
Supplementary information

Engineering cofactor supply and recycling to drive phenolic acid biosynthesis in yeast

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Supporting information

Engineering cofactor supply and recycling to drive phenolic acid biosynthesis in yeast

Ruibing Chen^{1,4}, Jiaoqi Gao¹, Wei Yu¹, Xianghui Chen^{4,6}, Xiaoxin Zhai¹, Yu Chen⁷,
Lei Zhang^{4,5,6,*}, Yongjin J. Zhou^{1,2,3,*}

¹Division of Biotechnology, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, 457 Zhongshan Road, Dalian 116023, China.

²CAS Key Laboratory of Separation Science for Analytical Chemistry, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian 116023, China.

³Dalian Key Laboratory of Energy Biotechnology, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, 457 Zhongshan Road, Dalian 116023, China.

⁴Department of Pharmaceutical Botany, School of Pharmacy, Naval Medical University, Shanghai 200433, China.

⁵Institute of Interdisciplinary Integrative Medicine Research, School of Medicine, Nantong University. 19 Qixiu Road, Nantong 226001, China.

⁶Biomedical Innovation R&D Center, School of Medicine, Shanghai University. 99 Shangda Road, BaoShan District, Shanghai 20444, China.

⁷Department of Biology and Biological Engineering, Chalmers University of Technology, Kemivägen 10, SE41296 Gothenburg, Sweden.

*Corresponding author:

Lei Zhang (Leizhang100@163.com)

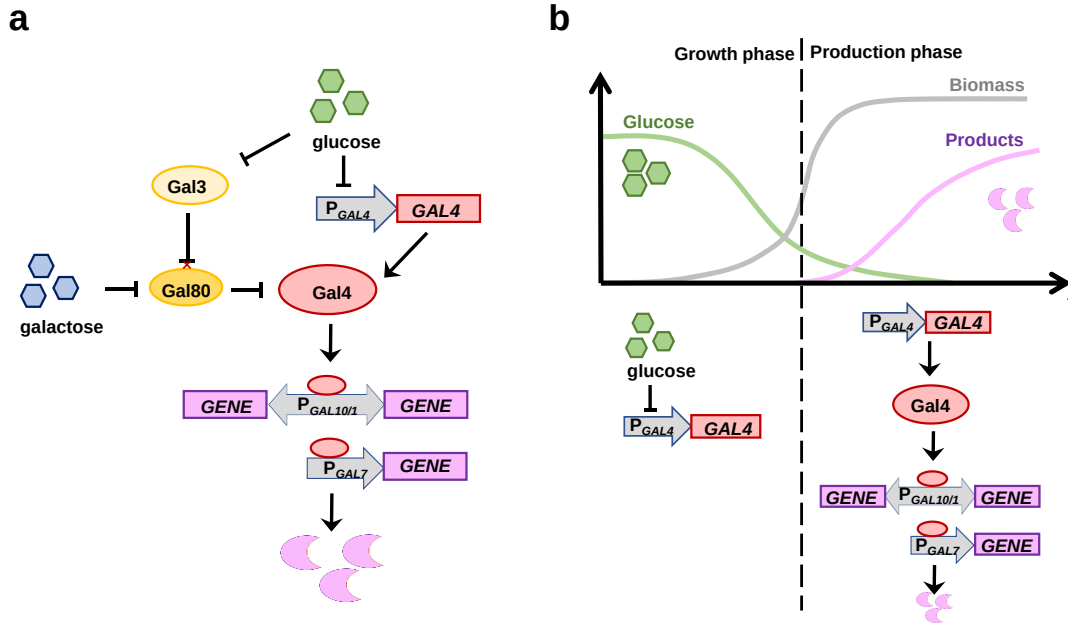
Yongjin J. Zhou (zhouyongjin@dicp.ac.cn)

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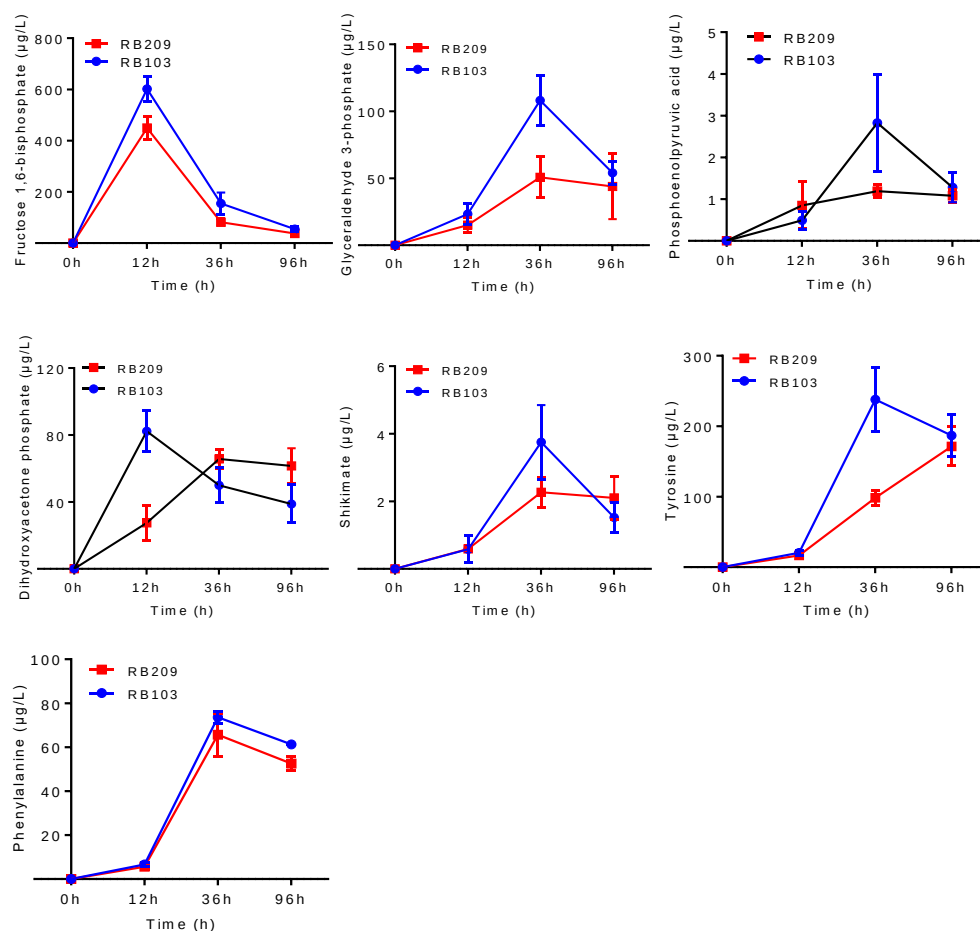
Supplementary Fig. 1-7

