW12p+tHXT7p-**SmCHI**-FBAt- XII-4 dn*
M11	*X-3 up-TPI1p-**EcaroL**-pYX212t-ADH1t-**ARO7** ^{G141S}-TEF1p-PGK1p-**ARO4** ^{K229L}-CYC1t- X-3 dn*
M12	*X-4 up-CYC1t-**ARO1**-TPI1p-TDH3p-**ARO2**-ADH1t-TDH2t-**ARO3**-TEF1p-X-4 dn*
M13	*X-2 up-GPM1p-**PHA2**-CYC1t-X-2 dn*
M14	*XII-1 up-TDH3p-**At4CL1**-ADH1t- XII-1 dn*
M15	*XII-1 up-TDH2t-**RsCHS**-CCW12p-tHXT7p-**PsCHI**-FBAt-XII-1 dn*
M16	*XII-1 up-TDH3p-**At4CL1**-ADH1t-TDH2t*
M17	*ADH1t-TDH2t-**RsCHS**-CCW12p-tHXT7p-**PsCHI**-FBAt-XII-1 dn*
M18	*XII-5 up-pYX212t-**PsCHI**-PGKp-TEF1p-**RsCHS**-FBAt-CYC1t*
M19	*FBAt-CYC1t-**At4CL1**-TPIp-XII-5 dn*
M20	*XII-5 up-CYC1t-**At4CL1**-TPIp-XII-5 dn*
M21	*XII-5 up-TEF1p-**RsCHS**-FBAt-XII-5 dn*
M22	*XII-5 up-pYX212t-**PsCHI**-PGKp-XII-5 dn*
M23	*XII-5 up-pYX212t-**PsCHI**-PGKp-TEF1p-**RsCHS**-FBAt-XII-5 dn*
M24	*XI-1 up-pYX212t-**PsCHI**-PGKp-TEF1p-**RsCHS**-FBAt-CYC1t*
M25	*FBAt-CYC1t-**At4CL1**-TPIp-XI-1 dn*
M26	*XI-1 up-CYC1t-**At4CL1**-TPIp-XI-1 dn*
M27	*XI-1 up-TEF1p-**RsCHS**-FBAt-XI-1 dn*
M28	*XI-1 up-pYX212t-**PsCHI**-PGKp-XI-1 dn*
M29	*XI-1 up-pYX212t-**PsCHI**-PGKp-TEF1p-**RsCHS**-FBAt-XI-1 dn*
M30	*XI-3 up-TDH2t-**RsCHS**-CCW12p-tHXT7p-**PsCHI**-FBAt-XI-3 dn*
M31	*XI-2 up-TPIp-ACC1* ^{S659A,S1157A} *up 500bp*
M32	***ACC1*** ^{S659A,S1157A}
M33	*ACC1* ^{S659A,S1157A} *dn 500bp-TDH2t-XI-2 dn*
M34	*XII-3 up-TDH2t-**matB**-TDH3p-tHXT7p*
M35	*TDH3p-tHXT7p-**matC**-CYC1t- XII-3 dn*
M36	*X-2 up-TEF1-**NLS_FapR**-ADH1t-X-2 dn*
M37	*XI-3 up-GPM1p-**AtPAL2**-FBA1t-XI-3 dn*
M38	*XI-3 up-CCW12p-**AtPAL2**-FBA1t-XI-3 dn*
M39	*XI-3 up-CCW12p_BS2-**AtPAL2**-FBA1t-XI-3 dn*
M40	*XI-3 up- CCW12p_BS123-**AtPAL2**-FBA1t-XI-3 dn*
M41	*XI-3 up-TDH3p-**AtPAL2**-FBA1t-XI-3 dn*
M42	*XI-3 up-TDH3p_BS23-**AtPAL2**-FBA1t-XI-3 dn*
M43	*XI-3 up-TEF1p-**AtPAL2**-FBA1t-XI-3 dn*
M44	*XI-3 up-TEF1p_BS123-**AtPAL2**-FBA1t-XI-3 dn*
M45	*FDC1 up-pYX212t-**DCR1**-TDH3p-tHXT7p*
M46	*TDH3p-tHXT7p-**AGO1**-CYC1t- FDC1 dn*
M47	*XI-5 up-TDH3p-FAS1_sense 200bp-rad9_intron1 80bp*
M48	*XI-5 up-TDH3p-FAS1_sense 250bp-rad9_intron1 80bp*

M49	*XI-5 up-TDH3_BS23p-FAS1_sense 200bp-rad9_intron1 80bp*
M50	*XI-5 up-TDH3_BS23p-FAS1_sense 250bp-rad9_intron1 80bp*
M51	*rad9_intron1 80bp-FAS1_antisense 200bp-TDH2t-XI-5 dn*
M52	*rad9_intron1 80bp-FAS1_antisense 250bp-TDH2t-XI-5 dn*

[a] Bold font indicates genes expressed; *p*, indicates promoter; *t*, indicates terminator; underline, indicates up-stream (up) and down-stream (dn) sequences for Cas9-mediated homologous recombination.

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