

Supplementary Information

Indigo Production Identifies Hotspots in Cytochrome P450 BM3 for Diversifying Aromatic Hydroxylation

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Supplementary Figure 2. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of 3. The conjugation of phenolic products to 4-aminoantipyrine was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.39

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Supplementary Table 1. P450 BM3 variants that accept compounds 1, 2, 3, 4, 5, and 11 as substrates as reported in prior reports.

Compound										
1	2	3	4	5	11					
F87A/ H171L /A184I /Q307 H/N31 9Y/A3 28I ¹	Wt ²⁻⁶	Wt ⁷⁻¹⁰	Wt ¹¹	Wt ⁴	Wt ²	A74C ¹²	A74D ¹²	A74E ¹²	A74F ¹²	A74G ¹²
R47L/ Y51F/I 263A/ E267V /I401P 1	R47S/ Y51W/ I401M ⁴ , ¹³	T268E ⁹	A191T /N239 H/I259 V/A27 6T/L3 53I ¹¹	R47S/ Y51W/ I401M ⁴ , ¹³	A74I ¹²	A74L ¹²	A74M ¹ ₂	A74P ¹²	A74Q ¹²	A74S ¹²
R47L/ Y51F/ A184I/ A191T /N239 H/I259 V/A27 6T/A3 30P/L 353I ¹	R47L/ Y51F/I 401P ³ , ₆	R47L/ Y51F/I 401P ⁷	F87A/ A191T /N239 H/I259 V/A27 6T/L3 53I ¹¹		A74T ¹²	A74V ¹²	A74W ¹ ₂	L75A ¹²	L75C ¹²	L75F ¹²
R47L/ Y51F/ A191T /N239 H/I259 V/A27 6T/L3 53I ¹	R47L/ Y51F/ H171L /Q307 H/N31 9Y ⁶	R47S/ Y51W/ I401M ⁴	F87L/ A191T /N239 H/I259 V/A27 6T/L3 53I ¹¹		L75G ¹²	L75H ¹²	L75I ¹² ₂	L75M ¹ ₂	L75S ¹²	L75T ¹²
R47L/ Y51F/ A191T /N239 H/I259 V/A27 6T/L3 53I/I4 01P ¹	R47L/ Y51F/ A330P ^{2,3,6}	F87A/ A330P /E377 A/D42 5N ¹⁴			L75Y ¹²	I263A ¹ ₂	I263C ¹ ₂	I263D ¹ ₂	I263E ¹ ₂	I263G ¹ ₂
R47L/ Y51F/I 401P ¹	R47L/ Y51F/ A330P /I401P ₃	A191T /N239 H/I259 V/A27 6T/L3 53I ⁷			I263H ¹ ₂	I263N ¹ ₂	I263P ¹ ₂	I263Q ¹ ₂	I263S ¹ ₂	I263T ¹ ₂
	I401P ³	R47L/ Y51F/ H171L /Q307			I263T ¹ ₂	P329A ₁₂	A330C ₁₂	A330D ₁₂	A330E ₁₂	A330F ₁₂

		H/N31 9Y ^{7,10}								
	F87A/ A330P /E377 A/D42 5N ²				A330G 12	A330H 12	A330I ¹ 2	A330K 12	A330L 12	A330M 12
	A330P 2,3				A330N 12	A330P 2	A330P 12,14	A330Q 12	A330S ¹ 2	A330T 12
	A191T /N239 H/I259 V/A27 6T/L3 53I ^{2,5,6}				A330V 12	A330 W ¹²	A330Y 12	M354C 12	M354D 12	M354E 12
					M354F 12	M354G 12	M354H 12	M354I ¹ 2	M354L 12	M354Q 12
					L437A 12	L437C ¹ 2	L437F ¹ 2	L437G ¹ 2	L437I ¹ 2	L437M 12
					L437V ¹ 2	L437Y ¹ 2	R47L/ Y51F/ A330P 2	A74G/ F87V/ L188Q 2	F87A/ H171L /Q307 H/N31 9Y ²	F87A/ A330P /E377 A/D42 5N ²

Supplementary Table 2. Variants, mutations, and phenotypes in the panel of 80 P450 BM3 variants screened for aromatic hydroxylation activity.

Variant	Phenotype	Variant Identity
A1	Blue	R255G
A2	Blue	F81R
A3	Blue	A82E
A4	Blue	A82Q
A5	Blue	F87P
A6	Blue	A180F
A7	Blue	A180M
A9	Blue	A184K
A10	Blue	M212K
A11	Blue	M212W
A12	Blue	R255P
B1	Blue	L75H
B2	Blue	I263G
B3	Blue	I263Q
B4	Blue	A180E/A184F/M212K/I263S
B5	Blue	A82Q/M177P/L181F/T256H
B6	Blue	I259P
B7	Blue	M177H/I259K
B8	Blue	F87L/M177H/L181I/R255T/I259G/I263N
B9	Blue	F81R/A82F/F87L/L181F

B10	Blue	F81Y/E143D/A180M/M212K
B11	Blue	F173E/A180F/M212R/I263G
B12	Blue	F87L/L181P/I259P
C1	Blue	F87P/A180M/I263G
C2	Blue	F87G
C3	Blue	F87L/M177L/A184K/Y256V
C4	Blue	F87P/M212W/Y256H
C5	Blue	F87G/A184P/M212W/R255I/I263Q
C6	Blue	M177Q
C7	Blue	D80N/F87S/M212P/R256G
C9	Blue	A180E/R255D/Y256H
C11	Blue	L75F/R255D
C12	Blue	F87L/Y256K
D1	Blue	L181F
D2	Blue	F81R/F87L/M177L
D3	Blue	F87L/A180E/A184F/Y256K/I259K
D4	Blue	F173P/R255D
D5	Blue	D80C/F81Y/F173H/M177H/L181P/I259G
D6	Blue	F87L/M177L/L181I
D7	Blue	F87S/I259P
D9	Blue	R255G/I259G
D10	Blue	D80N/M212P
D11	Blue	A180F/L181F
D12	Blue	A82E/L181I/R255I
E1	Beige	L71H
E2	Beige	L71N
E3	Beige	L71Q
E4	Beige	L75P
E5	Beige	D80L
E6	Blue	D80C
E7	Beige	G83F
E8	Beige	G83K
E9	Beige	F173C
E10	Beige	A180D
E11	Beige	A180N
E12	Beige	L181N
F1	Beige	Y256M
F2	Beige	I258F
F3	Beige	L262P
F4	Beige	H266K
F5	Beige	F87P/F173H/I263Q
F6	Blue	F81Y/F173H/A180P
F7	Beige	F81R/F87G/L181I/I259P

F8	Blue	A82P/F173H/L181I/R255I/T256K/I263Q
F9	Beige	F81R/T88P/F173H/A180W/M212W/I259K/I263H
F10	Beige	L75R/M177P/A180E/A184K/Y256K/I263H
F11	Beige	D80P/F87L/F173E/A184E/I259G/I263H
F12	Beige	F173E/M177L/L181I/M212R/Y256V/I263S
G1	Blue	D80P/A82F/F87P/L181F
G2	Beige	F81R/F173P/M177H/A180F/I259P
G3	Beige	L75R/I259G
G4	Beige	D80C/F173P/A180F/M212K/R255P
G5	Blue	F81Y/A82S/M212R/I263G
G6	Beige	D80P/F81L/I263N
G7	Blue	F87L/M177L/R255G/I263N
G8	Blue	P172H/Y256K/I263G
G9	Blue	M177H/I263S
G10	Blue	R255M/Y256H
G11	Blue	A82F
G12	Blue	A82F/L181F
H1	Beige	D80N/F81Y/F173P/R255G/Y256H
H2	Beige	F173E/M177H/M212R/I263S
H3	Beige	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V
H4	Beige	F87P/S164-STOP/R255P/I263G
H5	Beige	F81R/A82L/F173H/R255P
H6	Beige	M177L/A184F/M212P/Y256V/I259G
H7	Beige	F173P/I259G
H8	Blue	I259G
H9	Beige	A180M/I259G
H10	Blue	M212K/I259G
H12	Blue	D80C/M177H/A180F/R255M

Supplementary Table 3. Indigo (+) variants reported in the literature.

V78A ¹⁵	V78G ¹⁵	V78S ¹⁵	A82E ¹⁵
A82F ¹⁵⁻¹⁹	A82G ¹⁵	A82I ¹⁷	A82K ¹⁵
A82L ¹⁵	A82Q ¹⁵	A82W ^{15, 17, 18}	F87A ^{20, 21}
F87G ^{21, 22}	F87L ¹⁵	F87N ¹⁵	F87P ¹⁵
F87V ^{15, 23, 24}	F162I ²⁵	L188Q ²⁴	A264G ¹⁵
A264V ¹⁵	V78A/F87A ²¹	V78A/F87G ²¹	F87A/T268A ²¹
F87A/T268I ²¹	F87A/T268V ²¹	F87G/T268A ²¹	F87G/T268I ²¹
F87G/T268V ²¹	F87G/T268V ²¹	F87V/L188Q ²⁴	L148I/F162I ²⁵
F162I/E228K ²⁵	F162I/H236R ²⁵	F162I/K187E ²⁵	F162I/M237I ²⁵
A180F/L181V ^{16, 19}	A180I/L181F ^{16, 19}	A180I/L181Y ¹⁶	A180R/L181H ^{16, 19}
A180Y/L181F ¹⁹	A184I/L188Y ¹⁹	A184N/L188F ^{16, 19}	A184N/L188H ^{16, 19}
A184N/L188N ^{16, 19}	A184N/L188S ^{16, 19}	A184N/L188Y ^{16, 19}	A328C/A330V ¹⁹
A328F/A330F ¹⁹	A328L/A330I ¹⁹	A399F/Q403F ²⁶	A74G/F87V/L188Q ^{24, 27, 28}
F162I/K187E/M237I ²⁵	F162I/M185V/M237I ²⁵	A74G/F87V/D168H/L188Q ²⁸	A74G/F87V/L188Q/A225F ²⁸

A74G/F87V/L188Q/A2 25G ²⁸	A74G/F87V/L188Q/A2 25P ²⁸	A74G/F87V/L188Q/A2 25Q ²⁸	A74G/F87V/L188Q/E43 5D ²⁸
A74G/F87V/L188Q/E43 5T ²⁸	A74G/F87V/L188Q/K4 34R ²⁸	A74G/F87V/L188Q/V4 45A ²⁷	A74G/F87V/L188Q/V4 45G ²⁷
A74G/F87V/L188Q/V4 45M ²⁷	A74G/F87V/L188Q/V4 45S ²⁷	A74G/F87V/L188Q/V4 45T ²⁷	F162I/M185T/L188P/ M237I ²⁵
A74G/F87V/D168N/L1 88Q/A225V/K440N ²⁸			

Supplementary Table 4. Raw 4-AAP and NADPH rate assays data.