Supplementary Table 1-5

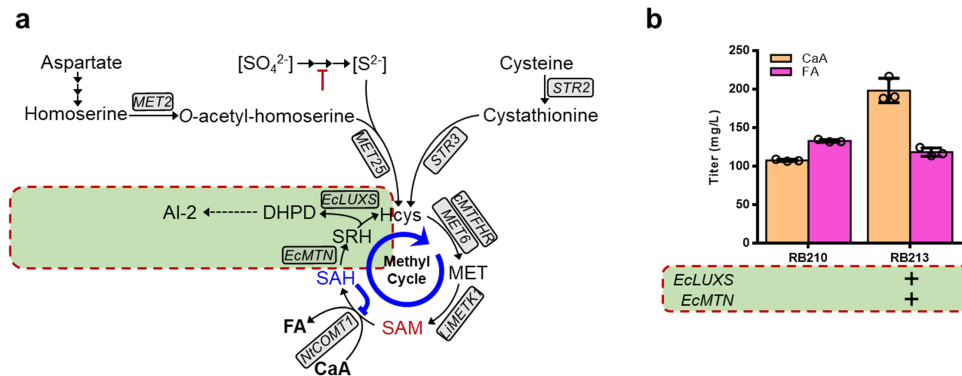
Supplementary Data legends



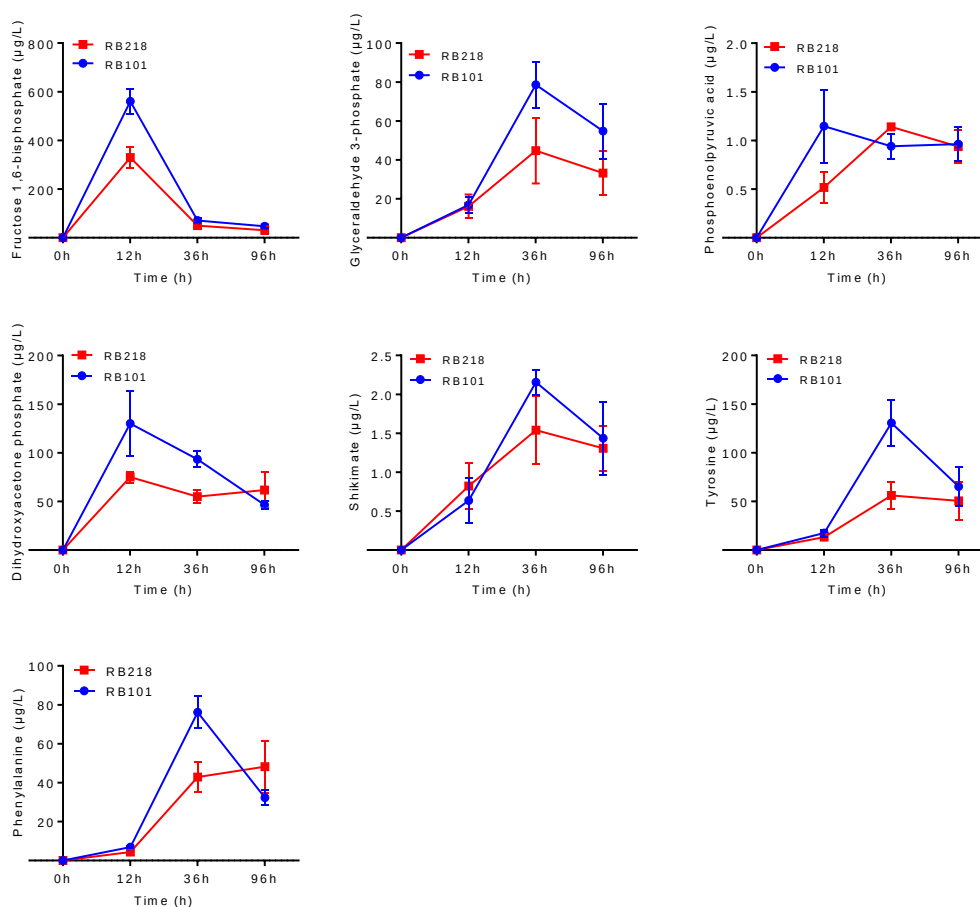
Supplementary Fig. 2. Dynamic regulation of product biosynthesis using P_{GAL} promoters. **a.** *GAL* regulatory network in the yeast strains. The transcription of genes initiated by the P_{GAL} promoters ($P_{GAL10/1}$, P_{GAL4} and P_{GAL7}) is inhibited by the presence of glucose. In the absence of galactose and in the presence of glucose, Gal80 acts as a repressor, interacting with the transcriptional activator Gal4 and inhibiting expression of the genes controlled by the P_{GAL} promoters. Deleting *GAL80* (*gal80Δ*) permits the expression of the P_{GAL} -controlled genes in the absence of glucose. **b.** After *GAL80* deletion, the expression of *GAL4* and the P_{GAL} -controlled genes was controlled solely by glucose, which enables repression of the P_{GAL} -controlled genes at high glucose concentration (growth phase) and expression at low glucose concentration (production phase). $P_{GAL10/1}$ is a bidirectional promoter.



