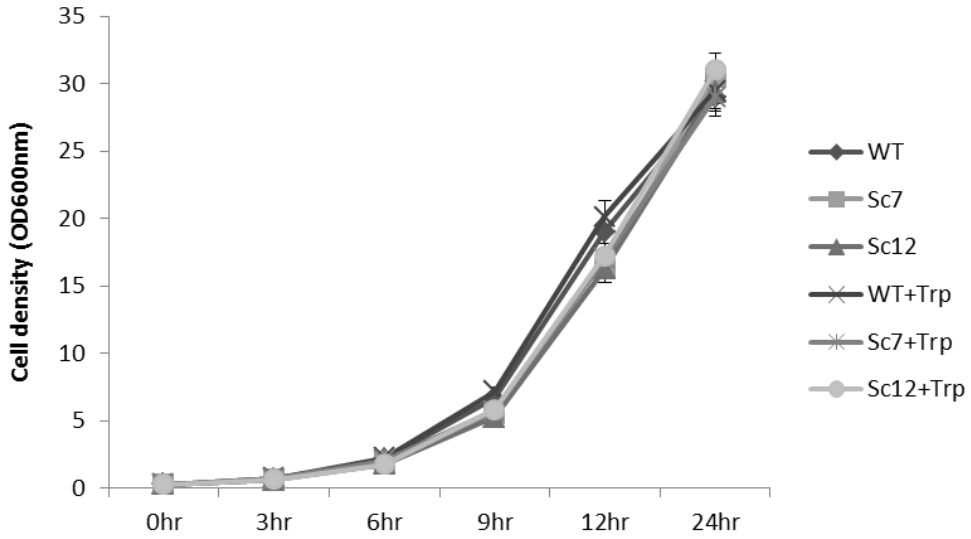
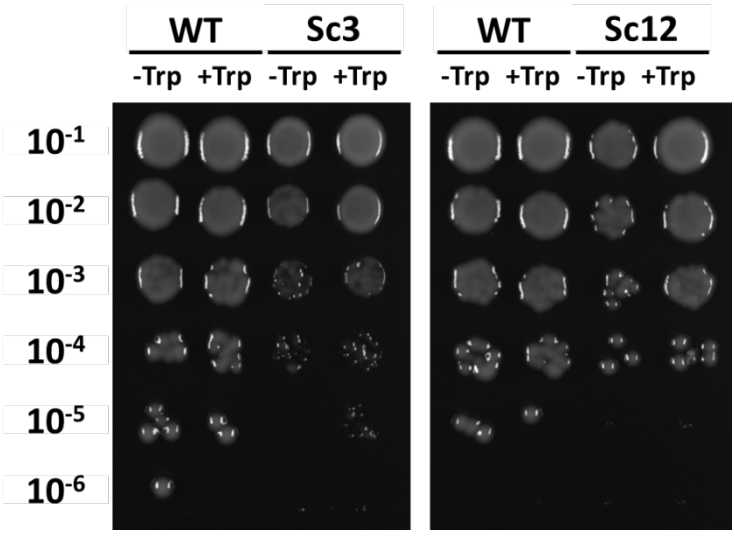
Additional file 1 (Supplemental files)



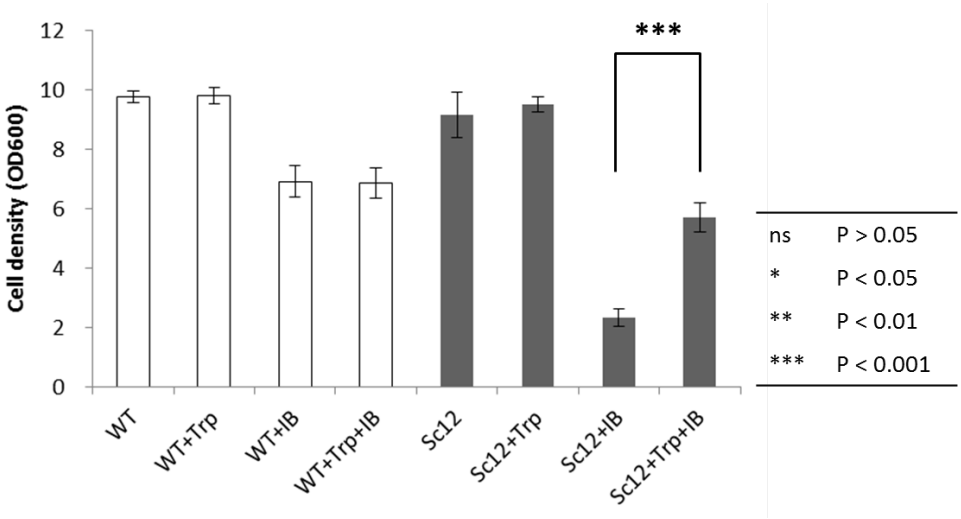
Supplemental Figure 1, Growth assay of a tryptophan biosynthesis defective strain under a standard growth condition.

The wild type and a tryptophan biosynthesis defective strain were tested in a standard medium with or without tryptophan addition (200 ug/ml). The growth rate shows no significantly difference between strains and between media with and without tryptophan addition. The data represent the mean±SD (n=3).