Variant	Phenotype	Enzyme concentration (μM)	N	Substrate	4-AAP Abs (a.u)	NADPH rate ($\mu\text{M}/\text{min}$)
WT	Beige	0.79	6	1	0.00	0.024
WT	Beige	0.79	6	2	0.00	0.019
WT	Beige	0.79	6	3	0.00	0.031
WT	Beige	0.79	6	4	0.00	0.047
WT	Beige	0.79	6	5	0.00	0.029
WT	Beige	0.79	6	6	0.00	0.071
WT	Beige	0.79	6	7	0.05	0.086
WT	Beige	0.79	6	8	0.00	0.081
WT	Beige	0.79	6	9	0.00	0.035
WT	Beige	0.79	6	10	0.00	0.060
WT	Beige	0.79	6	11	0.00	0.073
WT	Beige	0.79	6	12	0.41	0.043
His-A82Q	Blue	0.94	2	1	0.13	0.021
His-A82Q	Blue	0.94	2	2	0.01	0.026
His-A82Q	Blue	0.94	2	3	0.04	0.021
His-A82Q	Blue	0.94	2	4	0.05	0.008
His-A82Q	Blue	0.94	2	5	0.04	0.029
His-A82Q	Blue	0.94	2	6	0.02	0.030
His-A82Q	Blue	0.94	2	7	0.20	0.036
His-A82Q	Blue	0.94	2	8	0.04	0.039
His-A82Q	Blue	0.94	2	9	0.11	0.028
His-A82Q	Blue	0.94	2	10	0.09	0.052
His-A82Q	Blue	0.94	2	11	0.17	0.017
His-A82Q	Blue	0.94	2	12	0.17	0.032
A1	Blue	4.43	2	1	0.30	0.013
A1	Blue	4.43	2	2	0.36	0.024
A1	Blue	4.43	2	3	0.13	0.059
A1	Blue	4.43	2	4	0.28	0.068
A1	Blue	4.43	2	5	0.15	0.016
A1	Blue	4.43	2	6	0.27	0.047
A1	Blue	4.43	2	7	0.04	0.039
A1	Blue	4.43	2	8	0.06	0.078
A1	Blue	4.43	2	9	0.03	0.028
A1	Blue	4.43	2	10	0.10	0.034
A1	Blue	4.43	2	11	0.68	0.062
A1	Blue	4.43	2	12	0.06	0.044
A2	Blue	4.48	2	1	0.07	0.012
A2	Blue	4.48	2	2	0.08	0.018
A2	Blue	4.48	2	3	0.13	0.024
A2	Blue	4.48	2	4	0.04	0.021
A2	Blue	4.48	2	5	0.22	0.023
A2	Blue	4.48	2	6	0.07	0.046
A2	Blue	4.48	2	7	0.25	0.023
A2	Blue	4.48	2	8	0.13	0.065
A2	Blue	4.48	2	9	0.04	0.041
A2	Blue	4.48	2	10	0.01	0.064
A2	Blue	4.48	2	11	0.06	0.066
A2	Blue	4.48	2	12	0.13	0.042
A3	Blue	4.55	2	1	0.14	0.040
A3	Blue	4.55	2	2	0.23	0.032
A3	Blue	4.55	2	3	0.12	0.052

A3	Blue	4.55	2	4	0.15	0.064
A3	Blue	4.55	2	5	0.23	0.044
A3	Blue	4.55	2	6	0.14	0.064
A3	Blue	4.55	2	7	0.28	0.057
A3	Blue	4.55	2	8	0.09	0.063
A3	Blue	4.55	2	9	0.07	0.051
A3	Blue	4.55	2	10	0.03	0.061
A3	Blue	4.55	2	11	0.09	0.081
A3	Blue	4.55	2	12	0.48	0.040
A4	Blue	4.99	2	1	0.23	0.045
A4	Blue	4.99	2	2	0.27	0.021
A4	Blue	4.99	2	3	0.17	0.047
A4	Blue	4.99	2	4	0.06	0.056
A4	Blue	4.99	2	5	0.16	0.016
A4	Blue	4.99	2	6	0.07	0.062
A4	Blue	4.99	2	7	0.28	0.034
A4	Blue	4.99	2	8	0.10	0.036
A4	Blue	4.99	2	9	0.08	0.025
A4	Blue	4.99	2	10	0.07	0.053
A4	Blue	4.99	2	11	0.18	0.065
A4	Blue	4.99	2	12	0.61	0.044
A5	Blue	1.11	2	1	0.31	0.006
A5	Blue	1.11	2	2	0.81	0.058
A5	Blue	1.11	2	3	0.46	0.093
A5	Blue	1.11	2	4	0.41	0.077
A5	Blue	1.11	2	5	0.50	0.063
A5	Blue	1.11	2	6	0.37	0.094
A5	Blue	1.11	2	7	0.51	0.097
A5	Blue	1.11	2	8	0.31	0.093
A5	Blue	1.11	2	9	0.37	0.060
A5	Blue	1.11	2	10	0.40	0.059
A5	Blue	1.11	2	11	0.38	0.075
A5	Blue	1.11	2	12	0.90	0.059
A6	Blue	-0.47	2	1	0.00	0.059
A6	Blue	-0.47	2	2	0.00	0.064
A6	Blue	-0.47	2	3	0.00	0.071
A6	Blue	-0.47	2	4	0.00	0.054
A6	Blue	-0.47	2	5	0.00	0.067
A6	Blue	-0.47	2	6	0.00	0.069
A6	Blue	-0.47	2	7	0.00	0.076
A6	Blue	-0.47	2	8	0.00	0.071
A6	Blue	-0.47	2	9	0.00	0.058
A6	Blue	-0.47	2	10	0.00	0.103
A6	Blue	-0.47	2	11	0.00	0.076
A6	Blue	-0.47	2	12	0.00	0.082
A7	Blue	0.78	2	1	0.00	0.032
A7	Blue	0.78	2	2	0.06	0.032
A7	Blue	0.78	2	3	0.06	0.040
A7	Blue	0.78	2	4	0.00	0.045
A7	Blue	0.78	2	5	0.05	0.044
A7	Blue	0.78	2	6	0.00	0.037
A7	Blue	0.78	2	7	0.07	0.029
A7	Blue	0.78	2	8	0.03	0.038

A7	Blue	0.78	2	9	0.00	0.051
A7	Blue	0.78	2	10	0.00	0.031
A7	Blue	0.78	2	11	0.00	0.056
A7	Blue	0.78	2	12	0.22	0.044
A9	Blue	2.92	2	1	0.09	0.083
A9	Blue	2.92	2	2	0.54	0.044
A9	Blue	2.92	2	3	0.25	0.092
A9	Blue	2.92	2	4	0.24	0.088
A9	Blue	2.92	2	5	0.40	0.075
A9	Blue	2.92	2	6	0.21	0.156
A9	Blue	2.92	2	7	0.29	0.098
A9	Blue	2.92	2	8	0.13	0.118
A9	Blue	2.92	2	9	0.14	0.071
A9	Blue	2.92	2	10	0.15	0.101
A9	Blue	2.92	2	11	0.09	0.107
A9	Blue	2.92	2	12	0.82	0.129
A10	Blue	-0.20	2	1	0.06	0.021
A10	Blue	-0.20	2	2	0.05	0.029
A10	Blue	-0.20	2	3	0.15	0.044
A10	Blue	-0.20	2	4	0.08	0.021
A10	Blue	-0.20	2	5	0.04	0.034
A10	Blue	-0.20	2	6	0.03	0.045
A10	Blue	-0.20	2	7	0.13	0.066
A10	Blue	-0.20	2	8	0.07	0.037
A10	Blue	-0.20	2	9	0.05	0.022
A10	Blue	-0.20	2	10	0.09	0.053
A10	Blue	-0.20	2	11	0.17	0.040
A10	Blue	-0.20	2	12	0.28	0.037
A11	Blue	0.49	2	1	0.15	0.010
A11	Blue	0.49	2	2	0.23	0.015
A11	Blue	0.49	2	3	0.21	0.027
A11	Blue	0.49	2	4	0.20	0.016
A11	Blue	0.49	2	5	0.25	0.015
A11	Blue	0.49	2	6	0.22	0.031
A11	Blue	0.49	2	7	0.34	0.044
A11	Blue	0.49	2	8	0.18	0.022
A11	Blue	0.49	2	9	0.14	0.006
A11	Blue	0.49	2	10	0.16	0.042
A11	Blue	0.49	2	11	0.14	0.022
A11	Blue	0.49	2	12	0.42	0.028
A12	Blue	0.43	2	1	0.00	0.054
A12	Blue	0.43	2	2	0.50	0.063
A12	Blue	0.43	2	3	0.07	0.049
A12	Blue	0.43	2	4	0.00	0.053
A12	Blue	0.43	2	5	0.11	0.117
A12	Blue	0.43	2	6	0.00	0.048
A12	Blue	0.43	2	7	0.00	0.054
A12	Blue	0.43	2	8	0.00	0.047
A12	Blue	0.43	2	9	0.00	0.053
A12	Blue	0.43	2	10	0.00	-0.006
A12	Blue	0.43	2	11	0.02	0.068
A12	Blue	0.43	2	12	0.51	0.082
B1	Blue	1.32	2	1	0.17	-0.003

B1	Blue	1.32	2	2	0.01	0.018
B1	Blue	1.32	2	3	0.00	0.039
B1	Blue	1.32	2	4	0.12	0.028
B1	Blue	1.32	2	5	0.00	0.026
B1	Blue	1.32	2	6	0.17	0.062
B1	Blue	1.32	2	7	0.04	0.053
B1	Blue	1.32	2	8	0.03	0.051
B1	Blue	1.32	2	9	0.05	0.020
B1	Blue	1.32	2	10	0.08	0.060
B1	Blue	1.32	2	11	0.95	0.049
B1	Blue	1.32	2	12	0.08	0.078
B2	Blue	1.01	2	1	0.02	0.068
B2	Blue	1.01	2	2	0.48	0.096
B2	Blue	1.01	2	3	0.13	0.091
B2	Blue	1.01	2	4	0.12	0.085
B2	Blue	1.01	2	5	0.22	0.096
B2	Blue	1.01	2	6	0.09	0.089
B2	Blue	1.01	2	7	0.22	0.110
B2	Blue	1.01	2	8	0.07	0.110
B2	Blue	1.01	2	9	0.03	0.106
B2	Blue	1.01	2	10	0.01	0.110
B2	Blue	1.01	2	11	0.00	0.111
B2	Blue	1.01	2	12	0.36	0.097
B3	Blue	7.01	2	1	0.03	0.067
B3	Blue	7.01	2	2	0.24	0.048
B3	Blue	7.01	2	3	0.02	0.038
B3	Blue	7.01	2	4	0.00	0.030
B3	Blue	7.01	2	5	0.05	0.033
B3	Blue	7.01	2	6	0.00	0.031
B3	Blue	7.01	2	7	0.19	0.042
B3	Blue	7.01	2	8	0.03	0.033
B3	Blue	7.01	2	9	0.02	0.050
B3	Blue	7.01	2	10	0.04	0.054
B3	Blue	7.01	2	11	0.06	0.060
B3	Blue	7.01	2	12	0.39	0.047
B4	Blue	3.52	2	1	0.00	0.016
B4	Blue	3.52	2	2	0.00	0.017
B4	Blue	3.52	2	3	0.00	0.038
B4	Blue	3.52	2	4	0.00	0.030
B4	Blue	3.52	2	5	0.00	0.031
B4	Blue	3.52	2	6	0.00	0.048
B4	Blue	3.52	2	7	0.15	0.042
B4	Blue	3.52	2	8	0.00	0.054
B4	Blue	3.52	2	9	0.00	0.043
B4	Blue	3.52	2	10	0.00	0.085
B4	Blue	3.52	2	11	0.00	0.047
B4	Blue	3.52	2	12	0.00	0.035
B5	Blue	-0.66	2	1	0.18	0.013
B5	Blue	-0.66	2	2	0.13	0.007
B5	Blue	-0.66	2	3	0.15	0.033
B5	Blue	-0.66	2	4	0.13	0.027
B5	Blue	-0.66	2	5	0.18	0.037
B5	Blue	-0.66	2	6	0.21	0.038