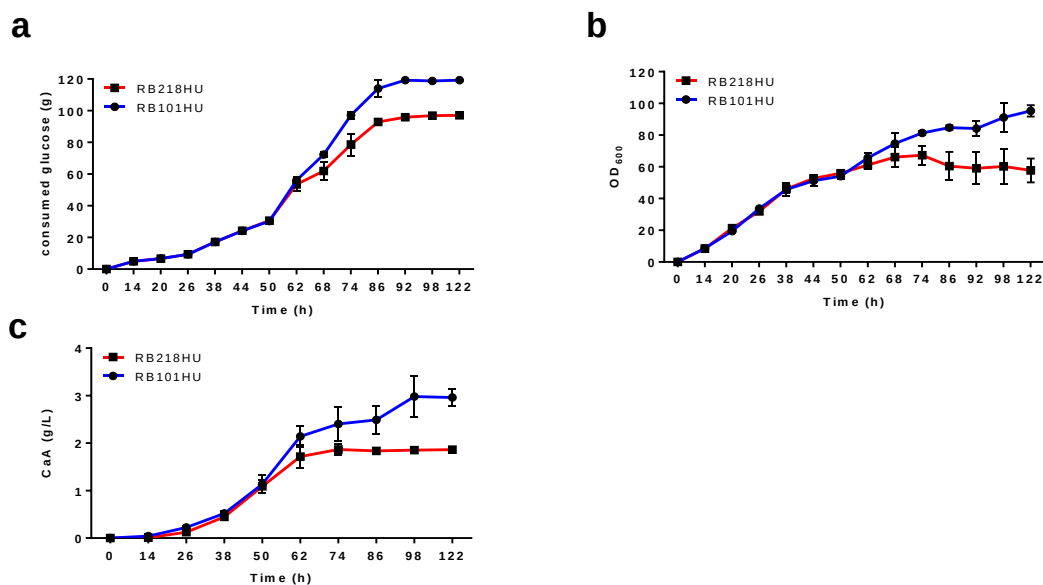
Supplementary Fig. 3. Quantification of cellular intermediates of CaA biosynthesis pathway in the CaA producing strains. All strains were grown at 30 °C in 20mL of Delft-D medium containing 20 g/L glucose. All data represent the mean of n=3 independent biological samples and error bars show standard deviation.



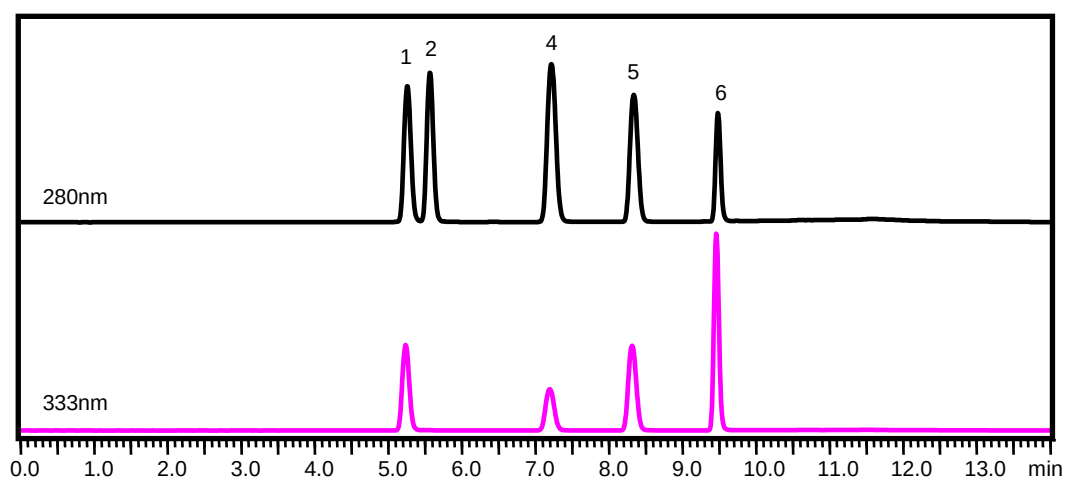
Supplementary Fig. 4. AI-2 pathway didn't promote FA synthesis, but instead increased CaA production. **a.** Schematic illustration of the methyl cycle and the AI-2 pathway. *EcMTN* encoding 5'-methylthioadenosine/S-adenosylhomocysteine nucleosidase, *EcLUXS* encoding S-ribosylhomocysteine lyase, *NiCOMT1* encoding *N. tabacum* caffeic acid O-methyltransferase 1, *MET2* encoding L-homoserine-O-acetyltransferase, *STR2* encoding cystathionine gamma-synthase, *MET25* encoding O-acetyl homoserine-O-acetyl serine sulphydrylase, *STR3* encoding peroxisomal cystathionine beta-lyase, *LiMETK1* encoding *Leishmania infantum* S-adenosylmethionine synthetases, *MET6* encoding methionine synthase, *cMTHFR* encoding chemerin methylenetetrahydrofolate reductase. SRH, S-ribosyl-L-homocysteine; DHPD, 4,5-dihydroxy 2,3-pentanedione; SAM, S-adenosylmethionine; Met, methionine; Hcys, homocysteine; SAH, S-adenosylhomocysteine; Ade, adenosine; CH₃-THF, 5-methyl tetrahydrogen folic acid; 5, 10-CH₂-THF, 5, 10-methylene tetrahydrogen folic acid; ATP, adenosine triphosphate. **b.** Expression of AI-2 pathway increased CaA titers. All data represent the mean of n=3 independent biological samples and error bars show standard deviation. All data represent the mean of n=3 independent biological samples and error bars show standard deviation. Statistical analysis was performed by using Student's *t* test (one-tailed; two-sample unequal variance; **p* < 0.05, ***p* < 0.01, ****p* < 0.001).