Supplemental Figure 2, Survival test of a tryptophan biosynthesis defective strain (Sc12) and a pentose phosphate pathway defective strain (Sc3)

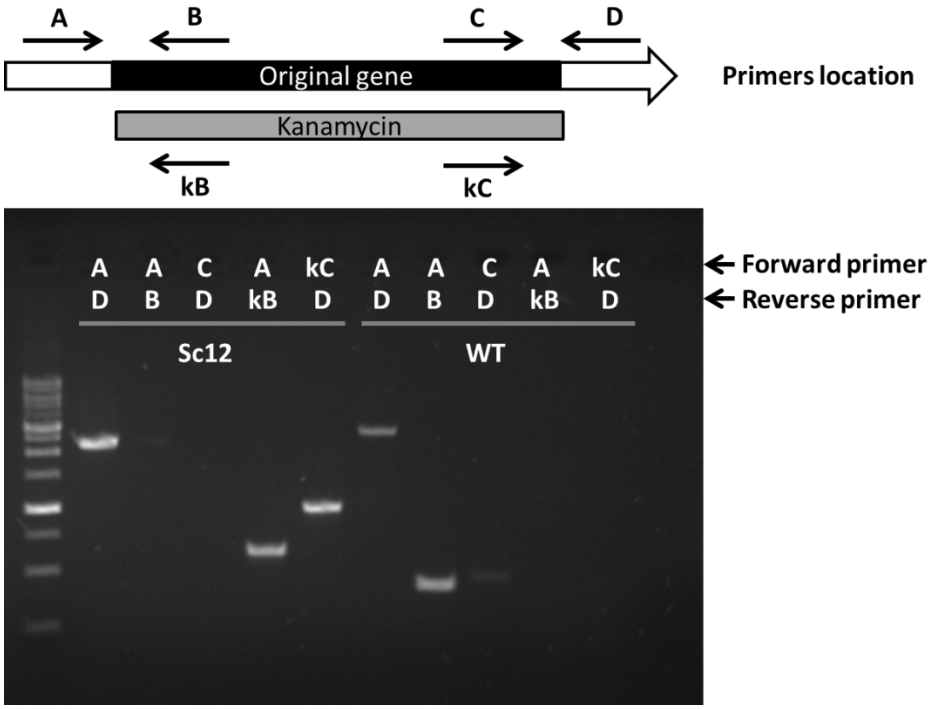
Both mutant strains Sc3 and Sc12 were sensitive to isbutanol, but could be recovered by adding tryptophan.



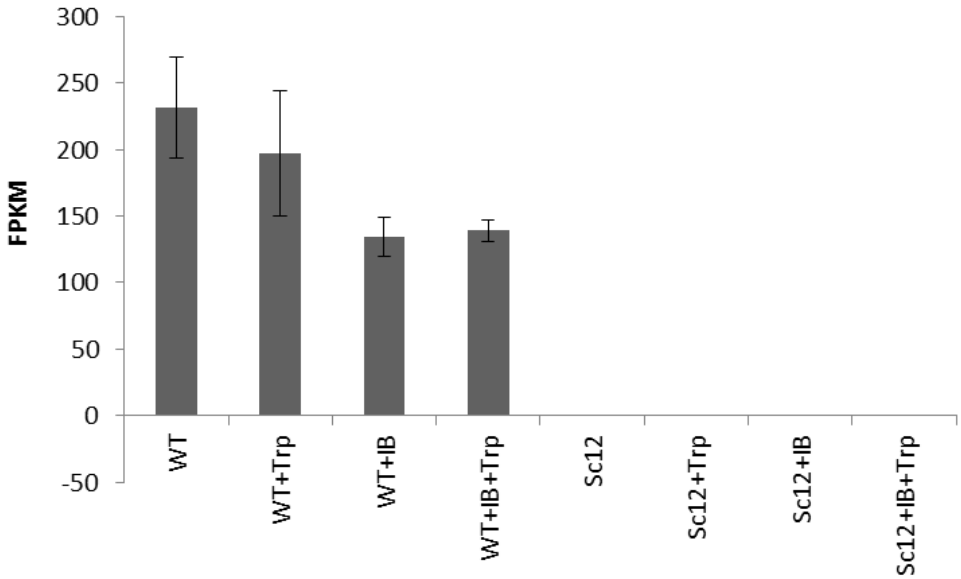
Supplemental Figure 3, Cell density assays of the wildtype and a tryptophan biosynthesis defective strain (Sc12) under different growth conditions

Yeasts were inoculated in 4ml medium with/without isobutanol and/or tryptophan. After 24 hours, the cell density was measured and RNA was harvested. The data represent the mean±SD (n=3). Notations: Trp, Tryptophan; IB, isobutanol

(a)

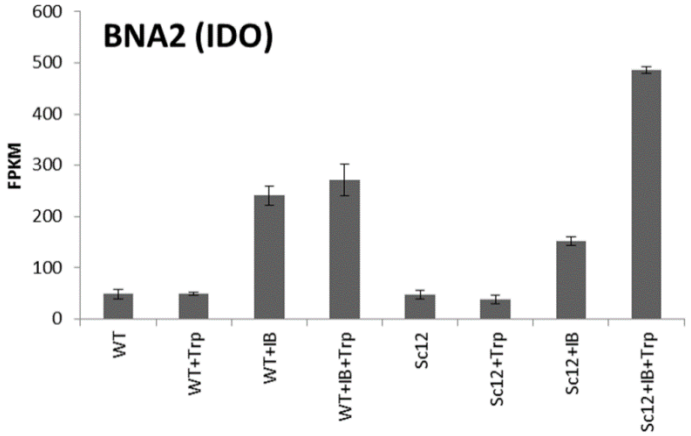


(b)



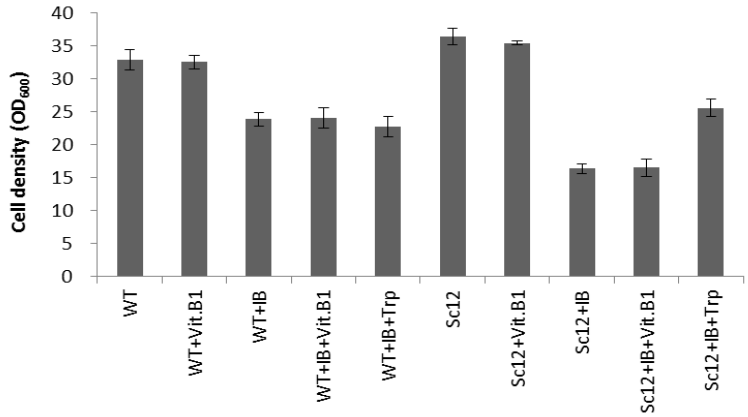
Supplemental Figure 4, Checking the gene deletion and expression level of the mutant gene *TRP5*

(a) PCR was applied to verify the gene deletion from genome. The arrows represent the direction of 6 primers, which include A, B, C, D, kB, and kC. **(b)** The expression levels of the *TRP5* gene under different growth conditions were estimated from NGS data.