B5	Blue	-0.66	2	7	0.34	0.090
B5	Blue	-0.66	2	8	0.25	0.032
B5	Blue	-0.66	2	9	0.23	0.017
B5	Blue	-0.66	2	10	0.27	0.046
B5	Blue	-0.66	2	11	0.27	0.026
B5	Blue	-0.66	2	12	0.24	0.010
B6	Blue	1.59	4	1	0.11	0.071
B6	Blue	1.59	4	2	0.26	0.054
B6	Blue	1.59	4	3	0.10	0.043
B6	Blue	1.59	4	4	0.01	0.040
B6	Blue	1.59	4	5	0.06	0.073
B6	Blue	1.59	4	6	0.18	0.042
B6	Blue	1.59	4	7	0.20	0.065
B6	Blue	1.59	4	8	0.07	0.055
B6	Blue	1.59	4	9	0.06	0.072
B6	Blue	1.59	4	10	0.06	0.067
B6	Blue	1.59	4	11	0.12	0.035
B6	Blue	1.59	4	12	0.35	0.041
B7	Blue	0.47	2	1	0.00	0.001
B7	Blue	0.47	2	2	0.00	0.003
B7	Blue	0.47	2	3	0.00	0.002
B7	Blue	0.47	2	4	0.00	-0.001
B7	Blue	0.47	2	5	0.00	0.002
B7	Blue	0.47	2	6	0.00	0.003
B7	Blue	0.47	2	7	0.03	0.002
B7	Blue	0.47	2	8	0.00	0.001
B7	Blue	0.47	2	9	0.00	0.002
B7	Blue	0.47	2	10	0.00	0.008
B7	Blue	0.47	2	11	0.00	0.002
B7	Blue	0.47	2	12	0.00	0.005
B8	Blue	0.95	2	1	0.27	0.078
B8	Blue	0.95	2	2	0.70	0.048
B8	Blue	0.95	2	3	0.41	0.042
B8	Blue	0.95	2	4	0.27	0.023
B8	Blue	0.95	2	5	0.44	0.048
B8	Blue	0.95	2	6	0.26	0.033
B8	Blue	0.95	2	7	0.38	0.054
B8	Blue	0.95	2	8	0.22	0.030
B8	Blue	0.95	2	9	0.20	0.068
B8	Blue	0.95	2	10	0.24	0.064
B8	Blue	0.95	2	11	0.20	0.057
B8	Blue	0.95	2	12	0.62	0.047
B9	Blue	0.33	2	1	0.00	0.042
B9	Blue	0.33	2	2	0.00	0.044
B9	Blue	0.33	2	3	0.00	0.047
B9	Blue	0.33	2	4	0.00	0.043
B9	Blue	0.33	2	5	0.00	0.051
B9	Blue	0.33	2	6	0.00	0.044
B9	Blue	0.33	2	7	0.00	0.034
B9	Blue	0.33	2	8	0.00	0.058
B9	Blue	0.33	2	9	0.00	0.052
B9	Blue	0.33	2	10	0.00	0.024
B9	Blue	0.33	2	11	0.03	0.036

B9	Blue	0.33	2	12	0.02	0.055
B10	Blue	0.92	2	1	0.22	0.033
B10	Blue	0.92	2	2	0.30	0.033
B10	Blue	0.92	2	3	0.31	0.039
B10	Blue	0.92	2	4	0.65	0.035
B10	Blue	0.92	2	5	0.26	0.027
B10	Blue	0.92	2	6	0.21	0.028
B10	Blue	0.92	2	7	0.36	0.040
B10	Blue	0.92	2	8	0.19	0.031
B10	Blue	0.92	2	9	0.21	0.031
B10	Blue	0.92	2	10	0.20	0.018
B10	Blue	0.92	2	11	0.18	0.035
B10	Blue	0.92	2	12	0.22	0.024
B11	Blue	2.92	2	1	0.23	0.012
B11	Blue	2.92	2	2	0.24	0.018
B11	Blue	2.92	2	3	0.21	0.006
B11	Blue	2.92	2	4	0.18	0.004
B11	Blue	2.92	2	5	0.25	0.026
B11	Blue	2.92	2	6	0.12	0.023
B11	Blue	2.92	2	7	0.31	0.022
B11	Blue	2.92	2	8	0.16	0.049
B11	Blue	2.92	2	9	0.18	0.008
B11	Blue	2.92	2	10	0.19	0.051
B11	Blue	2.92	2	11	0.29	0.058
B11	Blue	2.92	2	12	0.78	0.020
B12	Blue	0.41	4	1	0.04	0.045
B12	Blue	0.41	4	2	0.19	0.047
B12	Blue	0.41	4	3	0.13	0.057
B12	Blue	0.41	4	4	0.10	0.052
B12	Blue	0.41	4	5	0.33	0.052
B12	Blue	0.41	4	6	0.14	0.060
B12	Blue	0.41	4	7	0.18	0.042
B12	Blue	0.41	4	8	0.13	0.049
B12	Blue	0.41	4	9	0.14	0.044
B12	Blue	0.41	4	10	0.15	0.034
B12	Blue	0.41	4	11	0.18	0.041
B12	Blue	0.41	4	12	0.22	0.040
C1	Blue	1.34	2	1	0.00	0.050
C1	Blue	1.34	2	2	0.84	0.070
C1	Blue	1.34	2	3	0.38	0.104
C1	Blue	1.34	2	4	0.28	0.075
C1	Blue	1.34	2	5	0.61	0.086
C1	Blue	1.34	2	6	0.24	0.083
C1	Blue	1.34	2	7	0.34	0.050
C1	Blue	1.34	2	8	0.19	0.100
C1	Blue	1.34	2	9	0.25	0.038
C1	Blue	1.34	2	10	0.15	0.118
C1	Blue	1.34	2	11	0.20	0.072
C1	Blue	1.34	2	12	0.93	0.109
C2	Blue	2.81	2	1	0.09	0.042
C2	Blue	2.81	2	2	0.14	0.049
C2	Blue	2.81	2	3	0.27	0.067
C2	Blue	2.81	2	4	0.10	0.050

C2	Blue	2.81	2	5	0.11	0.070
C2	Blue	2.81	2	6	0.10	0.128
C2	Blue	2.81	2	7	0.33	0.070
C2	Blue	2.81	2	8	0.19	0.089
C2	Blue	2.81	2	9	0.14	0.074
C2	Blue	2.81	2	10	0.13	0.062
C2	Blue	2.81	2	11	0.12	0.091
C2	Blue	2.81	2	12	0.14	0.074
C3	Blue	0.11	2	1	0.21	0.010
C3	Blue	0.11	2	2	0.26	0.018
C3	Blue	0.11	2	3	0.24	0.030
C3	Blue	0.11	2	4	0.20	0.023
C3	Blue	0.11	2	5	0.14	0.030
C3	Blue	0.11	2	6	0.14	0.007
C3	Blue	0.11	2	7	0.24	0.016
C3	Blue	0.11	2	8	0.14	0.026
C3	Blue	0.11	2	9	0.20	0.024
C3	Blue	0.11	2	10	0.16	0.018
C3	Blue	0.11	2	11	0.90	0.027
C3	Blue	0.11	2	12	0.24	0.028
C4	Blue	1.38	2	1	0.08	0.066
C4	Blue	1.38	2	2	0.17	0.052
C4	Blue	1.38	2	3	0.19	0.038
C4	Blue	1.38	2	4	0.10	0.058
C4	Blue	1.38	2	5	0.02	0.045
C4	Blue	1.38	2	6	0.02	0.040
C4	Blue	1.38	2	7	0.24	0.054
C4	Blue	1.38	2	8	0.08	0.041
C4	Blue	1.38	2	9	0.07	0.025
C4	Blue	1.38	2	10	0.09	0.056
C4	Blue	1.38	2	11	0.13	0.117
C4	Blue	1.38	2	12	0.10	0.076
C5	Blue	0.69	2	1	0.04	0.045
C5	Blue	0.69	2	2	0.10	0.035
C5	Blue	0.69	2	3	0.08	0.049
C5	Blue	0.69	2	4	0.02	0.024
C5	Blue	0.69	2	5	0.10	0.022
C5	Blue	0.69	2	6	0.12	0.018
C5	Blue	0.69	2	7	0.26	0.045
C5	Blue	0.69	2	8	0.08	0.026
C5	Blue	0.69	2	9	0.08	0.035
C5	Blue	0.69	2	10	0.10	0.010
C5	Blue	0.69	2	11	0.11	0.035
C5	Blue	0.69	2	12	0.07	0.036
C6	Blue	7.01	2	1	0.06	0.052
C6	Blue	7.01	2	2	0.06	0.029
C6	Blue	7.01	2	3	0.00	0.046
C6	Blue	7.01	2	4	0.00	0.058
C6	Blue	7.01	2	5	0.00	0.027
C6	Blue	7.01	2	6	0.00	0.091
C6	Blue	7.01	2	7	0.21	0.043
C6	Blue	7.01	2	8	0.04	0.043
C6	Blue	7.01	2	9	0.03	0.093

C6	Blue	7.01	2	10	0.04	0.058
C6	Blue	7.01	2	11	0.05	0.070
C6	Blue	7.01	2	12	0.09	0.073
C7	Blue	0.30	2	1	0.14	0.021
C7	Blue	0.30	2	2	0.14	0.043
C7	Blue	0.30	2	3	0.06	0.027
C7	Blue	0.30	2	4	0.03	0.038
C7	Blue	0.30	2	5	0.03	0.030
C7	Blue	0.30	2	6	0.02	0.031
C7	Blue	0.30	2	7	0.15	0.017
C7	Blue	0.30	2	8	0.12	0.028
C7	Blue	0.30	2	9	0.09	0.017
C7	Blue	0.30	2	10	0.14	0.026
C7	Blue	0.30	2	11	0.15	0.015
C7	Blue	0.30	2	12	0.24	0.038
C9	Blue	-0.01	2	1	0.10	0.047
C9	Blue	-0.01	2	2	0.27	0.052
C9	Blue	-0.01	2	3	0.15	0.056
C9	Blue	-0.01	2	4	0.02	0.063
C9	Blue	-0.01	2	5	0.03	0.050
C9	Blue	-0.01	2	6	0.00	0.053
C9	Blue	-0.01	2	7	0.14	0.046
C9	Blue	-0.01	2	8	0.07	0.048
C9	Blue	-0.01	2	9	0.01	0.041
C9	Blue	-0.01	2	10	0.17	0.048
C9	Blue	-0.01	2	11	0.02	0.056
C9	Blue	-0.01	2	12	0.14	0.047
C11	Blue	-0.16	2	1	0.04	0.036
C11	Blue	-0.16	2	2	0.05	0.042
C11	Blue	-0.16	2	3	0.05	0.041
C11	Blue	-0.16	2	4	0.04	0.036
C11	Blue	-0.16	2	5	0.04	0.036
C11	Blue	-0.16	2	6	0.00	0.026
C11	Blue	-0.16	2	7	0.10	0.030
C11	Blue	-0.16	2	8	0.00	0.030
C11	Blue	-0.16	2	9	0.00	0.034
C11	Blue	-0.16	2	10	0.00	0.028
C11	Blue	-0.16	2	11	0.00	0.054
C11	Blue	-0.16	2	12	0.01	0.048
C12	Blue	0.48	4	1	0.08	0.013
C12	Blue	0.48	4	2	0.02	0.014
C12	Blue	0.48	4	3	0.11	0.021
C12	Blue	0.48	4	4	0.10	0.024
C12	Blue	0.48	4	5	0.03	0.029
C12	Blue	0.48	4	6	0.06	0.035
C12	Blue	0.48	4	7	0.18	0.042
C12	Blue	0.48	4	8	0.07	0.019
C12	Blue	0.48	4	9	0.10	0.013
C12	Blue	0.48	4	10	0.08	0.015
C12	Blue	0.48	4	11	0.10	0.018
C12	Blue	0.48	4	12	0.15	0.026
D1	Blue	-0.65	2	1	0.00	0.014
D1	Blue	-0.65	2	2	0.17	0.026

D1	Blue	-0.65	2	3	0.00	0.046
D1	Blue	-0.65	2	4	0.00	0.027
D1	Blue	-0.65	2	5	0.01	0.068
D1	Blue	-0.65	2	6	0.00	0.051
D1	Blue	-0.65	2	7	0.16	0.040
D1	Blue	-0.65	2	8	0.06	0.059
D1	Blue	-0.65	2	9	0.07	0.033
D1	Blue	-0.65	2	10	0.08	-0.015
D1	Blue	-0.65	2	11	0.06	0.032
D1	Blue	-0.65	2	12	0.29	0.043
D2	Blue	0.22	2	1	0.00	0.046
D2	Blue	0.22	2	2	0.00	0.040
D2	Blue	0.22	2	3	0.00	0.042
D2	Blue	0.22	2	4	0.00	0.039
D2	Blue	0.22	2	5	0.00	0.048
D2	Blue	0.22	2	6	0.00	0.067
D2	Blue	0.22	2	7	0.00	0.073
D2	Blue	0.22	2	8	0.00	0.072
D2	Blue	0.22	2	9	0.00	0.048
D2	Blue	0.22	2	10	0.14	0.062
D2	Blue	0.22	2	11	0.00	0.027
D2	Blue	0.22	2	12	0.00	0.039
D3	Blue	0.02	2	1	0.25	0.052
D3	Blue	0.02	2	2	0.24	0.046
D3	Blue	0.02	2	3	0.23	0.057
D3	Blue	0.02	2	4	0.26	0.053
D3	Blue	0.02	2	5	0.20	0.064
D3	Blue	0.02	2	6	0.20	0.067
D3	Blue	0.02	2	7	0.35	0.062
D3	Blue	0.02	2	8	0.23	0.067
D3	Blue	0.02	2	9	0.23	0.052
D3	Blue	0.02	2	10	0.25	0.050
D3	Blue	0.02	2	11	0.24	0.053
D3	Blue	0.02	2	12	0.31	0.066
D4	Blue	0.07	2	1	0.05	0.029
D4	Blue	0.07	2	2	0.10	0.035
D4	Blue	0.07	2	3	0.09	0.037
D4	Blue	0.07	2	4	0.14	0.046
D4	Blue	0.07	2	5	0.17	0.034
D4	Blue	0.07	2	6	0.00	0.052
D4	Blue	0.07	2	7	0.15	0.029
D4	Blue	0.07	2	8	0.06	0.037
D4	Blue	0.07	2	9	0.04	0.043
D4	Blue	0.07	2	10	0.06	0.031
D4	Blue	0.07	2	11	0.06	0.053
D4	Blue	0.07	2	12	0.24	0.034
D5	Blue	0.43	2	1	0.15	0.016
D5	Blue	0.43	2	2	0.11	0.008
D5	Blue	0.43	2	3	0.13	0.035
D5	Blue	0.43	2	4	0.14	0.021
D5	Blue	0.43	2	5	0.16	0.024
D5	Blue	0.43	2	6	0.15	0.056
D5	Blue	0.43	2	7	0.32	0.101