Supplementary Fig. 5. Quantification of cellular intermediates of FA biosynthesis pathway in the FA producing strains. All strains were grown at 30 °C in 20mL of Delft-D medium containing 20 g/L glucose. All data represent the mean of n=3 independent biological samples and error bars show standard deviation.



Supplementary Fig. 6. Fed-batch fermentation of strains RB101HU and RB218HU under glucose-limited conditions. **a.** Time courses of glucose consumption (**a**), cell growth (**b**) and CaA accumulation (**c**) of strain RB101HU and RB218 during fed-batch fermentation. During the fed-batch fermentation process, the amount of glucose added (W_{glu} , g), the concentration of residual glucose (C_{glu} , g/L) and the total volume of the medium (V , L) were recorded. The consumed glucose (U_{glu} , g) can be calculated by the following formula: $U_{glu} = 5 + (W_{glu}/V - C_{glu})V$. All data represent the mean of $n=3$ independent biological samples and error bars show standard deviation. All data represent the mean of $n=3$ independent biological samples and error bars show standard deviation.



Supplementary Fig. 7 Representative chromatographs of standards. Peaks in the chromatograph represent caffeic acid (**1**), syringic acid (**2**), *p*-coumaric acid (**4**), ferulic acid (**5**) and coniferyl aldehyde (**6**, not analyzed in this study).

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

Strains	Genotype
CEN.PK113-11C	<i>MATa, MAL2-8C, SUC2, ura3-52, his3Δ</i>
CEN.PK113-11C*	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ</i> =CEN.PK113-11C, <i>gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1})
RB2	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1})= CEN.PK113-11C*, <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcAROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>XII4::</i> (<i>T</i> _{PRM9} > <i>PtrC4H2</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>PtrC3H3</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{DIT1})
RB11	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>XII4::</i> (<i>T</i> _{PRM9} > <i>PtrC4H2</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>PtrC3H3</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{DIT1})
RB13	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>XII1::</i> (<i>T</i> _{PRM9} > <i>PtrC4H2</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1})
RB14	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>XII4::</i> (<i>T</i> _{PRM9} > <i>PtrC4H2</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>PtrC4H1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{PYK}), (<i>P</i> _{GAL7} > <i>PtrC3H3</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{DIT1})
RB15	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>X2::</i> (<i>T</i> _{PRM9} > <i>EcHPAB</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>EcHPAC</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{HIS3})
RB16	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>X2::</i> (<i>T</i> _{PRM9} > <i>EcHPAB/GGGS</i> / <i>EcHPAC</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1})
RB17	<i>MATa, MAL2-8C, SUC2, ura3Δ, his3Δ, gal80Δ, XI5::</i> (<i>P</i> _{TEF} - <i>CAS9-T</i> _{CYC1}), <i>aro10Δ</i> , <i>ARO10::</i> (<i>T</i> _{HIS3} > <i>ScARO7</i> ^{G141S} - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>ScARO4</i> ^{K229L} - <i>Sc</i> ^{OPT1} < <i>T</i> _{ENO2}) + (<i>P</i> _{GAL7} > <i>EcA</i> <i>ROL</i> < <i>T</i> _{ADH1}), <i>pdcs5Δ</i> , <i>PDC5::</i> (<i>T</i> _{CYC1} > <i>FjTAL</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SbPAL1</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{TDH2}) + (<i>T</i> _{FBA1} > <i>AtCPR1</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL7})=RB2, <i>X2::</i> (<i>T</i> _{PRM9} > <i>PaHPAB</i> - <i>Sc</i> ^{OPT1} < <i>P</i> _{GAL10/1} > <i>SeHPAC</i> - <i>Sc</i> ^{OPT1} < <i>T</i> _{HIS3})

RB18 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7})=RB2, **X2:::(T_{PRM9}>PaHPAB/GGGS/SeHPAC-Sc^{OPT1}<P_{GAL10/1})**

RB19 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1})=RB14,
X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})

RB26 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
 X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19,
X1:::(P_{TDH3}>ScMCH5<T_{SPO1})

RB27 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
 X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB26, **rib4Δ**

RB28 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
 X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19,
X3:::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})

RB29 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
 X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19,
X3:::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})

RB30 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdv5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), **XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),**
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
 X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19,
X3:::(T_{ENO2}>ScFMN1tr<P_{GAL10/1}>ScFAD1<T_{ADH1})

RB31 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19, X3::(T_{ENO2}>ScFMN1<P_{GAL10/1}>ScFAD1<T_{ADH1})

RB32 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19, X3::(T_{ENO2}>BiFADS-Sc^{OPT1}<P_{HXT7}), (P_{TDH3}>BsRIBBA-Sc^{OPT1}<T_{ADH1})

RB33 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19, X12::(T_{CYC1}>ScFLX1<P_{HXT7})+(P_{TDH3}>ScRIB1<T_{TDH2})

RB28A MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), X3::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})=RB28, X1::(P_{TDH3}>ScMCH5<T_{SPO1})

RB29A MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), X3::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})=RB29, X1::(P_{TDH3}>ScMCH5<T_{SPO1})

RB30A MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), X3::(T_{ENO2}>ScFMN1tr<P_{GAL10/1}>ScFAD1<T_{ADH1})=RB30, X1::(P_{TDH3}>ScMCH5<T_{SPO1})