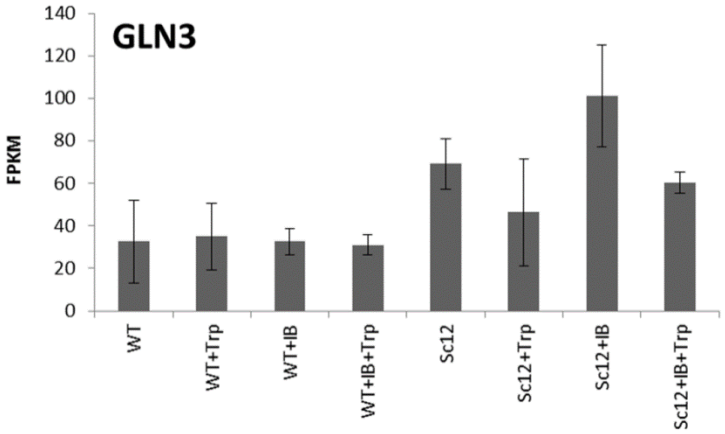


Supplemental Figure 5, Expression level of gene *BNA2*

BAN2 is responsible for de novo biosynthesis of NAD+ from tryptophan via kynurenine pathway. It was highly expressed in WT and Sc12 under isobutanol.

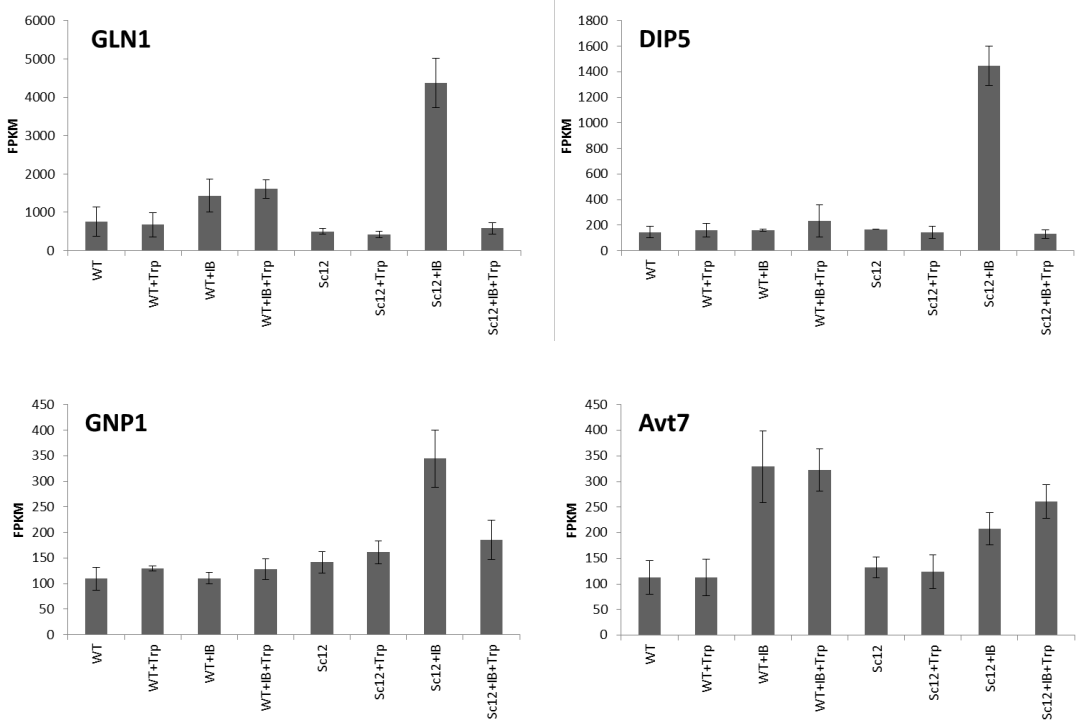


Supplemental Figure 6, **The recovery assay of wild type (WT) and tryptophan defective strain (Sc12) by supplementing of vitamin B1 (50*μ*g/ml) or tryptophan (200*μ*g/ml) under isobutanol (1%) stress.** Under isobutanol stress, Sc12 can be only recovered by trptophan. Vitamin B1 did not help Sc12 to tolerate isobutanol.



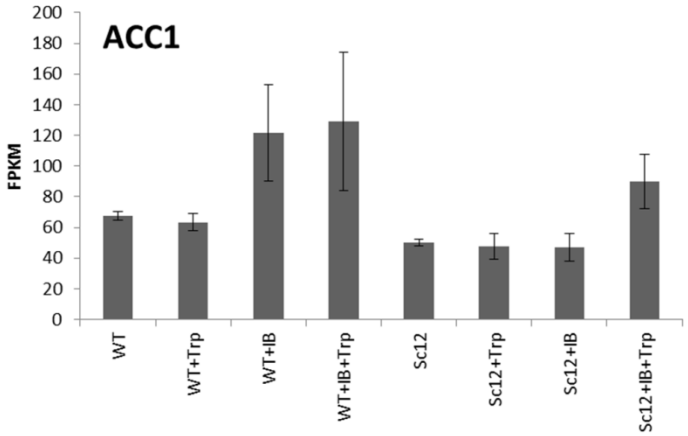
Supplemental Figure 7, Expression level of gene *GLN3*

GLN3 plays a key role in yeast's response to nitrogen starvation, including depletion of glutamine. It was upregulated when Sc12 was under isobutanol pressure; its expression level could be recovered by adding external tryptophan.