D5	Blue	0.43	2	8	0.17	0.058
D5	Blue	0.43	2	9	0.17	0.034
D5	Blue	0.43	2	10	0.20	0.019
D5	Blue	0.43	2	11	0.22	0.008
D5	Blue	0.43	2	12	0.16	0.021
D6	Blue	0.49	2	1	0.15	0.061
D6	Blue	0.49	2	2	0.13	0.055
D6	Blue	0.49	2	3	0.12	0.077
D6	Blue	0.49	2	4	0.08	0.074
D6	Blue	0.49	2	5	0.20	0.087
D6	Blue	0.49	2	6	0.07	0.118
D6	Blue	0.49	2	7	0.28	0.119
D6	Blue	0.49	2	8	0.12	0.080
D6	Blue	0.49	2	9	0.15	0.083
D6	Blue	0.49	2	10	0.13	0.084
D6	Blue	0.49	2	11	0.16	0.078
D6	Blue	0.49	2	12	0.20	0.094
D7	Blue	0.05	2	1	0.32	0.055
D7	Blue	0.05	2	2	0.61	0.045
D7	Blue	0.05	2	3	0.32	0.063
D7	Blue	0.05	2	4	0.23	0.052
D7	Blue	0.05	2	5	0.29	0.041
D7	Blue	0.05	2	6	0.21	0.050
D7	Blue	0.05	2	7	0.36	0.067
D7	Blue	0.05	2	8	0.28	0.039
D7	Blue	0.05	2	9	0.29	0.034
D7	Blue	0.05	2	10	0.26	0.042
D7	Blue	0.05	2	11	0.26	0.071
D7	Blue	0.05	2	12	0.32	0.045
D9	Blue	0.29	2	1	0.22	0.009
D9	Blue	0.29	2	2	0.12	0.003
D9	Blue	0.29	2	3	0.08	0.029
D9	Blue	0.29	2	4	0.08	0.010
D9	Blue	0.29	2	5	0.04	-0.005
D9	Blue	0.29	2	6	0.23	0.024
D9	Blue	0.29	2	7	0.09	0.013
D9	Blue	0.29	2	8	0.11	0.005
D9	Blue	0.29	2	9	0.25	-0.012
D9	Blue	0.29	2	10	0.17	0.021
D9	Blue	0.29	2	11	0.34	0.001
D9	Blue	0.29	2	12	0.11	0.033
D10	Blue	-0.14	2	1	0.03	-0.006
D10	Blue	-0.14	2	2	0.01	0.023
D10	Blue	-0.14	2	3	0.00	0.030
D10	Blue	-0.14	2	4	0.03	0.012
D10	Blue	-0.14	2	5	0.00	0.046
D10	Blue	-0.14	2	6	0.00	0.073
D10	Blue	-0.14	2	7	0.13	0.109
D10	Blue	-0.14	2	8	0.00	0.062
D10	Blue	-0.14	2	9	0.02	0.032
D10	Blue	-0.14	2	10	0.04	0.119
D10	Blue	-0.14	2	11	0.04	0.028
D10	Blue	-0.14	2	12	0.07	0.050

D11	Blue	0.14	2	1	0.00	0.017
D11	Blue	0.14	2	2	0.00	0.023
D11	Blue	0.14	2	3	0.00	0.030
D11	Blue	0.14	2	4	0.00	0.027
D11	Blue	0.14	2	5	0.00	0.038
D11	Blue	0.14	2	6	0.00	0.064
D11	Blue	0.14	2	7	0.00	0.105
D11	Blue	0.14	2	8	0.00	0.047
D11	Blue	0.14	2	9	0.00	0.021
D11	Blue	0.14	2	10	0.00	0.094
D11	Blue	0.14	2	11	0.00	0.012
D11	Blue	0.14	2	12	0.00	0.029
D12	Blue	0.19	2	1	0.11	0.030
D12	Blue	0.19	2	2	0.04	0.046
D12	Blue	0.19	2	3	0.04	0.047
D12	Blue	0.19	2	4	0.02	0.034
D12	Blue	0.19	2	5	0.04	0.065
D12	Blue	0.19	2	6	0.00	0.052
D12	Blue	0.19	2	7	0.17	0.090
D12	Blue	0.19	2	8	0.03	0.059
D12	Blue	0.19	2	9	0.08	0.042
D12	Blue	0.19	2	10	0.10	0.068
D12	Blue	0.19	2	11	0.13	0.032
D12	Blue	0.19	2	12	0.11	0.060
E1	Beige	0.91	2	1	0.00	0.022
E1	Beige	0.91	2	2	0.31	0.020
E1	Beige	0.91	2	3	0.16	0.023
E1	Beige	0.91	2	4	0.08	0.030
E1	Beige	0.91	2	5	0.14	0.028
E1	Beige	0.91	2	6	0.21	0.037
E1	Beige	0.91	2	7	0.33	0.079
E1	Beige	0.91	2	8	0.16	0.042
E1	Beige	0.91	2	9	0.17	0.022
E1	Beige	0.91	2	10	0.18	0.061
E1	Beige	0.91	2	11	0.18	0.030
E1	Beige	0.91	2	12	0.40	0.023
E2	Beige	0.38	2	1	0.00	0.083
E2	Beige	0.38	2	2	0.44	0.024
E2	Beige	0.38	2	3	0.20	0.027
E2	Beige	0.38	2	4	0.11	0.017
E2	Beige	0.38	2	5	0.23	0.039
E2	Beige	0.38	2	6	0.11	0.021
E2	Beige	0.38	2	7	0.23	0.022
E2	Beige	0.38	2	8	0.13	0.021
E2	Beige	0.38	2	9	0.11	0.048
E2	Beige	0.38	2	10	0.12	0.010
E2	Beige	0.38	2	11	0.13	0.015
E2	Beige	0.38	2	12	0.60	0.044
E3	Beige	-0.37	4	1	0.07	0.020
E3	Beige	-0.37	4	2	0.05	0.014
E3	Beige	-0.37	4	3	0.07	0.028
E3	Beige	-0.37	4	4	0.05	0.004
E3	Beige	-0.37	4	5	0.04	0.023

E3	Beige	-0.37	4	6	0.05	0.041
E3	Beige	-0.37	4	7	0.15	0.072
E3	Beige	-0.37	4	8	0.09	0.029
E3	Beige	-0.37	4	9	0.10	0.021
E3	Beige	-0.37	4	10	0.14	0.079
E3	Beige	-0.37	4	11	0.14	0.023
E3	Beige	-0.37	4	12	0.13	0.040
E4	Beige	0.14	4	1	0.01	0.083
E4	Beige	0.14	4	2	0.03	0.074
E4	Beige	0.14	4	3	0.00	0.064
E4	Beige	0.14	4	4	0.00	0.066
E4	Beige	0.14	4	5	0.03	0.084
E4	Beige	0.14	4	6	0.00	0.106
E4	Beige	0.14	4	7	0.09	0.075
E4	Beige	0.14	4	8	0.03	0.095
E4	Beige	0.14	4	9	0.03	0.077
E4	Beige	0.14	4	10	0.04	0.092
E4	Beige	0.14	4	11	0.08	0.066
E4	Beige	0.14	4	12	0.14	0.090
E5	Beige	0.12	4	1	0.01	0.038
E5	Beige	0.12	4	2	0.27	0.057
E5	Beige	0.12	4	3	0.09	0.063
E5	Beige	0.12	4	4	0.00	0.044
E5	Beige	0.12	4	5	0.13	0.063
E5	Beige	0.12	4	6	0.00	0.081
E5	Beige	0.12	4	7	0.03	0.075
E5	Beige	0.12	4	8	0.00	0.062
E5	Beige	0.12	4	9	0.00	0.046
E5	Beige	0.12	4	10	0.12	0.096
E5	Beige	0.12	4	11	0.00	0.047
E5	Beige	0.12	4	12	0.22	0.065
E6	Beige	-0.24	2	1	0.05	0.016
E6	Beige	-0.24	2	2	0.08	0.007
E6	Beige	-0.24	2	3	0.00	0.021
E6	Beige	-0.24	2	4	0.00	0.010
E6	Beige	-0.24	2	5	0.00	0.008
E6	Beige	-0.24	2	6	0.00	0.013
E6	Beige	-0.24	2	7	0.19	0.013
E6	Beige	-0.24	2	8	0.08	0.005
E6	Beige	-0.24	2	9	0.08	0.004
E6	Beige	-0.24	2	10	0.09	0.005
E6	Beige	-0.24	2	11	0.06	0.013
E6	Beige	-0.24	2	12	0.06	0.021
E7	Beige	0.14	2	1	0.13	0.055
E7	Beige	0.14	2	2	0.32	0.033
E7	Beige	0.14	2	3	0.16	0.037
E7	Beige	0.14	2	4	0.09	0.031
E7	Beige	0.14	2	5	0.16	0.039
E7	Beige	0.14	2	6	0.08	0.059
E7	Beige	0.14	2	7	0.19	0.058
E7	Beige	0.14	2	8	0.12	0.051
E7	Beige	0.14	2	9	0.12	0.060
E7	Beige	0.14	2	10	0.11	0.064

E7	Beige	0.14	2	11	0.16	0.045
E7	Beige	0.14	2	12	0.47	0.058
E8	Beige	0.37	2	1	0.27	0.041
E8	Beige	0.37	2	2	0.71	0.030
E8	Beige	0.37	2	3	0.36	0.028
E8	Beige	0.37	2	4	0.25	0.027
E8	Beige	0.37	2	5	0.26	0.031
E8	Beige	0.37	2	6	0.14	0.022
E8	Beige	0.37	2	7	0.32	0.015
E8	Beige	0.37	2	8	0.15	0.031
E8	Beige	0.37	2	9	0.16	0.038
E8	Beige	0.37	2	10	0.17	0.011
E8	Beige	0.37	2	11	0.15	0.031
E8	Beige	0.37	2	12	0.58	0.046
E9	Beige	0.41	4	1	0.10	0.056
E9	Beige	0.41	4	2	0.45	0.045
E9	Beige	0.41	4	3	0.20	0.046
E9	Beige	0.41	4	4	0.11	0.052
E9	Beige	0.41	4	5	0.27	0.044
E9	Beige	0.41	4	6	0.20	0.048
E9	Beige	0.41	4	7	0.09	0.050
E9	Beige	0.41	4	8	0.13	0.042
E9	Beige	0.41	4	9	0.17	0.058
E9	Beige	0.41	4	10	0.16	0.043
E9	Beige	0.41	4	11	0.16	0.057
E9	Beige	0.41	4	12	0.32	0.066
E10	Beige	-0.27	4	1	0.14	0.041
E10	Beige	-0.27	4	2	0.41	0.048
E10	Beige	-0.27	4	3	0.20	0.055
E10	Beige	-0.27	4	4	0.11	0.052
E10	Beige	-0.27	4	5	0.19	0.049
E10	Beige	-0.27	4	6	0.08	0.046
E10	Beige	-0.27	4	7	0.18	0.040
E10	Beige	-0.27	4	8	0.13	0.050
E10	Beige	-0.27	4	9	0.12	0.048
E10	Beige	-0.27	4	10	0.10	0.029
E10	Beige	-0.27	4	11	0.15	0.043
E10	Beige	-0.27	4	12	0.39	0.066
E11	Beige	0.58	4	1	0.04	0.062
E11	Beige	0.58	4	2	0.55	0.051
E11	Beige	0.58	4	3	0.19	0.054
E11	Beige	0.58	4	4	0.05	0.053
E11	Beige	0.58	4	5	0.31	0.048
E11	Beige	0.58	4	6	0.05	0.032
E11	Beige	0.58	4	7	0.16	0.044
E11	Beige	0.58	4	8	0.07	0.038
E11	Beige	0.58	4	9	0.03	0.058
E11	Beige	0.58	4	10	0.06	0.028
E11	Beige	0.58	4	11	0.09	0.037
E11	Beige	0.58	4	12	0.59	0.052
E12	Beige	0.79	4	1	0.10	0.062
E12	Beige	0.79	4	2	0.28	0.041
E12	Beige	0.79	4	3	0.23	0.057