RB31A MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,

	ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>), <i>X3</i>::(<i>T_{ENO2}</i>><i>ScFMN1</i><<i>P_{GAL10/1}</i>><i>ScFAD1</i><<i>T_{ADH1}</i>)=RB31, <i>X1</i>::(<i>P_{TDH3}</i>><i>ScMCH5</i><<i>T_{spo1}</i>)
RB32A	<i>MATa</i>, <i>MAL2-8C</i>, <i>SUC2</i>, <i>ura3Δ</i>, <i>his3Δ</i>, <i>gal80Δ</i>, <i>XI5</i>::(<i>P_{TEF}</i>-<i>CAS9</i>-<i>T_{CYC1}</i>), <i>aro10Δ</i>, ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>), <i>X3</i>::(<i>T_{ENO2}</i>><i>BiFADS</i>-Sc^{OPT1}<<i>P_{tht7}</i>), (<i>P_{TDH3}</i>><i>BsRIBBA</i>-Sc^{OPT1}<<i>T_{ADH1}</i>)=RB32, <i>X1</i>::(<i>P_{TDH3}</i>><i>ScMCH5</i><<i>T_{spo1}</i>)
RB33A	<i>MATa</i>, <i>MAL2-8C</i>, <i>SUC2</i>, <i>ura3Δ</i>, <i>his3Δ</i>, <i>gal80Δ</i>, <i>XI5</i>::(<i>P_{TEF}</i>-<i>CAS9</i>-<i>T_{CYC1}</i>), <i>aro10Δ</i>, ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>), <i>XI2</i>::(<i>T_{CYC1}</i>><i>ScFLX1</i><<i>P_{tht7}</i>)+(<i>P_{TDH3}</i>><i>ScRIB1</i><<i>T_{TDH2}</i>)=RB33, <i>X1</i>::(<i>P_{TDH3}</i>><i>ScMCH5</i><<i>T_{spo1}</i>)
RB79	<i>MATa</i>, <i>MAL2-8C</i>, <i>SUC2</i>, <i>ura3Δ</i>, <i>his3Δ</i>, <i>gal80Δ</i>, <i>XI5</i>::(<i>P_{TEF}</i>-<i>CAS9</i>-<i>T_{CYC1}</i>), <i>aro10Δ</i>, ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>)=RB19, <i>XII5</i>::(<i>T_{CPS1}</i>><i>NtCOMT1</i>-Sc^{OPT1}<<i>P_{GAL10}</i>><<i>T_{HIS5}</i>)
RB84	<i>MATa</i>, <i>MAL2-8C</i>, <i>SUC2</i>, <i>ura3Δ</i>, <i>his3Δ</i>, <i>gal80Δ</i>, <i>XI5</i>::(<i>P_{TEF}</i>-<i>CAS9</i>-<i>T_{CYC1}</i>), <i>aro10Δ</i>, ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>), <i>XII5</i>::(<i>T_{CPS1}</i>><i>NtCOMT1</i>-Sc^{OPT1}<<i>P_{GAL10}</i>><<i>T_{HIS5}</i>)=RB79, <i>hoΔ</i>, <i>HO</i>::(<i>THSP26</i>><i>ScMET6</i><<i>P_{GAL10}</i>><i>MTFHR</i> <i>chimera1</i>-Sc^{OPT1}<<i>T_{PDC6}</i>>)+(<i>P_{GAL7}</i>><i>METK1</i>-Sc^{OPT1}<<i>T_{UBX6}</i>)
RB85	<i>MATa</i>, <i>MAL2-8C</i>, <i>SUC2</i>, <i>ura3Δ</i>, <i>his3Δ</i>, <i>gal80Δ</i>, <i>XI5</i>::(<i>P_{TEF}</i>-<i>CAS9</i>-<i>T_{CYC1}</i>), <i>aro10Δ</i>, ARO10::(<i>T_{HIS3}</i>><i>ScARO7</i>^{G141S}-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>ScARO4</i>^{K229L}-Sc^{OPT1}<<i>T_{ENO2}</i>>)+(<i>P_{GAL7}</i>><i>EcA</i> <i>ROL</i><<i>T_{ADH1}</i>), <i>pdcs5Δ</i>, <i>PDC5</i>::(<i>T_{CYC1}</i>><i>FjTAL</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SbPAL1</i>-Sc^{OPT1}<<i>T_{TDH2}</i>>)+(<i>T_{FBA1}</i>><i>AtCPR1</i>-Sc^{OPT1}< <i>P_{GAL7}</i>), <i>XII4</i>::(<i>T_{PRM9}</i>><i>PtrC4H2</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>PtrC4H1</i>-Sc^{OPT1}<<i>T_{PYK}</i>), (<i>P_{GAL7}</i>><i>PtrC3H3</i>-Sc^{OPT1}<<i>T_{DIT1}</i>), <i>X2</i>::(<i>T_{PRM9}</i>><i>PaHPAB</i>-Sc^{OPT1}<<i>P_{GAL10/1}</i>><i>SeHPAC</i>-Sc^{OPT1}<<i>T_{HIS3}</i>), <i>XII5</i>::(<i>T_{CPS1}</i>><i>NtCOMT1</i>-Sc^{OPT1}<<i>P_{GAL10}</i>><<i>T_{HIS5}</i>)=RB79, <i>hoΔ</i>, <i>HO</i>::(<i>P_{GAL7}</i>><i>LiMETK1</i>-Sc^{OPT1}<<i>T_{UBX6}</i>)

- RB100 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3})=RB19, **XIII::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})**
- RB101 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), *XII5::*(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10}><T_{HIS5})=RB79, **XIII::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})**
- RB101HU MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), *XII5::*(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10}><T_{HIS5}), *XIII::*(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB101, **HIS3::(P_{HIS3}>HIS3<T_{HIS3}), URA3::(P_{URA3}>URA3<T_{URA3})**
- RB103 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), *XIII::*(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB100, **XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5})**
- RB103HU MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), *XIII::*(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB100, *XI8::*(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), **HIS3::(P_{HIS3}>HIS3<T_{HIS3}), URA3::(P_{URA3}>URA3<T_{URA3})**
- RB104 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcc5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}), (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),

XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10}><T_{HIS5}),
XIII::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB101,
XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5})

RB119 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10}><T_{HIS5}),
XIII::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB101,
***gpp1Δ*, GPP1::**(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5})

RB141 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XIII::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}),
XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5})=RB103, ***gpp1Δ*,**
GPP1::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>BbXFPK-Sc^{OPT1}<T_{HIS5})

RB144 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XIII::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}),
XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5})=RB103, ***gpp1Δ*,**
GPP1::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5})

RB148 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XIII::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB100,
***gpp1Δ*, GPP1::**(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5})

RB149 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}), *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}),
 (P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}),
X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),

XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5})=RB100,
gpp1Δ, **GPP1::**(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{HXT7})+(P_{UAS/TDH3}>NtCOMT1-Op^{OPT1}<T_{HIS5})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADHI}), *pdcc5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB186 *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}),
XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*,
 GPP1:::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5})=RB144,
XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADHI}), *pdcc5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB187 *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1:::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5})=RB148,
XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADHI}), *pdcc5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB197 *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}),
XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*,
 GPP1:::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1})=RB186, *XI6::*(P_{GAL7}>ScTKL1<T_{ENO2})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADHI}), *pdcc5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB202 *XII4::*(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), *X2::*(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1:::(T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5})=RB187,
XI7::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), *XI6::*(P_{GAL7}>ScTKL1<T_{ENO2})

RB203 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdz5Δ*, PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8:::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7:::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, **X1:::(P_{TDH3}>ScMCH5<T_{SPO1})**

RB204 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdz5Δ*, PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8:::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7:::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, **X3:::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})**

RB205 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdz5Δ*, PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8:::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7:::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, **X3:::(T_{ENO2}>ScFMN1tr<P_{HXT7})+(P_{TDH3}>ScFAD1<T_{ADH1})**

RB206 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdz5Δ*, PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8:::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7:::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, **X3:::(T_{ENO2}>ScFMN1tr<P_{GAL10/1}>ScFAD1<T_{ADH1})**

- RB207 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, X3::(T_{ENO2}>ScFMN1<P_{GAL10/1}>ScFAD1<T_{ADH1})
- RB209 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2})=RB197, X3::(T_{ENO2}>BiFADS-Sc^{OPT1}<P_{HXT7})+(P_{TDH3}>BsRIBBA-Sc^{OPT1}<T_{ADH1})
- RB209HU MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), XI8::(T_{CPS1}>ScPHA2<P_{GAL10/1}>MtPDH1-Sc^{OPT1}<T_{HIS5}), *gpp1Δ*, GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2}), X3::(T_{ENO2}>BiFADS-Sc^{OPT1}<P_{HXT7})+(P_{TDH3}>BsRIBBA-Sc^{OPT1}<T_{ADH1}) =RB209, **HIS3::(P_{HIS3}>HIS3<T_{HIS3}), URA3::(P_{URA3}> URA3<T_{URA3})**
- RB210 MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*, ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA ROL<T_{ADH1}), *pdcs5Δ*, PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<P_{GAL7}), XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT1}<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}), XII1::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*, GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}), XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}), XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}), XI7::(T_{PRM9}><P_{GAL10/1}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2})=RB202, **hoΔ**, **HO::(T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR chimera1-Sc^{OPT1}<T_{PDC6})+(P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6})**

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
 1<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 RB213 XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7:::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
 chimera1-Sc^{OPT1}<T_{PDC6})+(P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6})=RB210,
V1:::(T_{PRM9}>EcLUXS<P_{GAL10/1}>EcMTN<T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB217 XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
 1<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7:::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
 chimera1-Sc^{OPT1}<T_{PDC6})+(P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6})=RB210,
V3:::(T_{PRM9}>ScADO1<P_{GAL10/1}><T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10:::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2})+(P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5:::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2})+(T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 RB218 XII4:::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK})+(P_{GAL7}>PtrC3H3-Sc^{OPT}
 1<T_{DIT1}), X2:::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XII1:::(P_{GAL7}>ScARO1<T_{ENO2})+(T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1:::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8:::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7:::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6:::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
 chimera1-Sc^{OPT1}<T_{PDC6})+(P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6})=RB210,
V3:::(T_{PRM9}>ScADO1<P_{GAL10/1}>ScSAH1<T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XIII1::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
chimera1-Sc^{OPT1}<T_{PDC6}) + (P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6}),
 V3::(T_{PRM9}>ScADO1<P_{GAL10/1}>ScSAH1<T_{PYK1}) = RB218, **HIS3::**(P_{HIS3}>HIS3<T_{HIS3}),
URA3:: (P_{URA3}> URA3<T_{URA3})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XIII1::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
chimera1-Sc^{OPT1}<T_{PDC6}) + (P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6}) = RB210,
V3::(P_{GAL7}>ScTAD1<T_{ENO2}) + (T_{PRM9}>ScADO1<P_{GAL10/1}>ScSAH1<T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XIII1::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),
 XII5::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI8::(T_{CPS1}>NtCOMT1-Sc^{OPT1}<P_{GAL10/1}>NtCOMT1-Op^{OPT1}<T_{HIS5}),
 XI7::(T_{PRM9}><P_{GAL10}>ScTAL1<T_{PYK1}), XI6::(P_{GAL7}>ScTKL1<T_{ENO2}), *hoΔ*,
 (T_{HSP26}>ScMET6<P_{GAL10/1}>MTFHR
chimera1-Sc^{OPT1}<T_{PDC6}) + (P_{GAL7}>LiMETK1-Sc^{OPT1}<T_{UBX6}) = RB210,
III1::(T_{PRM9}>ScMET2<P_{GAL10/1}> <T_{PYK1})