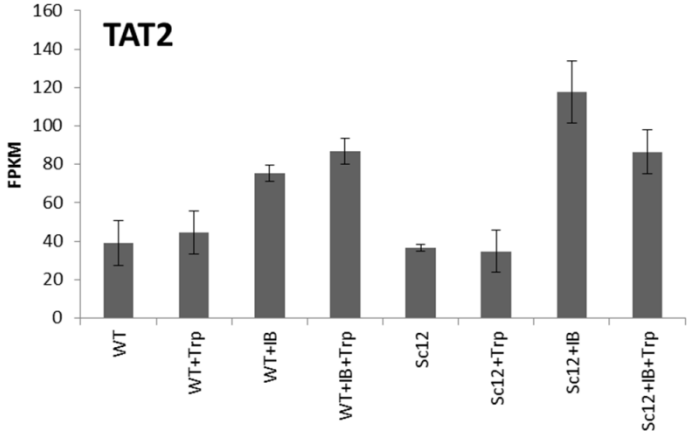
Supplemental Figure 8, Gene expression related to glutamine biosynthesis and transporter

The gene expression related to glutamine biosynthesis and transport was affected by adding tryptophan (Trp) and/or isobutanol (IB). *GLN1* was upregluated in WT when isobutanol was added, and was upregulated in the mutant strain Sc12. *DIP5* and *GNP1* were up-regulated when isobutanol was added. *Avt7* was up-regulated when WT and Sc12 were under isobutanol stress.



Supplemental Figure 9, Expression level of the *ACC1* gene

ACC1 is the rate-limiting step for de novo fatty acid biosynthesis. It was up-regulated in WT under isobutanol stress. When the tryptophan pathway was defective, the expression of *ACC1* was down-regulated under isobutanol stress but could be recovered by adding external tryptophan.



Supplemental Figure 10, Expression level of the *TAT2* gene

TAT2 is a tryptophan amino acid transporter and was up-regulated when WT and Sc12 were under isobutanol stress.

Supplemental Table 1, Genes related to isobutanol tolerance

No.	Gene	Symbol	Calculated log ratio	p-value	Annotation cluster of enrichment analysis
1	YDR127W	*ARO1*	2.074	2.83E-16	Trp biosynth
2	YKL211C	*TRP3*	1.799	7.99E-16	Trp biosynth
3	YDL225W	*SHS1*	1.864	2.65E-11	
4	YOR295W	*UAF30*	1.802	5.42E-11	
5	YER090W	*TRP2*	2.260	1.41E-10	Trp biosynth
6	YDR354W	*TRP4*	1.615	2.27E-10	Trp biosynth
7	YIL076W	*SEC28*	1.393	5.42E-10	
8	YDR007W	*TRP1*	2.216	6.06E-10	Trp biosynth
9	YPR123C		2.089	1.74E-09	
10	YNL079C	*TPM1*	2.050	1.13E-08	
11	YDL020C	*RPN4*	1.632	1.21E-08	
12	YLR110C	*CCW12*	1.597	2.50E-08	
13	YBR200W	*BEM1*	1.406	3.72E-08	
14	YJL120W		1.944	4.27E-08	
15	YOR198C	*BFR1*	1.842	5.22E-08	
16	YNL111C	*CYB5*	1.557	5.70E-08	
17	YPL188W	*POS5*	1.379	6.88E-08	
18	YFL023W	*BUD27*	1.208	7.91E-08	
19	YDR293C	*SSD1*	1.205	8.61E-08	
20	YER111C	*SWI4*	1.800	9.40E-08	
21	YJL121C	*RPE1*	1.871	1.41E-07	PPP
22	YPR153W	*44340*	1.740	5.66E-07	
23	YPR067W	*ISA2*	1.958	8.76E-07	
24	YLR044C	*PDC1*	1.018	1.00E-06	
25	YHL025W	*SNF6*	1.733	1.20E-06	
26	YAL013W	*DEP1*	1.010	1.24E-06	
27	YKL048C	*ELM1*	1.642	1.30E-06	
28	YGL026C	*TRP5*	1.669	1.64E-06	Trp biosynth
29	YDL045W-A	*MRP10*	1.360	2.49E-06	
30	YNL241C	*ZWF1*	1.637	2.59E-06	PPP
31	YBL094C		1.632	2.76E-06	
32	YMR304W	*UBP15*	1.397	4.13E-06	Ubiquitination
33	YGL168W	*HUR1*	1.545	5.16E-06	
34	YDR207C	*UME6*	1.722	6.33E-06	

35	YDL172C		1.267	7.24E-06	
36	YLR087C	*CSF1*	0.935	7.61E-06	
37	YCR081W	*SRB8*	1.263	7.74E-06	
38	YGL148W	*ARO2*	1.516	7.78E-06	Trp biosynth
39	YER083C	*GET2*	1.254	8.21E-06	
40	YBR171W	*SEC66*	1.280	9.83E-06	
41	YCL046W		1.238	1.09E-05	
42	YLR386W	*VAC14*	1.682	1.15E-05	
43	YCL045C	*EMC1*	1.225	1.36E-05	
44	YNL066W	*SUN4*	1.578	1.38E-05	
45	YJR090C	*GRR1*	1.733	1.59E-05	Ubiquitination
46	YLR342W	*FKS1*	1.659	1.61E-05	
47	YLR111W		0.902	1.63E-05	
48	YNL133C	*FYV6*	1.558	1.80E-05	
49	YDR186C	*SND1*	1.644	1.99E-05	
50	YCL037C	*SRO9*	1.193	2.29E-05	
51	YJL183W	*MNN11*	1.623	2.70E-05	
52	YHR183W	*GND1*	1.178	2.92E-05	PPP
53	YDL052C	*SLC1*	1.194	4.04E-05	
54	YPR139C	*LOA1*	1.426	4.40E-05	
55	YBR095C	*RXT2*	1.177	5.22E-05	
56	YMR032W	*HOF1*	0.845	5.61E-05	
57	YAL021C	*CCR4*	1.621	5.86E-05	
58	YDL018C	*ERP3*	1.167	6.14E-05	
59	YPR074C	*TKL1*	1.437	6.93E-05	PPP
60	YDR008C		1.112	8.87E-05	
61	YNR021W		1.420	9.95E-05	
62	YHR008C	*SOD2*	1.393	1.20E-04	
63	YGL020C	*GET1*	1.532	1.58E-04	
64	YHR060W	*VMA22*	1.065	1.65E-04	
65	YBR106W	*SND3*	1.085	2.08E-04	
66	YER122C	*GLO3*	1.493	2.36E-04	
67	YBR134W		1.060	2.95E-04	
68	YHL011C	*PRS3*	1.297	3.64E-04	PPP
69	YMR007W		0.748	3.89E-04	
70	YNL064C	*YDJ1*	1.292	4.29E-04	
71	YIL052C	*RPL34B*	0.801	4.34E-04	