E12	Beige	0.79	4	4	0.09	0.048
E12	Beige	0.79	4	5	0.13	0.052
E12	Beige	0.79	4	6	0.05	0.059
E12	Beige	0.79	4	7	0.20	0.066
E12	Beige	0.79	4	8	0.08	0.065
E12	Beige	0.79	4	9	0.07	0.068
E12	Beige	0.79	4	10	0.09	0.068
E12	Beige	0.79	4	11	0.08	0.065
E12	Beige	0.79	4	12	0.36	0.088
F1	Blue	0.08	2	1	0.15	0.005
F1	Blue	0.08	2	2	0.19	0.009
F1	Blue	0.08	2	3	0.12	0.044
F1	Blue	0.08	2	4	0.15	0.023
F1	Blue	0.08	2	5	0.10	0.029
F1	Blue	0.08	2	6	0.09	0.049
F1	Blue	0.08	2	7	0.31	0.097
F1	Blue	0.08	2	8	0.17	0.022
F1	Blue	0.08	2	9	0.19	0.026
F1	Blue	0.08	2	10	0.17	0.104
F1	Blue	0.08	2	11	0.45	0.001
F1	Blue	0.08	2	12	0.36	0.068
F2	Beige	0.32	2	1	0.00	0.044
F2	Beige	0.32	2	2	0.50	0.039
F2	Beige	0.32	2	3	0.07	0.056
F2	Beige	0.32	2	4	0.00	0.054
F2	Beige	0.32	2	5	0.11	0.054
F2	Beige	0.32	2	6	0.00	0.075
F2	Beige	0.32	2	7	0.00	0.055
F2	Beige	0.32	2	8	0.00	0.056
F2	Beige	0.32	2	9	0.00	0.055
F2	Beige	0.32	2	10	0.00	0.089
F2	Beige	0.32	2	11	0.02	0.076
F2	Beige	0.32	2	12	0.51	0.066
F3	Beige	-0.41	4	1	0.03	0.046
F3	Beige	-0.41	4	2	0.03	0.041
F3	Beige	-0.41	4	3	0.04	0.032
F3	Beige	-0.41	4	4	0.05	0.040
F3	Beige	-0.41	4	5	0.01	0.064
F3	Beige	-0.41	4	6	0.00	0.071
F3	Beige	-0.41	4	7	0.13	0.065
F3	Beige	-0.41	4	8	0.03	0.073
F3	Beige	-0.41	4	9	0.08	0.057
F3	Beige	-0.41	4	10	0.08	0.064
F3	Beige	-0.41	4	11	0.11	0.052
F3	Beige	-0.41	4	12	0.09	0.069
F4	Beige	0.13	2	1	0.05	0.061
F4	Beige	0.13	2	2	0.00	0.053
F4	Beige	0.13	2	3	0.00	0.070
F4	Beige	0.13	2	4	0.00	0.044
F4	Beige	0.13	2	5	0.00	0.084
F4	Beige	0.13	2	6	0.00	0.082
F4	Beige	0.13	2	7	0.11	0.040
F4	Beige	0.13	2	8	0.00	0.057

F4	Beige	0.13	2	9	0.04	0.063
F4	Beige	0.13	2	10	0.04	0.080
F4	Beige	0.13	2	11	0.03	0.075
F4	Beige	0.13	2	12	0.02	0.092
F5	Beige	0.21	2	1	0.09	0.037
F5	Beige	0.21	2	2	0.05	0.042
F5	Beige	0.21	2	3	0.00	0.044
F5	Beige	0.21	2	4	0.11	0.039
F5	Beige	0.21	2	5	0.00	0.053
F5	Beige	0.21	2	6	0.00	0.054
F5	Beige	0.21	2	7	0.11	0.059
F5	Beige	0.21	2	8	0.06	0.057
F5	Beige	0.21	2	9	0.06	0.049
F5	Beige	0.21	2	10	0.06	0.092
F5	Beige	0.21	2	11	0.06	0.058
F5	Beige	0.21	2	12	0.06	0.051
F6	Beige	0.75	4	1	0.16	0.010
F6	Beige	0.75	4	2	0.19	0.021
F6	Beige	0.75	4	3	0.06	0.051
F6	Beige	0.75	4	4	0.11	0.041
F6	Beige	0.75	4	5	0.08	0.043
F6	Beige	0.75	4	6	0.09	0.058
F6	Beige	0.75	4	7	0.24	0.078
F6	Beige	0.75	4	8	0.16	0.046
F6	Beige	0.75	4	9	0.16	0.029
F6	Beige	0.75	4	10	0.24	0.062
F6	Beige	0.75	4	11	0.29	0.071
F6	Beige	0.75	4	12	0.33	0.044
F7	Beige	0.16	2	1	0.09	0.061
F7	Beige	0.16	2	2	0.56	0.090
F7	Beige	0.16	2	3	0.21	0.098
F7	Beige	0.16	2	4	0.12	0.096
F7	Beige	0.16	2	5	0.19	0.077
F7	Beige	0.16	2	6	0.08	0.085
F7	Beige	0.16	2	7	0.23	0.085
F7	Beige	0.16	2	8	0.12	0.114
F7	Beige	0.16	2	9	0.10	0.067
F7	Beige	0.16	2	10	0.11	0.091
F7	Beige	0.16	2	11	0.20	0.106
F7	Beige	0.16	2	12	0.59	0.104
F8	Beige	2.51	2	1	0.04	0.012
F8	Beige	2.51	2	2	0.10	0.010
F8	Beige	2.51	2	3	0.08	0.006
F8	Beige	2.51	2	4	0.02	0.021
F8	Beige	2.51	2	5	0.10	0.017
F8	Beige	2.51	2	6	0.12	0.020
F8	Beige	2.51	2	7	0.26	0.031
F8	Beige	2.51	2	8	0.08	0.016
F8	Beige	2.51	2	9	0.08	0.005
F8	Beige	2.51	2	10	0.10	0.014
F8	Beige	2.51	2	11	0.11	0.006
F8	Beige	2.51	2	12	0.07	0.008
F9	Beige	0.52	2	1	0.01	-0.008

F9	Beige	0.52	2	2	0.00	0.004
F9	Beige	0.52	2	3	0.02	0.001
F9	Beige	0.52	2	4	0.01	0.002
F9	Beige	0.52	2	5	0.02	0.012
F9	Beige	0.52	2	6	0.24	0.030
F9	Beige	0.52	2	7	0.06	0.043
F9	Beige	0.52	2	8	0.06	0.036
F9	Beige	0.52	2	9	0.09	0.007
F9	Beige	0.52	2	10	0.05	0.026
F9	Beige	0.52	2	11	0.10	0.013
F9	Beige	0.52	2	12	0.07	0.007
F10	Beige	0.68	2	1	0.11	0.002
F10	Beige	0.68	2	2	0.00	-0.005
F10	Beige	0.68	2	3	0.11	0.009
F10	Beige	0.68	2	4	0.15	0.019
F10	Beige	0.68	2	5	0.04	0.028
F10	Beige	0.68	2	6	0.06	0.022
F10	Beige	0.68	2	7	0.25	0.052
F10	Beige	0.68	2	8	0.11	0.021
F10	Beige	0.68	2	9	0.11	0.011
F10	Beige	0.68	2	10	0.13	0.054
F10	Beige	0.68	2	11	0.17	0.012
F10	Beige	0.68	2	12	0.21	0.003
F11	Beige	0.03	2	1	0.19	0.021
F11	Beige	0.03	2	2	0.15	0.004
F11	Beige	0.03	2	3	0.14	0.022
F11	Beige	0.03	2	4	0.20	0.020
F11	Beige	0.03	2	5	0.18	0.053
F11	Beige	0.03	2	6	0.15	0.045
F11	Beige	0.03	2	7	0.29	0.088
F11	Beige	0.03	2	8	0.20	0.039
F11	Beige	0.03	2	9	0.23	0.010
F11	Beige	0.03	2	10	0.31	0.044
F11	Beige	0.03	2	11	0.24	0.013
F11	Beige	0.03	2	12	0.27	0.042
F12	Blue	0.34	2	1	0.22	0.019
F12	Blue	0.34	2	2	0.13	0.012
F12	Blue	0.34	2	3	0.18	0.010
F12	Blue	0.34	2	4	0.19	-0.005
F12	Blue	0.34	2	5	0.19	0.018
F12	Blue	0.34	2	6	0.12	0.026
F12	Blue	0.34	2	7	0.27	0.086
F12	Blue	0.34	2	8	0.18	0.013
F12	Blue	0.34	2	9	0.24	0.024
F12	Blue	0.34	2	10	0.17	0.038
F12	Blue	0.34	2	11	0.16	-0.001
F12	Blue	0.34	2	12	0.19	-0.007
G1	Beige	-0.19	2	1	0.00	0.052
G1	Beige	-0.19	2	2	0.00	0.060
G1	Beige	-0.19	2	3	0.00	0.058
G1	Beige	-0.19	2	4	0.00	0.058
G1	Beige	-0.19	2	5	0.00	0.051
G1	Beige	-0.19	2	6	0.00	0.041

G1	Beige	-0.19	2	7	0.00	0.024
G1	Beige	-0.19	2	8	0.00	0.043
G1	Beige	-0.19	2	9	0.00	0.052
G1	Beige	-0.19	2	10	0.00	0.047
G1	Beige	-0.19	2	11	0.00	0.054
G1	Beige	-0.19	2	12	0.00	0.053
G2	Beige	-1.29	2	1	0.23	0.005
G2	Beige	-1.29	2	2	0.12	0.002
G2	Beige	-1.29	2	3	0.13	-0.001
G2	Beige	-1.29	2	4	0.17	0.022
G2	Beige	-1.29	2	5	0.24	0.023
G2	Beige	-1.29	2	6	0.15	0.025
G2	Beige	-1.29	2	7	0.29	0.039
G2	Beige	-1.29	2	8	0.31	0.042
G2	Beige	-1.29	2	9	0.31	0.041
G2	Beige	-1.29	2	10	0.23	0.040
G2	Beige	-1.29	2	11	0.21	0.017
G2	Beige	-1.29	2	12	0.23	0.042
G3	Beige	0.13	2	1	0.03	0.025
G3	Beige	0.13	2	2	0.00	0.024
G3	Beige	0.13	2	3	0.00	0.034
G3	Beige	0.13	2	4	0.00	0.021
G3	Beige	0.13	2	5	0.00	0.038
G3	Beige	0.13	2	6	0.00	0.049
G3	Beige	0.13	2	7	0.02	0.055
G3	Beige	0.13	2	8	0.00	0.056
G3	Beige	0.13	2	9	0.00	0.045
G3	Beige	0.13	2	10	0.00	0.063
G3	Beige	0.13	2	11	0.00	0.039
G3	Beige	0.13	2	12	0.00	0.030
G4	Beige	0.03	2	1	0.03	0.059
G4	Beige	0.03	2	2	0.08	0.044
G4	Beige	0.03	2	3	0.05	0.037
G4	Beige	0.03	2	4	0.06	0.032
G4	Beige	0.03	2	5	0.07	0.059
G4	Beige	0.03	2	6	0.01	0.054
G4	Beige	0.03	2	7	0.19	0.051
G4	Beige	0.03	2	8	0.14	0.075
G4	Beige	0.03	2	9	0.15	0.028
G4	Beige	0.03	2	10	0.23	0.061
G4	Beige	0.03	2	11	0.24	0.022
G4	Beige	0.03	2	12	0.27	0.033
G5	Beige	0.03	2	1	0.05	0.074
G5	Beige	0.03	2	2	0.02	0.083
G5	Beige	0.03	2	3	0.00	0.079
G5	Beige	0.03	2	4	0.00	0.074
G5	Beige	0.03	2	5	0.00	0.086
G5	Beige	0.03	2	6	0.00	0.076
G5	Beige	0.03	2	7	0.15	0.076
G5	Beige	0.03	2	8	0.07	0.084
G5	Beige	0.03	2	9	0.05	0.062
G5	Beige	0.03	2	10	0.12	0.014
G5	Beige	0.03	2	11	0.08	0.085