MATa, MAL2-8C, SUC2, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(P_{TEF}-CAS9-T_{CYC1}), *aro10Δ*,
 ARO10::(T_{HIS3}>ScARO7^{G141S}-Sc^{OPT1}<P_{GAL10/1}>ScARO4^{K229L}-Sc^{OPT1}<T_{ENO2}) + (P_{GAL7}>EcA
 ROL<T_{ADH1}), *pdcs5Δ*,
 PDC5::(T_{CYC1}>FjTAL-Sc^{OPT1}<P_{GAL10/1}>SbPAL1-Sc^{OPT1}<T_{TDH2}) + (T_{FBA1}>AtCPR1-Sc^{OPT1}<
 P_{GAL7}),
 XII4::(T_{PRM9}>PtrC4H2-Sc^{OPT1}<P_{GAL10/1}>PtrC4H1-Sc^{OPT1}<T_{PYK}) + (P_{GAL7}>PtrC3H3-Sc^{OPT}
¹<T_{DIT1}), X2::(T_{PRM9}>PaHPAB-Sc^{OPT1}<P_{GAL10/1}>SeHPAC-Sc^{OPT1}<T_{HIS3}),
 XIII1::(P_{GAL7}>ScARO1<T_{ENO2}) + (T_{CPS1}>ScARO2<P_{GAL10/1}>ScARO3<T_{HIS5}), *gpp1Δ*,
 GPP1::(TENO2T_{ENO2}>CkPTA-Sc^{OPT1}<P_{GAL10/1}>LmXFPK-Op^{OPT1}<T_{HIS5}),

XII5::(*T_{CPS1}*>*NtCOMT1*-Sc^{OPT1}<*P_{GAL10/1}*>*NtCOMT1*-Op^{OPT1}<*T_{HIS5}*),
XI8::(*T_{CPS1}*>*NtCOMT1*-Sc^{OPT1}<*P_{GAL10/1}*>*NtCOMT1*-Op^{OPT1}<*T_{HIS5}*),
XI7::(*T_{PRM9}*><*P_{GAL10}*>*ScTAL1*<*T_{PYK1}*), *XI6::*(*P_{GAL7}*>*ScTKL1*<*T_{ENO2}*), *hoΔ*,
(*T_{HSP26}*>*ScMET6*<*P_{GAL10/1}*>*MTFHR*
chimera1-Sc^{OPT1}<*T_{PDC6}*)<(P_{GAL7}>*LiMETK1*-Sc^{OPT1}<*T_{UBX6}*)=RB210,
***III1::*(*T_{PRM9}*>*ScMET2*<*P_{GAL10/1}*>*ScSTR2*<*T_{PYK1}*)**

RB224

MATa, *MAL2-8C*, *SUC2*, *ura3Δ*, *his3Δ*, *gal80Δ*, *XI5::*(*P_{TEF}*-*CAS9*-*T_{CYC1}*), *aro10Δ*,
ARO10::(*T_{HIS3}*>*ScARO7*^{G141S}-Sc^{OPT1}<*P_{GAL10/1}*>*ScARO4*^{K229L}-Sc^{OPT1}<*T_{ENO2}*)<(P_{GAL7}>*EcA*
ROL<*T_{ADH1}*), *pdcc5Δ*,
PDC5::(*T_{CYC1}*>*FjTAL*-Sc^{OPT1}<*P_{GAL10/1}*>*SbPAL1*-Sc^{OPT1}<*T_{TDH2}*)<(P_{FBA1}>*AtCPR1*-Sc^{OPT1}<
P_{GAL7}),
XII4::(*T_{PRM9}*>*PtrC4H2*-Sc^{OPT1}<*P_{GAL10/1}*>*PtrC4H1*-Sc^{OPT1}<*T_{PYK}*)<(P_{GAL7}>*PtrC3H3*-Sc^{OPT}
¹<*T_{DIT1}*), *X2::*(*T_{PRM9}*>*PaHPAB*-Sc^{OPT1}<*P_{GAL10/1}*>*SeHPAC*-Sc^{OPT1}<*T_{HIS3}*),
XIII1::(*P_{GAL7}*>*ScARO1*<*T_{ENO2}*)<(P_{CPS1}>*ScARO2*<*P_{GAL10/1}*>*ScARO3*<*T_{HIS5}*), *gpp1Δ*,
GPP1::(*TENO2*<*T_{ENO2}*>*CkPTA*-Sc^{OPT1}<*P_{GAL10/1}*>*LmXFPK*-Op^{OPT1}<*T_{HIS5}*),
XII5::(*T_{CPS1}*>*NtCOMT1*-Sc^{OPT1}<*P_{GAL10/1}*>*NtCOMT1*-Op^{OPT1}<*T_{HIS5}*),
XI8::(*T_{CPS1}*>*NtCOMT1*-Sc^{OPT1}<*P_{GAL10/1}*>*NtCOMT1*-Op^{OPT1}<*T_{HIS5}*),
XI7::(*T_{PRM9}*><*P_{GAL10}*>*ScTAL1*<*T_{PYK1}*), *XI6::*(*P_{GAL7}*>*ScTKL1*<*T_{ENO2}*), *hoΔ*,
(*T_{HSP26}*>*ScMET6*<*P_{GAL10/1}*>*MTFHR*
chimera1-Sc^{OPT1}<*T_{PDC6}*)<(P_{GAL7}>*LiMETK1*-Sc^{OPT1}<*T_{UBX6}*),
V3::(*T_{PRM9}*>*ScADO1*<*P_{GAL10/1}*>*ScSAH1*<*T_{PYK1}*)=RB218,
***III1::*(*T_{PRM9}*>*ScMET2*<*P_{GAL10/1}*> <*T_{PYK1}*)**

Supplementary Table 2. The parameters used for HPLC analysis of phenolic acids.