72	YER141W	*COX15*	1.201	4.45E-04	
73	YDR364C	*CDC40*	0.899	5.18E-04	
74	YBR111W-A	*SUS1*	1.405	5.84E-04	
75	YHR180W		1.249	6.21E-04	
76	YNL315C	*ATP11*	1.376	7.70E-04	
77	YCL007C		1.370	8.15E-04	
78	YGR104C	*SRB5*	1.143	8.45E-04	
79	YKL098W	*MTC2*	1.141	8.63E-04	
80	YDR418W	*RPL12B*	0.863	8.81E-04	
81	YDR245W	*MNN10*	1.362	8.87E-04	
82	YLR224W	*UCC1*	1.133	9.35E-04	Ubiquitination
83	YDR204W	*COQ4*	1.337	1.05E-03	
84	YFL001W	*DEG1*	1.115	1.16E-03	
85	YOR200W		1.102	1.30E-03	
86	YBR097W	*VPS15*	1.319	1.32E-03	
87	YMR326C		0.917	1.34E-03	
88	YOR044W	*IRC23*	1.134	1.40E-03	
89	YPR132W	*RPS23B*	1.117	1.46E-03	
90	YJL006C	*CTK2*	1.307	1.48E-03	
91	YEL012W	*UBC8*	1.165	1.51E-03	Ubiquitination
92	YMR183C	*SSO2*	0.671	1.57E-03	
93	YKL139W	*CTK1*	1.161	1.67E-03	
94	YML011C	*RAD33*	0.663	1.78E-03	
95	YJR066W	*TOR1*	1.058	2.09E-03	
96	YBR133C	*HSL7*	1.246	2.56E-03	
97	YLR207W	*HRD3*	1.025	2.86E-03	
98	YHR013C	*ARD1*	0.843	3.07E-03	
99	YNR052C	*POP2*	0.878	3.10E-03	
100	YER066C-A		0.826	3.78E-03	
101	YJL184W	*GON7*	1.196	3.96E-03	
102	YKL011C	*CCE1*	0.989	4.04E-03	
103	YBR144C		0.855	4.07E-03	
104	YJL176C	*SWI3*	1.201	4.52E-03	
105	YFR019W	*FAB1*	0.837	4.97E-03	
106	YGL167C	*PMR1*	0.962	5.36E-03	
107	YKL054C	*DEF1*	0.950	5.83E-03	Ubiquitination
108	YFR033C	*QCR6*	0.969	5.96E-03	

109	YGL024W		0.968	5.98E-03	
110	YLR233C	*EST1*	1.164	6.52E-03	
111	YPR089W		1.012	6.53E-03	
112	YDL185W	*VMA1*	1.135	6.57E-03	
113	YER042W	*MXR1*	0.768	7.22E-03	
114	YGL240W	*DOC1*	1.122	7.28E-03	Ubiquitination
115	YDR532C	*KRE28*	0.803	7.30E-03	
116	YJR011C		0.773	7.32E-03	
117	YCR045C	*RRT12*	0.769	7.61E-03	
118	YGR208W	*SER2*	0.761	7.79E-03	
119	YAL016W	*TPD3*	1.108	8.15E-03	
120	YJR075W	*HOC1*	0.984	8.33E-03	
121	YOR331C		1.102	8.52E-03	
122	YBR077C	*SLM4*	0.983	8.58E-03	
123	YGR272C		1.095	9.01E-03	
124	YGL023C	*PIB2*	0.912	9.77E-03	
125	YCL062W		0.739	9.92E-03	
126	YLR292C	*SEC72*	1.120	9.96E-03	
127	YHR135C	*YCK1*	0.738	9.98E-03	
128	YBL100C		0.962	1.02E-02	
129	YCL042W		0.729	1.10E-02	
130	YFL003C	*MSH4*	0.881	1.12E-02	
131	YER019C-A	*SBH2*	0.726	1.14E-02	
132	YEL036C	*ANP1*	1.062	1.16E-02	
133	YGL192W	*IME4*	1.054	1.24E-02	
134	YDR363W-A	*SEM1*	0.877	1.30E-02	
135	YPL045W	*VPS16*	1.039	1.38E-02	
136	YCL061C	*MRC1*	0.703	1.44E-02	
137	YAL047C	*SPC72*	0.694	1.67E-02	
138	YLL027W	*ISA1*	1.011	1.70E-02	
139	YDL013W	*SLX5*	0.716	1.79E-02	Ubiquitination
140	YER014C-A	*BUD25*	0.998	1.86E-02	
141	YJR105W	*ADO1*	0.887	1.88E-02	
142	YLR093C	*NYV1*	0.504	1.95E-02	
143	YFR032C-A	*RPL29*	0.808	2.26E-02	
144	YBL067C	*UBP13*	0.801	2.38E-02	Ubiquitination
145	YNL098C	*RAS2*	0.853	2.41E-02	