G5	Beige	0.03	2	12	0.17	0.087
G6	Beige	0.10	2	1	0.01	0.053
G6	Beige	0.10	2	2	0.05	0.060
G6	Beige	0.10	2	3	0.00	0.062
G6	Beige	0.10	2	4	0.00	0.063
G6	Beige	0.10	2	5	0.03	0.061
G6	Beige	0.10	2	6	0.00	0.051
G6	Beige	0.10	2	7	0.05	0.045
G6	Beige	0.10	2	8	0.00	0.062
G6	Beige	0.10	2	9	0.01	0.051
G6	Beige	0.10	2	10	0.07	0.038
G6	Beige	0.10	2	11	0.06	0.041
G6	Beige	0.10	2	12	0.19	0.056
G7	Beige	0.34	2	1	0.06	0.056
G7	Beige	0.34	2	2	0.09	0.061
G7	Beige	0.34	2	3	0.00	0.050
G7	Beige	0.34	2	4	0.00	0.049
G7	Beige	0.34	2	5	0.01	0.049
G7	Beige	0.34	2	6	0.07	0.049
G7	Beige	0.34	2	7	0.19	0.037
G7	Beige	0.34	2	8	0.02	0.025
G7	Beige	0.34	2	9	0.02	0.040
G7	Beige	0.34	2	10	0.01	0.020
G7	Beige	0.34	2	11	0.03	0.050
G7	Beige	0.34	2	12	0.19	0.051
G8	Beige	0.06	2	1	0.24	0.069
G8	Beige	0.06	2	2	0.60	0.056
G8	Beige	0.06	2	3	0.41	0.039
G8	Beige	0.06	2	4	0.26	0.063
G8	Beige	0.06	2	5	0.33	0.049
G8	Beige	0.06	2	6	0.10	0.027
G8	Beige	0.06	2	7	0.28	0.029
G8	Beige	0.06	2	8	0.23	0.039
G8	Beige	0.06	2	9	0.20	0.071
G8	Beige	0.06	2	10	0.19	0.052
G8	Beige	0.06	2	11	0.24	0.051
G8	Beige	0.06	2	12	0.65	0.072
G9	Beige	1.85	2	1	0.18	0.036
G9	Beige	1.85	2	2	0.41	0.033
G9	Beige	1.85	2	3	0.11	0.042
G9	Beige	1.85	2	4	0.06	0.016
G9	Beige	1.85	2	5	0.17	0.045
G9	Beige	1.85	2	6	0.05	0.021
G9	Beige	1.85	2	7	0.24	0.043
G9	Beige	1.85	2	8	0.10	0.011
G9	Beige	1.85	2	9	0.09	0.033
G9	Beige	1.85	2	10	0.08	0.034
G9	Beige	1.85	2	11	0.11	0.033
G9	Beige	1.85	2	12	0.38	0.034
G10	Beige	-0.08	2	1	0.14	0.001
G10	Beige	-0.08	2	2	0.15	0.018
G10	Beige	-0.08	2	3	0.17	0.030
G10	Beige	-0.08	2	4	0.08	0.010

G10	Beige	-0.08	2	5	0.14	0.022
G10	Beige	-0.08	2	6	0.07	0.012
G10	Beige	-0.08	2	7	0.27	0.012
G10	Beige	-0.08	2	8	0.14	0.027
G10	Beige	-0.08	2	9	0.13	0.030
G10	Beige	-0.08	2	10	0.11	0.009
G10	Beige	-0.08	2	11	0.18	0.014
G10	Beige	-0.08	2	12	0.32	0.032
G11	Beige	-0.53	2	1	0.34	0.026
G11	Beige	-0.53	2	2	0.26	0.025
G11	Beige	-0.53	2	3	0.22	0.027
G11	Beige	-0.53	2	4	0.18	0.015
G11	Beige	-0.53	2	5	0.20	0.028
G11	Beige	-0.53	2	6	0.17	0.018
G11	Beige	-0.53	2	7	0.33	0.025
G11	Beige	-0.53	2	8	0.28	0.031
G11	Beige	-0.53	2	9	0.28	0.031
G11	Beige	-0.53	2	10	0.27	0.032
G11	Beige	-0.53	2	11	0.26	0.034
G11	Beige	-0.53	2	12	0.24	0.053
G12	Beige	1.54	2	1	0.00	0.004
G12	Beige	1.54	2	2	0.00	0.013
G12	Beige	1.54	2	3	0.00	0.012
G12	Beige	1.54	2	4	0.00	0.015
G12	Beige	1.54	2	5	0.00	0.020
G12	Beige	1.54	2	6	0.00	0.016
G12	Beige	1.54	2	7	0.06	0.021
G12	Beige	1.54	2	8	0.00	0.020
G12	Beige	1.54	2	9	0.00	0.019
G12	Beige	1.54	2	10	0.00	0.018
G12	Beige	1.54	2	11	0.00	0.020
G12	Beige	1.54	2	12	0.19	0.025
H1	Beige	0.68	2	1	0.47	0.032
H1	Beige	0.68	2	2	0.48	0.036
H1	Beige	0.68	2	3	0.45	0.039
H1	Beige	0.68	2	4	0.46	0.024
H1	Beige	0.68	2	5	0.45	0.038
H1	Beige	0.68	2	6	0.39	0.037
H1	Beige	0.68	2	7	0.52	0.060
H1	Beige	0.68	2	8	0.45	0.037
H1	Beige	0.68	2	9	0.45	0.028
H1	Beige	0.68	2	10	0.51	0.040
H1	Beige	0.68	2	11	0.52	0.035
H1	Beige	0.68	2	12	0.54	0.051
H2	Beige	0.12	2	1	0.00	0.020
H2	Beige	0.12	2	2	0.00	0.021
H2	Beige	0.12	2	3	0.00	0.028
H2	Beige	0.12	2	4	0.00	0.036
H2	Beige	0.12	2	5	0.00	0.038
H2	Beige	0.12	2	6	0.00	0.050
H2	Beige	0.12	2	7	0.04	0.052
H2	Beige	0.12	2	8	0.00	0.053
H2	Beige	0.12	2	9	0.00	0.041

H2	Beige	0.12	2	10	0.00	0.033
H2	Beige	0.12	2	11	0.00	0.015
H2	Beige	0.12	2	12	0.00	0.026
H3	Beige	0.45	2	1	0.41	0.015
H3	Beige	0.45	2	2	0.41	0.021
H3	Beige	0.45	2	3	0.37	0.036
H3	Beige	0.45	2	4	0.42	0.032
H3	Beige	0.45	2	5	0.35	0.032
H3	Beige	0.45	2	6	0.39	0.031
H3	Beige	0.45	2	7	0.45	0.050
H3	Beige	0.45	2	8	0.44	0.023
H3	Beige	0.45	2	9	0.38	0.015
H3	Beige	0.45	2	10	0.44	0.040
H3	Beige	0.45	2	11	0.42	0.040
H3	Beige	0.45	2	12	0.51	0.029
H4	Beige	-0.18	2	1	0.00	-0.012
H4	Beige	-0.18	2	2	0.00	0.000
H4	Beige	-0.18	2	3	0.00	0.006
H4	Beige	-0.18	2	4	0.00	0.013
H4	Beige	-0.18	2	5	0.00	0.012
H4	Beige	-0.18	2	6	0.00	0.027
H4	Beige	-0.18	2	7	0.00	0.030
H4	Beige	-0.18	2	8	0.00	0.034
H4	Beige	-0.18	2	9	0.00	0.023
H4	Beige	-0.18	2	10	0.00	0.029
H4	Beige	-0.18	2	11	0.00	0.006
H4	Beige	-0.18	2	12	0.00	0.010
H5	Beige	0.31	2	1	0.00	0.020
H5	Beige	0.31	2	2	0.18	0.018
H5	Beige	0.31	2	3	0.00	0.025
H5	Beige	0.31	2	4	0.00	0.034
H5	Beige	0.31	2	5	0.00	0.056
H5	Beige	0.31	2	6	0.00	0.050
H5	Beige	0.31	2	7	0.05	0.069
H5	Beige	0.31	2	8	0.00	0.061
H5	Beige	0.31	2	9	0.00	0.047
H5	Beige	0.31	2	10	0.00	0.065
H5	Beige	0.31	2	11	0.00	0.059
H5	Beige	0.31	2	12	0.20	0.036
H6	Beige	0.17	2	1	0.04	0.006
H6	Beige	0.17	2	2	0.00	0.008
H6	Beige	0.17	2	3	0.00	0.017
H6	Beige	0.17	2	4	0.00	0.014
H6	Beige	0.17	2	5	0.00	0.017
H6	Beige	0.17	2	6	0.00	0.015
H6	Beige	0.17	2	7	0.18	0.067
H6	Beige	0.17	2	8	0.04	0.040
H6	Beige	0.17	2	9	0.03	0.021
H6	Beige	0.17	2	10	0.10	0.043
H6	Beige	0.17	2	11	0.06	0.020
H6	Beige	0.17	2	12	0.12	0.049
H7	Beige	-0.60	2	1	0.00	0.022
H7	Beige	-0.60	2	2	0.00	0.023

H7	Beige	-0.60	2	3	0.00	0.035
H7	Beige	-0.60	2	4	0.00	0.029
H7	Beige	-0.60	2	5	0.00	0.032
H7	Beige	-0.60	2	6	0.00	0.050
H7	Beige	-0.60	2	7	0.00	0.054
H7	Beige	-0.60	2	8	0.00	0.060
H7	Beige	-0.60	2	9	0.00	0.049
H7	Beige	-0.60	2	10	0.00	0.051
H7	Beige	-0.60	2	11	0.00	0.036
H7	Beige	-0.60	2	12	0.00	0.039
H8	Beige	3.04	2	1	0.13	0.040
H8	Beige	3.04	2	2	0.11	0.016
H8	Beige	3.04	2	3	0.04	0.040
H8	Beige	3.04	2	4	0.01	0.062
H8	Beige	3.04	2	5	0.01	0.023
H8	Beige	3.04	2	6	0.00	0.031
H8	Beige	3.04	2	7	0.22	0.035
H8	Beige	3.04	2	8	0.07	0.063
H8	Beige	3.04	2	9	0.05	0.022
H8	Beige	3.04	2	10	0.04	0.025
H8	Beige	3.04	2	11	0.04	0.078
H8	Beige	3.04	2	12	0.14	0.022
H9	Blue	-0.22	2	1	0.19	0.012
H9	Blue	-0.22	2	2	0.12	0.020
H9	Blue	-0.22	2	3	0.15	0.002
H9	Blue	-0.22	2	4	0.10	-0.005
H9	Blue	-0.22	2	5	0.20	0.029
H9	Blue	-0.22	2	6	0.11	0.037
H9	Blue	-0.22	2	7	0.26	0.090
H9	Blue	-0.22	2	8	0.12	0.042
H9	Blue	-0.22	2	9	0.14	0.020
H9	Blue	-0.22	2	10	0.16	0.024
H9	Blue	-0.22	2	11	0.15	-0.003
H9	Blue	-0.22	2	12	0.16	-0.001
H10	Beige	-0.63	2	1	0.15	0.011
H10	Beige	-0.63	2	2	0.11	0.015
H10	Beige	-0.63	2	3	0.11	0.022
H10	Beige	-0.63	2	4	0.10	0.009
H10	Beige	-0.63	2	5	0.08	0.043
H10	Beige	-0.63	2	6	0.12	0.028
H10	Beige	-0.63	2	7	0.24	0.089
H10	Beige	-0.63	2	8	0.10	0.038
H10	Beige	-0.63	2	9	0.16	0.040
H10	Beige	-0.63	2	10	0.20	0.005
H10	Beige	-0.63	2	11	0.20	-0.010
H10	Beige	-0.63	2	12	0.16	0.022
H12	Beige	-0.25	2	1	0.09	0.023
H12	Beige	-0.25	2	2	0.13	0.032
H12	Beige	-0.25	2	3	0.05	0.029
H12	Beige	-0.25	2	4	0.02	0.024
H12	Beige	-0.25	2	5	0.00	0.019
H12	Beige	-0.25	2	6	0.00	0.018
H12	Beige	-0.25	2	7	0.12	0.037

H12	Beige	-0.25	2	8	0.01	0.015
H12	Beige	-0.25	2	9	0.00	0.026
H12	Beige	-0.25	2	10	0.05	0.027
H12	Beige	-0.25	2	11	0.00	0.045
H12	Beige	-0.25	2	12	0.00	0.020

*Negative enzyme concentrations are the results of no enzyme expression or a failed CO difference spectroscopy assay (repeated in duplicate). Some variants with seemingly negative concentration showed substrate activity, which could indicate very low enzyme concentration that could not be detected with this assay.