Time (min)	A (%)	B (%)
0	95	5
3	90	10
4	88	12
5	88	12
6	85	15
7	85	15
10	40	60
12	95	5
14	95	5

Column: 3×100 mm 2.7µm Poroshell 120 EC-C18 (Agilent)

Flow rate: 0.8 mL/min

Mobile phases A: H₂O+0.05% HCOOH

mobile phases B: acetonitrile+0.05% HCOOH

Wavelength: 280 nm and 330 nm

Supplementary Table 3. The parameters used for HPLC analysis of FMN(H₂), FAD(H₂) and riboflavin.

Time (min)	A (%)	B (%)
0	95	5
6.25	95	5
18.75	75	25
19	50	50
22.25	50	50
22.5	95	5
28.5	95	5

Column: 3×100 mm 2.7um Poroshell 120 EC-C18 (Agilent)

Flow rate: 0.8 mL/min

Mobile phases A: phosphate buffer (50 mM, pH 3.1)

mobile phases B: 100% acetonitrile

Wavelength: 450nm

Supplementary Table 4. The parameters used for intermediate analysis.**(1) Parameters for metabolite quantification by UHPLC-MS/MS^a**

No.	Compounds	Transition (m/z)	Fragmentor (V)	CE (eV)
1	phenylalanine	164.1 -> 147.1	90	9
2	tyrosine	180.2 -> 163.2	75	10
3	shikimate	173.0 -> 111.0	85	9
4	phosphoenolpyruvic acid	167.0 -> 79.0	70	13
5	fructose 1,6-bisphosphate	339.0 -> 79.0	110	73

^aThe temperatures of source drying gas and sheath gas were 300 °C and 350 °C. The flow rates of source drying gas and sheath gas were 5 and 11 L/min, respectively. The pressure of nebulizer was 45 psi, and capillary voltage was 4000 V.

Time (min)	A (%)	B (%)
0	10	90
1	10	90
14	30	70
15	45	55
17	45	55
17.5	10	90
20	10	90

Column: Merck SeQuant® ZIC-pHILIC column (100 mm × 2.1 mm, 5 µm); Flow rate: 0.2 mL/min

Mobile phases A: water containing 15mM ammonium acetate (pH 9)

mobile phases B: 90% acetonitrile

(2) Parameters for metabolite quantification by UHPLC-HRMS^b

No.	Compounds ^c	Accurate (m/z)
1	Dihydroxyacetone phosphate	244.0380
2	Glyceraldehyde 3-phosphate	319.0853

^bSpray voltage was set to 4000 V. Capillary and Probe Heater Temperature were separately 320°C and 320°C. Sheath gas flow rate was 35 (Arb, arbitrary unit), and Aux gas flow rate was 10 (Arb). S-Lens RF Level was 50 (Arb). The full scan was operated at a high-resolution of 35000 FWHM (m/z=200) at a range of 120-600 m/z with AGC Target setting at 1 × 10⁶.

^cAdd 2 µL of N-(3-Dimethylaminopropyl)-N'-ethylcarbodiimide (EDC) and 2 µL of aniline to 20 µL of the extracted sample and react for 2 hours at room temperature for derivatization.

Time (min)	A (%)	B (%)
0	99	1
8	90	10
15	0	100
18	0	100

Column: Waters HSS T3 column (2.1mm × 100 mm, 1.8 µm)

Flow rate: 0.25 mL/min

Mobile phases A: water

mobile phases B: acetonitrile/water (90:10, v/v), both with 5 mM ammonium acetate

Supplementary Table 5. Physiological parameters of engineered producing strains

	RB103UH	RB209UH	RB101UH	RB218UH
μ (max) (h^{-1})	0.11806 $\pm$ 0.00339	0.11528 $\pm$ 0.04924	0.09125 $\pm$ 0.00386	0.06774 $\pm$ 0.01550
Y (x/s) (g g^{-1})	0.01815 $\pm$ 0.00161	0.02589 $\pm$ 0.00263	0.00550 $\pm$ 0.00070	0.01705 $\pm$ 0.00106
q (glucose) ($\text{mmol gDCW}^{-1} \text{h}^{-1}$)	-0.41330 $\pm$ 0.03367	-0.52598 $\pm$ 0.04396	-0.63989 $\pm$ 0.03219	-0.88314 $\pm$ 0.10636
q (alcohol) ($\text{mmol gDCW}^{-1} \text{h}^{-1}$)	0.00702 $\pm$ 0.00046	0.02160 $\pm$ 0.00850	0.00699 $\pm$ 0.00065	0.01420 $\pm$ 0.00819
q (CaA) ($\text{mmol gDCW}^{-1} \text{h}^{-1}$)	0.00750 $\pm$ 0.00084	0.01364 $\pm$ 0.00208	0.00706 $\pm$ 0.00014	0.00742 $\pm$ 0.00085
q (FA) ($\text{mmol gDCW}^{-1} \text{h}^{-1}$)	/	/	0.00325 $\pm$ 0.00029	0.01391 $\pm$ 0.00108
q (biomass) (g h^{-1})	0.06095 $\pm$ 0.00274	0.05063 $\pm$ 0.00663	0.06960 $\pm$ 0.00374	0.04133 $\pm$ 0.00446

Data represent the mean $\pm$ SD of n = 3 biologically independent samples.

Supplementary Data 1. Primers used in this study.

Supplementary Data 2. Overview of DNA constructs used in this study.

Supplementary Data 3. Codon optimized genes used in this study.

Supplementary Data 4. Homology sequences for integration at selected chromosomal loci.

Supplementary Data 5. New reactions for metabolic flux analysis.

Supplementary Data 6. Code of culture simulation for metabolic flux analysis.

Supplementary Data 7. Code of yeast genome-scale metabolic model for metabolic flux analysis.