146	YER078C	*ICP55*	0.829	2.93E-02	
147	YGL180W	*ATG1*	0.760	3.01E-02	
148	YDR417C		0.926	3.08E-02	
149	YJL140W	*RPB4*	0.984	3.24E-02	
150	YBR196C-A		0.917	3.27E-02	
151	YDL047W	*SIT4*	0.745	3.37E-02	
152	YKL096W-A	*CWP2*	0.805	3.43E-02	
153	YGR105W	*VMA21*	0.731	3.58E-02	
154	YGR210C		0.785	4.06E-02	
155	YDR226W	*ADK1*	0.954	4.12E-02	
156	YER116C	*SLX8*	0.716	4.18E-02	Ubiquitination
157	YML035C	*AMD1*	0.773	4.30E-02	
158	YPR135W	*CTF4*	0.716	4.43E-02	
159	YNL025C	*SSN8*	0.764	4.58E-02	
160	YML124C	*TUB3*	0.767	4.61E-02	
161	YBR173C	*UMP1*	0.695	4.87E-02	Ubiquitination

Abbreviation: Isobutanol, IB; Trp, Tryptophan; PPP, Pentose phosphate pathway

Supplemental Table 2, Tophat mapping rate of NGS reads

Samples	Input	Mapped	Mapped%
1. WT	18,220,832	17,985,218	98.7%
2. WT	18,534,880	18,310,476	98.8%
3. WT	18,264,239	18,021,675	98.7%
4. WT+Trp	19,048,752	18,715,890	98.3%
5. WT+Trp	17,865,622	17,635,022	98.7%
6. WT+Trp	17,557,389	16,990,440	96.8%
7. WT+IB	18,683,975	18,371,614	98.3%
8. WT+IB	17,800,152	17,515,351	98.4%
9. WT+IB	13,837,961	13,610,922	98.4%
10. WT+Trp+IB	14,772,542	14,532,935	98.4%
11. WT+Trp+IB	14,674,845	14,428,832	98.3%
12. WT+Trp+IB	13,843,855	13,631,284	98.5%
13. Sc12	13,602,232	13,407,182	98.6%
14. Sc12	13,505,045	13,350,107	98.9%
15. Sc12	8,618,503	8,506,648	98.7%
16. Sc12+Trp	9,197,535	9,073,303	98.6%
17. Sc12+Trp	15,935,132	15,720,327	98.7%
18. Sc12+Trp	15,186,545	14,986,752	98.7%
19. Sc12+IB	15,868,238	15,668,376	98.7%
20. Sc12+IB	14,699,642	14,516,412	98.8%
21. Sc12+IB	14,990,531	14,853,447	99.1%
22. Sc12+Trp+IB	14,345,141	14,122,303	98.4%
23. Sc12+Trp+IB	13,622,548	13,423,455	98.5%
24. Sc12+Trp+IB	14,857,726	14,644,703	98.6%

Abbreviation: Trp = Tryptophan, IB = Isobutanol

Supplemental Table 3, Gene names and numbers used in clustering analysis

1. Biosynthesis of amino acids (Figure 5a)

No.	Genes	Gene synonyms
1	YAL012W	*CYS3, CYI1, FUN35, STR1*
2	YAL038W	*CDC19, PYK1*
3	YBL068W	*PRS4*
4	YBR115C	*LYS2*
5	YBR117C	*TKL2*
6	YBR166C	*TYR1*
7	YBR218C	*PYC2*
8	YBR248C	*HIS7*
9	YBR249C	*ARO4*
10	YBR263W	*SHM1, SHMT1, TMP3*
11	YCL009C	*ILV6*
12	YCL030C	*HIS4*
13	YCL064C	*CHA1*
14	YCR005C	*CIT2*
15	YCR012W	*PGK1*
16	YCR053W	*THR4*
17	YDL021W	*GPM2*
18	YDL066W	*IDP1*
19	YDL131W	*LYS21*
20	YDL171C	*GLT1*
21	YDL182W	*LYS20*
22	YDR007W	*TRP1*
23	YDR035W	*ARO3*
24	YDR050C	*TPI1*
25	YDR111C	*ALT2*
26	YDR127W	*ARO1*
27	YDR158W	*HOM2, THR2*
28	YDR234W	*LYS4, LYS3*
29	YDR300C	*PRO1*
30	YDR354W	*TRP4*
31	YDR502C	*SAM2, ETH2*
32	YEL046C	*GLY1*
33	YER023W	*PRO3, ORE2*
34	YER052C	*HOM3, BOR1, SIL4, THR3*

35	YER055C	*HIS1*
36	YER069W	*ARG5,6*
37	YER081W	*SER3*
38	YER086W	*ILV1, ISO1*
39	YER090W	*TRP2*
40	YER091C	*MET6*
41	YER099C	*PRS2*
42	YFR025C	*HIS2*
43	YFR055W	*IRC7*
44	YGL009C	*LEU1*
45	YGL026C	*TRP5*
46	YGL062W	*PYC1*
47	YGL148W	*ARO2*
48	YGL184C	*STR3*
49	YGL202W	*ARO8*
50	YGR012W	*MCY1*
51	YGR043C	*NQM1*
52	YGR124W	*ASN2*
53	YGR155W	*CYS4, NHS5, STR4, VMA41*
54	YGR192C	*TDH3, GLD1, HSP35, HSP36, S*
55	YGR208W	*SER2*
56	YGR240C	*PFK1*
57	YGR254W	*ENO1, HSP48*
58	YHL011C	*PRS3*
59	YHR018C	*ARG4*
60	YHR025W	*THR1*
61	YHR033W	Uncharacterized
62	YHR174W	*ENO2*
63	YHR208W	*BAT1, ECA39, TWT1*
64	YIL020C	*HIS6*
65	YIL074C	*SER33*
66	YIL094C	*LYS12, LYS10, LYS11*
67	YIL116W	*HIS5*
68	YIR034C	*LYS1*
69	YJL052W	*TDH1, GLD3*
70	YJL071W	*ARG2, HRB574*
71	YJL088W	*ARG3*
72	YJL121C	*RPE1, EPI1, POS18*