Supplementary Table 5. Top P450 BM3 variant rankings across all substrates (1-12) combined, according to 4-AAP absorbance results.

Variant	Identity	Overall rank across all substrates
A5	F87P	1
H1	D80N/F81Y/F173P/R255G/Y256H	2
H3	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	3
B8	F87L/M177H/L181I/R255T/I259G/I263N	4
D7	F87S/I259P	5
G8	P172H/Y256K/I263G	6
C1	F87P/A180M/I263G	7
D3	F87L/A180E/A184F/Y256K/I259K	8
B10	F81Y/E143D/A180M/M212K	9
G11	A82F	10

Supplementary Table 6. Top P450 BM3 variant rankings across each substrate (1-12), according to 4-AAP absorbance results.^a

Rank	Substrate					
	1	2	3	4	5	6
1	D80N/F81Y/F173P/R255G/Y256H	F87P/A180M/I263G	F87P	F81Y/E143D/A180M/M212K	F87P/A180M/I263G	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V
2	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	F87P	D80N/F81Y/F173P/R255G/Y256H	D80N/F81Y/F173P/R255G/Y256H	F87P	D80N/F81Y/F173P/R255G/Y256H
3	A82F/L85P	G83K	F87L/M177H/L181I/R255T/I259G/I263N	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	D80N/F81Y/F173P/R255G/Y256H	F87P
4	F87S/I259P	F87L/M177H/L181I/R255T/I259G/I263N	P172H/Y256K/I263G	F87P	F87L/M177H/L181I/R255T/I259G/I263N	R255G
5	F87P	F87S/I259P	F87P/A180M/I263G	F87P/A180M/I263G	A184K	F87L/M177H/L181I/R255T/I259G/I263N
6	R255G	R255P	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	R255G	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	F87P/A180M/I263G
7	G83K	P172H/Y256K/I263G	G83K	F87L/M177H/L181I/R255T/I259G/I263N	F87L/L181P/I259P	F81R/T87P/F173H/A180W/M212W/I259K/I263H
8	F87L/M177H/L181I/R255T/I259G/I263N	F81R/F87G/L180I/I259P	F87S/I259P	P172H/Y256K/I263G	P172H/Y256K/I263G	R255G/I259G
9	F87L/A180E/A184F/Y256K/I259K	A180N	F81Y/E143D/A180M/M212K	F87L/A180E/A184F/Y256K/I259K	A180N	M212W
10	P172H/Y256K/I263G	A184K	F87G	I263G	F87S/I259P	F81Y/E143D/A180M/M212K

Rank	Substrate					
	7	8	9	10	11	12
1	D80N/F81Y/F173P/R255G/Y256H	D80N/F81Y/F173P/R255G/Y256H	D80N/F81Y/F173P/R255G/Y256H	D80N/F81Y/F173P/R255G/Y256H	L75H	F87P/A180M/I263G
2	F87P	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	F87L/M177L/A184K/Y256V	F87P
3	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	F87P	F87P	F87P	R255G	A184K
4	F87L/M177H/L181I/R255T/I259G/I263N	F81R/F173P/M177H/A180F/I259P	F81R/F173P/M177H/A180F/I259P	D80P/F87L/F173E/A184E/I259G/I263H	D80N/F81Y/F173P/R255G/Y256H	F173E/A180F/M212R/I263G
5	F81Y/E143D/A180M/M212K	F87S/I259P	F87S/I259P	A82F/L85P	Y256M	P172H/Y256K/I263G
6	F87S/I259P	A82F/L85P	A82F/L85P	A82Q/M177P/L181F/T256H	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	F87L/M177H/L181I/R255T/I259G/I263N
7	F87L/A180E/A184F/Y256K/I259K	A82Q/M177P/L181F/T256H	F87P/A180M/I263G	F87S/I259P	F87P	A82Q
8	F87P/A180M/I263G	P172H/Y256K/I263G	R255G/I259G	F87L/A180E/A184F/Y256K/I259K	R255G/I259G	L71N
9	M212W	F87L/A180E/A184F/Y256K/I259K	F173E/M177L/L181I/M212R/Y256V/I263S	F81Y/F173H/A180P	F81Y/F173H/A180P	A180N
10	A82Q/M177P/L181F/T256H	F87L/M177H/L181I/R255T/I259G/I263N	D80P/F87L/F173E/A184E/I259G/I263H	F87L/M177H/L181I/R255T/I259G/I263N	F173E/A180F/M212R/I263G	F81R/F87G/L180I/I259P

^aThe three overall top variants (Supplementary Table 2) are highlighted in blue, black and green, respectively

Supplementary Table 7. Variant rankings for substrates **1-12** according to 4-AAP absorbance results for variant A5 – F87P.

Variant A5 (F87P)	
Substrate	Rank
1	5
2	2
3	1
4	4
5	2
6	3
7	2
8	3
9	3
10	3
11	7
12	2

Supplementary Table 8. Comparison of rank for 4-AAP absorbance results and NADPH consumption rate for reaction of variant A9 (A184K) with substrates **1-12**. A high and low rank are highlighted with a green to red gradient.

Substrate	4-AAP Assay (Rank)	NADPH Consumption Rate (Rank)
1	46	3
2	10	30
3	11	4
4	12	2
5	5	9
6	14	1
7	20	6
8	26	1
9	27	7
10	30	6
11	53	3
12	3	1

Supplementary Table 9. P450 BM3 variant enzyme concentration. The concentrations of the P450 variants in the clarified cell lysate (stock concentration) is shown in descending order. Expression was determined at least in duplicate. For wild-type, n=8.

Variant	Phenotype	Variant Identity	Stock [P450] (μM)
His-A82Q ^a	Blue	A82Q	13.0
B3	Blue	I263Q	7.0
C6	Blue	M177Q	7.0
A4	Blue	A82Q	5.0
A3	Blue	A82E	4.5
A2	Blue	F81R	4.5
A1	Blue	R255G	4.4

B4	Blue	A180E/A184F/M212K/I263S	3.5
H8	Blue	I259G	3.0
A9	Blue	A184K	2.9
B11	Blue	F173E/A180F/M212R/I263G	2.9
C2	Blue	F87G	2.8
F8	Blue	A82P/F173H/L181I/R255I/T256K/I263Q	2.5
G9	Blue	M177H/I263S	1.8
A9 ^a	Blue	A184K	1.6
B6	Blue	I259P	1.6
G12	Blue	A82F/L181F	1.5
C4	Blue	F87P/M212W/Y256H	1.4
C1	Blue	F87P/A180M/I263G	1.3
C1 ^a	Blue	F87P/A180M/I263G	1.3
B1	Blue	L75H	1.3
A10 ^a	Blue	M212K	1.2
A5	Blue	F87P	1.1
B2	Blue	I263G	1.0
B8	Blue	F87L/M177H/L181I/R255T/I259G/I263N	0.9
A82Q ALI	Blue	A82Q	0.9
B10	Blue	F81Y/E143D/A180M/M212K	0.9
E1	Beige	L71H	0.9
E12	Beige	L181N	0.8
WT	Beige	N/A	0.8
A7	Blue	A180M	0.8
F6	Blue	F81Y/F173H/A180P	0.7
C5	Blue	F87G/A184P/M212W/R255I/I263Q	0.7
H1	Beige	D80N/F81Y/F173P/R255G/Y256H	0.7
F10	Beige	L75R/M177P/A180E/A184K/Y256K/I263H	0.7
E6 ^a	Blue	D80C	0.6
E11	Beige	A180N	0.6
F9	Beige	F81R/T87P/F173H/A180W/M212W/I259K/I263H	0.5
A11	Blue	M212W	0.5
D6	Blue	F87L/M177L/L181I	0.5
C12	Blue	F87L/Y256K	0.5
A6 ^a	Blue	A180F	0.5
B7	Blue	M177H/I259K	0.5
H3	Beige	L75H/F81Y/F87P/L181P/M212R/R255D/Y256V	0.4
D5	Blue	D80C/F81Y/F173H/M177H/L181P/I259G	0.4
A12	Blue	R255P	0.4
B12	Blue	F87L/L181P/I259P	0.4
E9	Beige	F173C	0.4
E2	Beige	L71N	0.4
E8	Beige	G83K	0.4