73	YJL200C	*ACO2*
74	YJR009C	*TDH2, GLD2*
75	YJR016C	*ILV3*
76	YJR130C	*STR2*
77	YJR139C	*HOM6, THR6*
78	YJR148W	*BAT2, ECA40, TWT2*
79	YKL060C	*FBA1, LOT1*
80	YKL106W	*AAT1*
81	YKL152C	*GPM1*
82	YKL181W	*PRS1, PRP1*
83	YKL211C	*TRP3*
84	YLL058W	Putative cystathionine gamma-synthase
85	YLR027C	*AAT2, ASP5*
86	YLR058C	*SHM2, SHMT2*
87	YLR089C	*ALT1*
88	YLR174W	*IDP2*
89	YLR180W	*SAM1, ETH10*
90	YLR304C	*ACO1, GLU1*
91	YLR354C	*TAL1*
92	YLR355C	*ILV5*
93	YML082W	Putative carbon-sulfur lyase
94	YMR062C	*ARG7*
95	YMR108W	*ILV2, SMR1, THI1*
96	YMR205C	*PFK2*
97	YMR323W	*ERR3*
98	YNL009W	*IDP3*
99	YNL037C	*IDH1*
100	YNL104C	*LEU4*
101	YNL277W	*MET2*
102	YNL316C	*PHA2*
103	YNR001C	*CIT1, LYS6*
104	YNR050C	*LYS9, LYS13*
105	YOL056W	*GPM3*
106	YOL058W	*ARG1, ARG10*
107	YOL061W	*PRS5*
108	YOL140W	*ARG8*
109	YOR095C	*RKI1*
110	YOR108W	*LEU9*

111	YOR136W	*IDH2*
112	YOR184W	*SER1, ADE9*
113	YOR202W	*HIS3, HIS10, HIS8*
114	YOR323C	*PRO2*
115	YOR347C	*PYK2*
116	YPL111W	*CAR1, LPH15*
117	YPR001W	*CIT3*
118	YPR035W	*GLN1*
119	YPR060C	*ARO7, HGS1, OSM2, TYR7*
120	YPR074C	*TKL1*
121	YPR145W	*ASN1*

2. Amino acid transporters (Figure 5b)

No.	Genes	Gene Synonyms	Transport direction	Substrate(s)
1	YCL025C	*Agp1*	ext to cyt	Broad range (not Lys or Arg); Ile, Leu, Phe, Cys, Gln, Asn
2	YBR132C	*Agp2*	ext to cyt	Val, Ile, Leu, Phe, Thr
3	YFL055W	*Agp3*	ext to cyt	Val, Ile, Leu, Phe, Ser, Thr, Glu, Asp
4	YNL270C	*Alp1*	ext to cyt	Arg
5	YBR068C	*Bap2*	ext to cyt	Val, Ile, Leu, Ala, Phe, Tyr, Met, Cy
6	YDR046C	*Bap3*	ext to cyt	Val, Ile, Leu, Ala, Phe, Tyr, Trp, Met, Cys, Thr
7	YEL063C	*Can1*	ext to cyt	His, Lys, Arg, Orn
8	YPL265W	*Dip5*	ext to cyt	Ala, Gly, Ser, Gln, Asn, Glu, Asp
9	YKR039W	*Gap1*	ext to cyt	All natural aa, Cit, Orn, Leu
10	YDR508C	*Gnp1*	ext to cyt	Leu, Pro, Met, Cys, Ser, Thr, Gln, Asn
11	YGR191W	*Hip1*	ext to cyt	His
12	YLL061W	*Mmp1*	ext to cyt	S-Methylmethionine
13	YNL268W	*Lyp1*	ext to cyt	Met, Lys
14	YOR348C	*Put4*	ext to cyt	Ala, Gly, Pro
15	YPL274W	*Sam3*	ext to cyt	S-Adenosylmethionine
16	YBR069C	*Tat1*	ext to cyt	Val, Leu, Ile, Cys, Thr, Tyr, Trp, His
17	YOL020W	*Tat2*	ext to cyt	Ala, Gly, Cys, Phe, Tyr, Trp
18	YGR055W	*Mup1*	ext to cyt	Met, Cys
19	YHL036W	*Mup3*	ext to cyt	Met
20	YLL055W	*Yct1*	ext to cyt	Cys
21	YKR105C	*Vba5*	cyt to ext	Lys, Arg

22	YMR088C	*Vba1*	cyt to vac	His, Lys
23	YBR293W	*Vba2*	cyt to vac	His, Lys, Arg
24	YCL069W	*Vba3*	cyt to vac	His, Lys
25	YCL038C	*Atg22*	vact to cy	Ile, Leu, Tyr
26	YJR001W	*Avt1*	cyt to vac	Neutral aa, His
27	YKL146W	*Avt3*	vact to cy	Neutral aa
28	YNL101W	*Avt4*	vact to cy	Neutral aa, His, Lys, Arg
29	YER119C	*Avt6*	vact to cy	Glu, Asp
30	YIL088C	*Avt7*	vact to cy	Pro, Gln
31	YCR075C	*Ers1*	vact to cy	Cys
32	YOL092W	*Ypq1*	cyt to vac	Lys, Arg
33	YDR352W	*Ypq2*	cyt to vac	Arg
34	YBR147W	*Ypq3*	cyt to vac	His
35	YPR021C	*Agc1*	cyt ↔ mit	Glu, Asp
36	YDL119C	*Hem25*	cyt ↔ mit	Gly
37	YOR130C	*Ort1*	cyt ↔ mit	Lys, Arg, Orn
38	YNL003C	*Sam5*	cyt ↔ mit	S-Adenosylmethionine, S-adenosylhomocysteine
39	YDL210W	*Uga4*	ext to cyt or cyt to vac	γ -Aminobutyric acid
40	YNL065W	*Aqr1*	cyt to ext	Ala, Glu, Asp

Abbreviation: ext: extracellular; cyt: cytosol; vac: vacuolar lumen; mit: mitochondrial matrix; aa: amino acids. Reference: Microbiology and Molecular Biology Reviews 83.4 (2019): e00024-19.

3. Pentose phosphate pathway (Figure 5c)

No.	Genes	Gene Synonyms
1	YBL068W	PRS4
2	YBR117C	TKL2
3	YBR196C	PGI1, CDC30
4	YCR036W	RBK1
5	YCR073W-A	SOL2, YCRX13W
6	YDR248C	Putative gluconokinase
7	YER099C	PRS2
8	YGR043C	NQM1
9	YGR240C	PFK1
10	YGR248W	SOL4

11	YGR256W	GND2
12	YHL011C	PRS3
13	YHR163W	SOL3
14	YHR183W	GND1
15	YJL121C	RPE1, EPI1, POS18
16	YKL060C	FBA1, LOT1
17	YKL127W	PGM1
18	YKL181W	PRS1, PRP1
19	YLR354C	TAL1
20	YLR377C	FBP1, ACN8
21	YMR105C	PGM2, GAL5
22	YMR205C	PFK2
23	YMR278W	PRM15, PGM3
24	YNL241C	ZWF1, MET19, POS10
25	YNR034W	SOL1
26	YOL061W	PRS5
27	YOR095C	RKI1
28	YPR074C	TKL1

4. Tryptophan metabolism (Figure 5d)

No.	Genes	Gene Synonyms
1	YJR078W	*BNA2*
2	YDR428C	*BNA7*
3	YBL098W	*BNA4*
4	YLR231C	*BNA5*
5	YJR025C	*BNA1*
6	YDR148C	*KGD2*
7	YFL018C	*LPD1*
8	YPL028W	*ERG10*
9	YJL060W	*BNA3*
10	YOR374W	*ALD4*
11	YPL061W	*ALD6*
12	YER073W	*ALD5*
13	YMR110C	*HFD1*
14	YMR169C	*ALD3*
15	YMR170C	*ALD2*
16	YGL202W	*ARO8*
17	YIL164C	*NIT1*

18	YDR242W	*AMD2*
19	YDR256C	*CTA1*
20	YGR088W	*CTT1*

5. Nicotinate and nicotinamide metabolism (Figure 5e)

No.	Genes	Gene Synonyms
1	YFR047C	*BNA6*
2	YOR209C	*NPT1*
3	YLR209C	*PNP1*
4	YNL129W	*NRK1*
5	YOR155C	*ISN1*
6	YGL224C	*SDT1*
7	YDR400W	*URH1*
8	YLR328W	*NMA1*
9	YGR010W	*NMA2*
10	YCL047C	*POF1*
11	YGL067W	*NPY1*
12	YHR074W	*QNS1*
13	YGL037C	*PNC1*
14	YDL042C	*SIR2*
15	YOL068C	*HST1*
16	YPL015C	*HST2*
17	YDR191W	*HST4*
18	YOR025W	*HST3*
19	YJR049C	*UTR1*
20	YBR006W	*UGA2*

6. Vitamin B6 metabolism (Figure 5f)

No.	Genes	Gene Synonyms
1	YBR035C	*PDX3*
2	YCR053W	*THR4*
3	YEL029C	*BUD16*
4	YFL059W	*SNZ3*
5	YFL060C	*SNO3*
6	YGR017W	Uncharacterized protein
7	YMR095C	*SNO1*
8	YMR096W	*SNZ1*
9	YNL333W	*SNZ2*

10	YNL334C	*SNO2*
11	YNR027W	*BUD17*
12	YOR184W	*SER1, ADE9*
13	YPR127W	Putative pyridoxine 4-dehydrogenase

7. Thiamine metabolism: Vitamin B_1 (Figure 5g)

No.	Genes	Gene Synonyms
1	YAR071W	*PHO11*
2	YBR092C	*PHO3*
3	YBR093C	*PHO5*
4	YCL017C	*NFS1, SPL1*
5	YDL024C	*DIA3*
6	YDL244W	*THI13*
7	YDR226W	*ADK1, AKY1, AKY2*
8	YDR481C	*PHO8*
9	YER170W	*ADK2, AKY3, PAK3*
10	YFL058W	*THI5*
11	YGR144W	*THI4, ESP*
12	YHR215W	*PHO12, PHO10*
13	YJR156C	*THI11*
14	YNL332W	*THI12*
15	YOL055C	*THI20*
16	YOR143C	*THI80*
17	YPL214C	*THI6*
18	YPL258C	*THI21*
19	YPR073C	*LTP*

8. Fatty acid metabolism (Figure 5h)

No.	Genes	Gene Synonyms
1	YBR026C	*ETR1*
2	YBR159W	*IFA38*
3	YCR034W	*ELO2, FEN1, GNS1, VBM2*
4	YDL015C	*TSC13*
5	YER015W	*FAA2, FAM1*
6	YER061C	*CEM1*
7	YGL055W	*OLE1, MDM2*
8	YGL205W	*POX1, FOX1*
9	YHR067W	*HTD2, RMD12*

10	YIL009W	*FAA3*
11	YIL160C	*POT1, FOX3, POX3*
12	YJL097W	*PHS1*
13	YJL196C	*ELO1*
14	YKL055C	*OAR1*
15	YKL182W	*FAS1*
16	YLR372W	*ELO3, APA1, SRE1, SUR4, VBM1*
17	YMR207C	*HFA1*
18	YMR246W	*FAA4*
19	YNR016C	*ACC1,*
20	YOR221C	*MCT1*
21	YOR317W	*FAA1*
22	YPL028W	*ERG10, LPB3, TSM0115*
23	YPL231W	*FAS2*