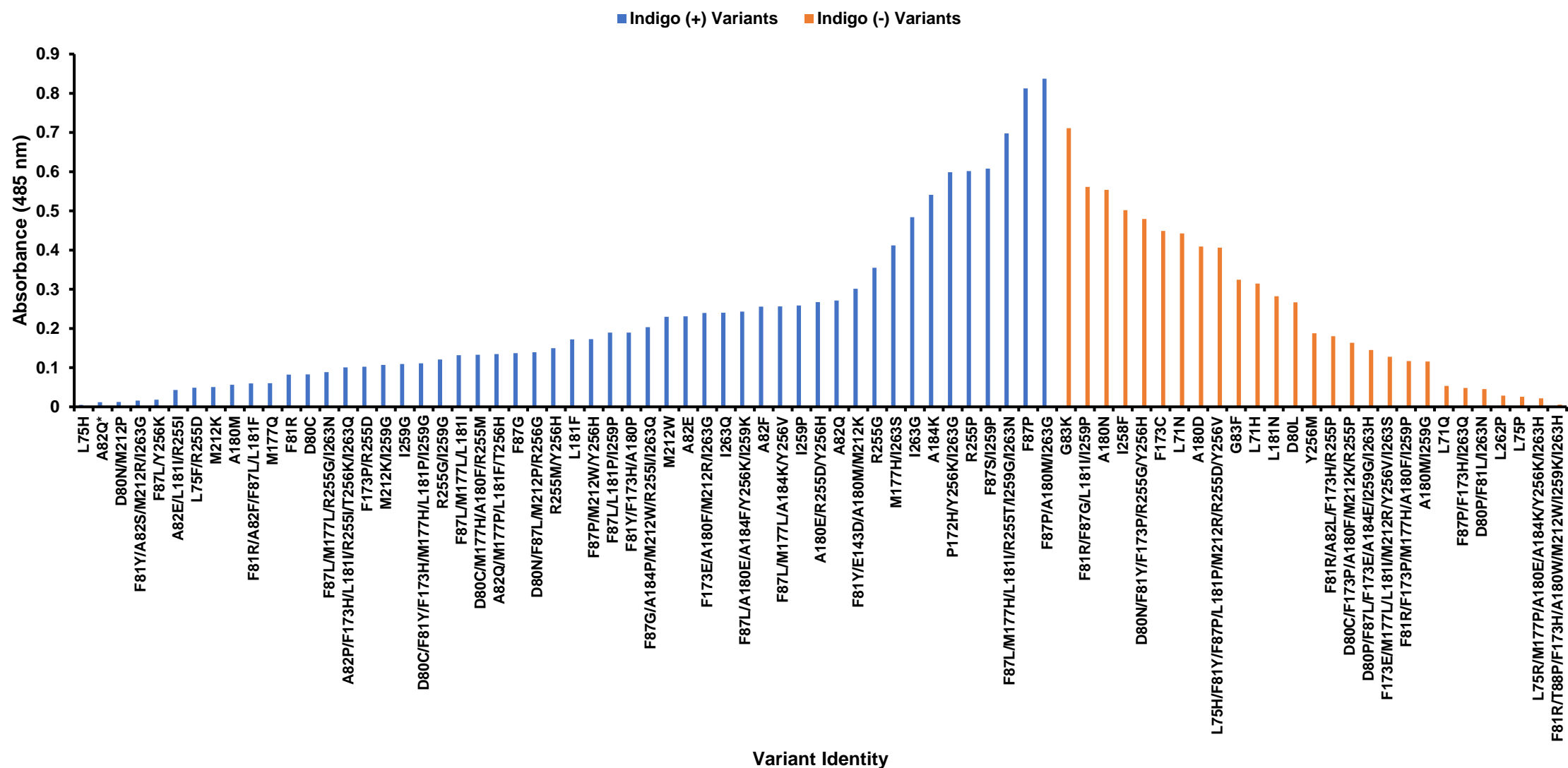
F12	Beige	F173E/M177L/L181I/M212R/Y256V/I263S	0.3
B12	Blue	F87L/L181P/I259P	0.3
G7	Blue	F87L/M177L/R255G/I263N	0.3
B9	Blue	F81R/A82F/F87L/L181F	0.3
F2	Beige	I258F	0.3
E9	Beige	F173C	0.3
H5	Beige	F81R/A82L/F173H/R255P	0.3
C7	Blue	D80N/F87S/M212P/R256G	0.3
D9	Blue	R255G/I259G	0.3
A7 ^a	Blue	A180M	0.3
B2 ^a	Blue	I263G	0.3
D2	Blue	F81R/F87L/M177L	0.2
F5	Beige	F87P/F173H/I263Q	0.2
D12	Blue	A82E/L181I/R255I	0.2
H6	Beige	M177L/A184F/M212P/Y256V/I259G	0.2
A5 ^a	Blue	F87P	0.2
C12	Blue	F87L/Y256K	0.2
F7	Beige	F81R/F87G/L181I/I259P	0.2
B6	Blue	I259P	0.2
F5	Beige	F87P/F173H/I263Q	0.1
E4	Beige	L75P	0.1
E7	Beige	G83F	0.1
D11	Blue	A180F/L181F	0.1
F4	Beige	H266K	0.1
G3	Beige	L75R/I259G	0.1
E5	Beige	D80L	0.1
E3	Beige	L71Q	0.1
E5	Beige	D80L	0.1
H2	Beige	F173E/M177H/M212R/I263S	0.1
C3	Blue	F87L/M177L/A184K/Y256V	0.1
G6	Beige	D80P/F81L/I263N	0.1
F1	Beige	Y256M	0.1
D4	Blue	F173P/R255D	0.1
G8	Blue	P172H/Y256K/I263G	0.1
D7	Blue	F87S/I259P	0.1
E12	Beige	L181N	0.03
G4	Beige	D80C/F173P/A180F/M212K/R255P	0.03
G7 ^a	Blue	F87L/M177L/R255G/I263N	0.03
F11	Beige	D80P/F87L/F173E/A184E/I259G/I263H	0.03
G5	Blue	F81Y/A82S/M212R/I263G	0.03
E2 ^a	Beige	L71N	0.02
D3	Blue	F87L/A180E/A184F/Y256K/I259K	0.02
E11	Beige	A180N	0.02

^aVariants used for assays with NADPH recycling.

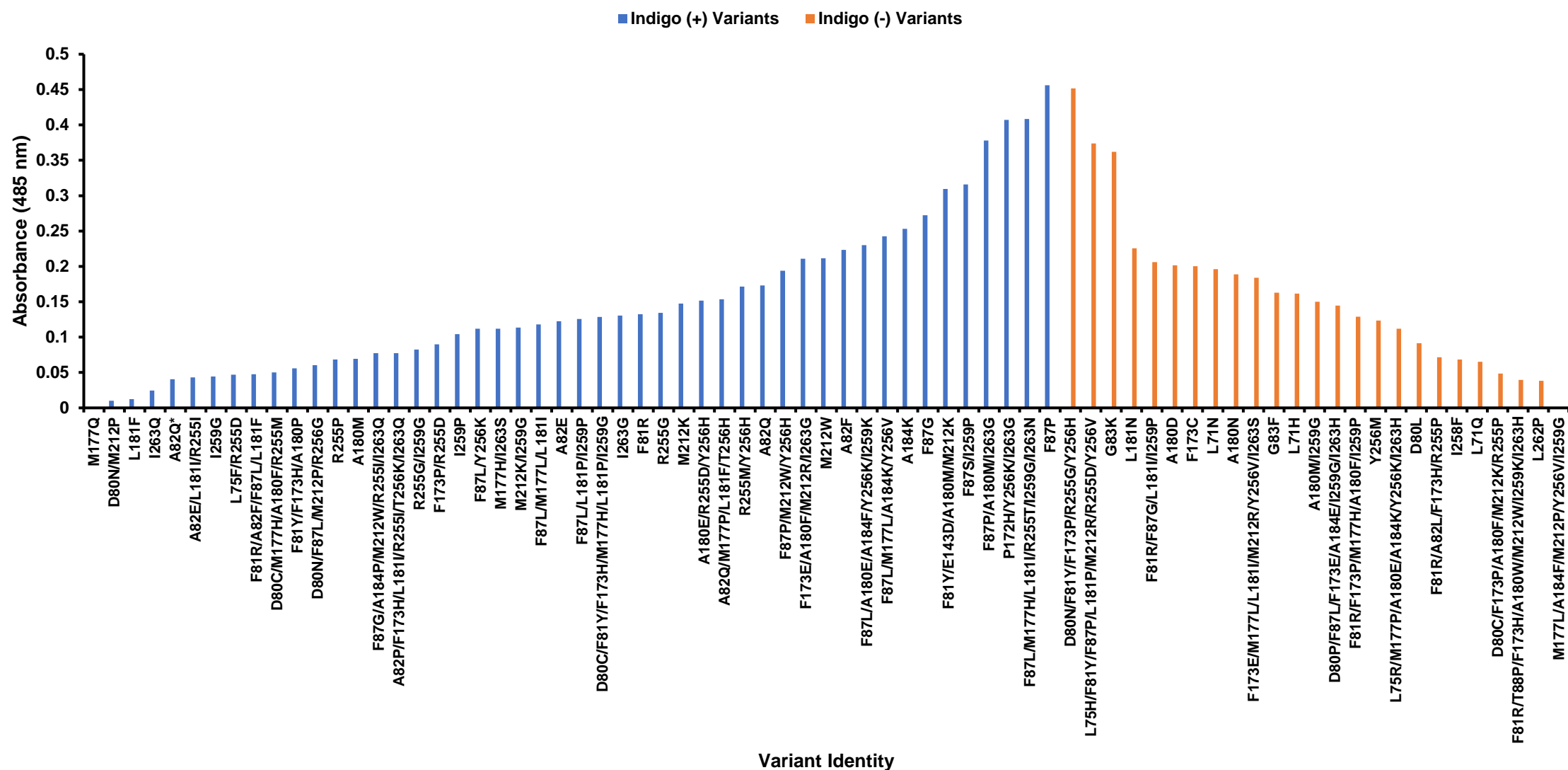
Supplementary Table 10. Relationship between 4-AAP absorbance assays and reactions conversion with NADPH recycling.

Variant Name	Variant Identity	Phenotype	4-AAP Assay Absorbance (485 nm) ^a	% Conversion (Product Formation) ^b
A10	M212K	Blue	0.275	98
E2	L71N	Beige	0.597	93
E6	D80C	Blue	0.063	91
A6	A180F	Blue	0.000	70
B2	I263G	Blue	0.364	68
C1	F87P/A180M/I263G	Blue	0.928	67
A9	A184K	Blue	0.818	66
A7	A180M	Blue	0.225	61
A5	F87P	Blue	0.895	12
His-A82Q	His-A82Q	Blue	0.173	8
G7	F87L/M177L/R255G/I263N	Blue	0.186	5

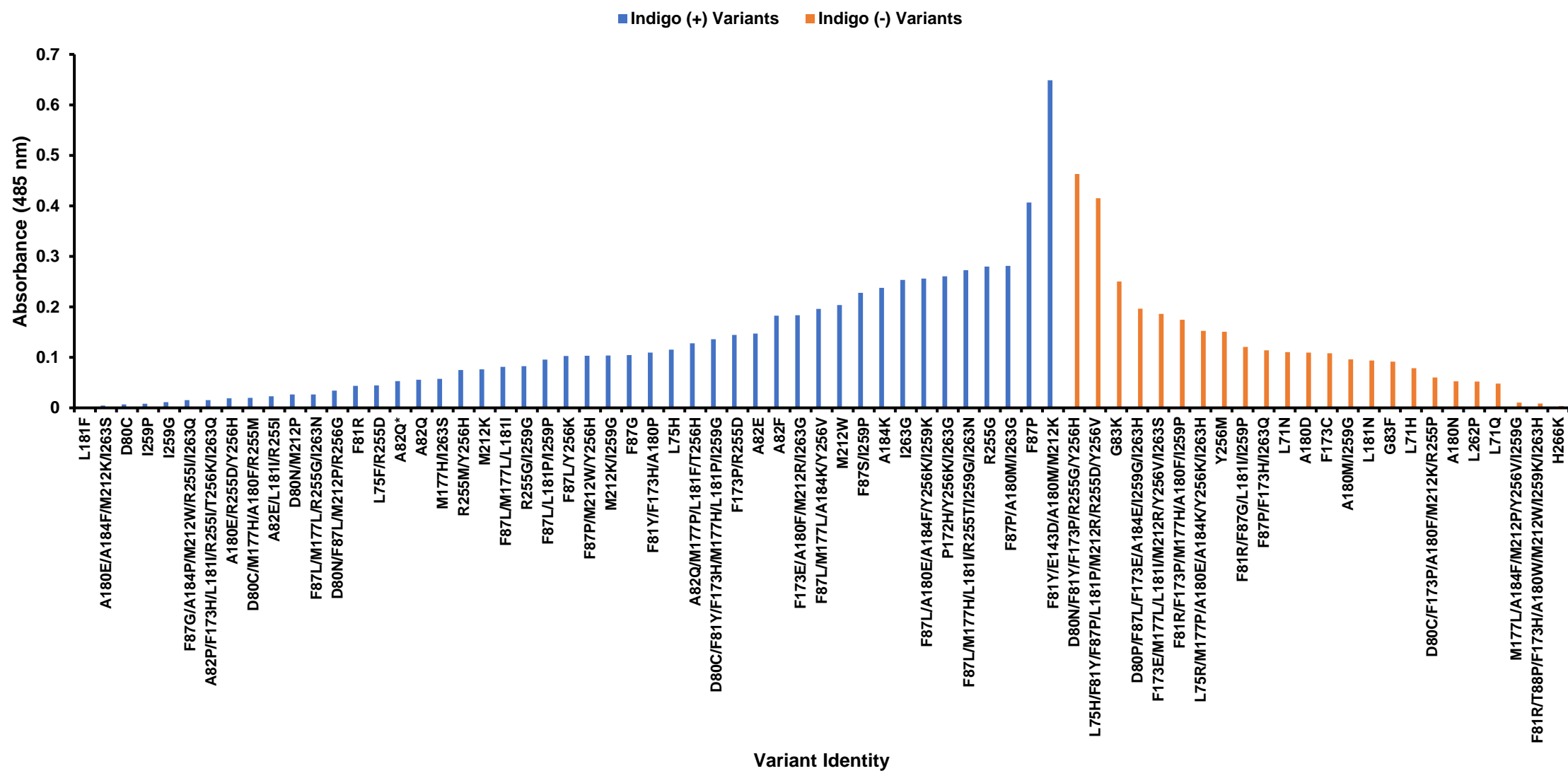
^aAssays performed using 409 μ M NADPH with a 1-hour reaction time. ^bAssays performed using an NADPH recycling system with a 3-hour reaction time. All measurements were performed in at least duplicate.



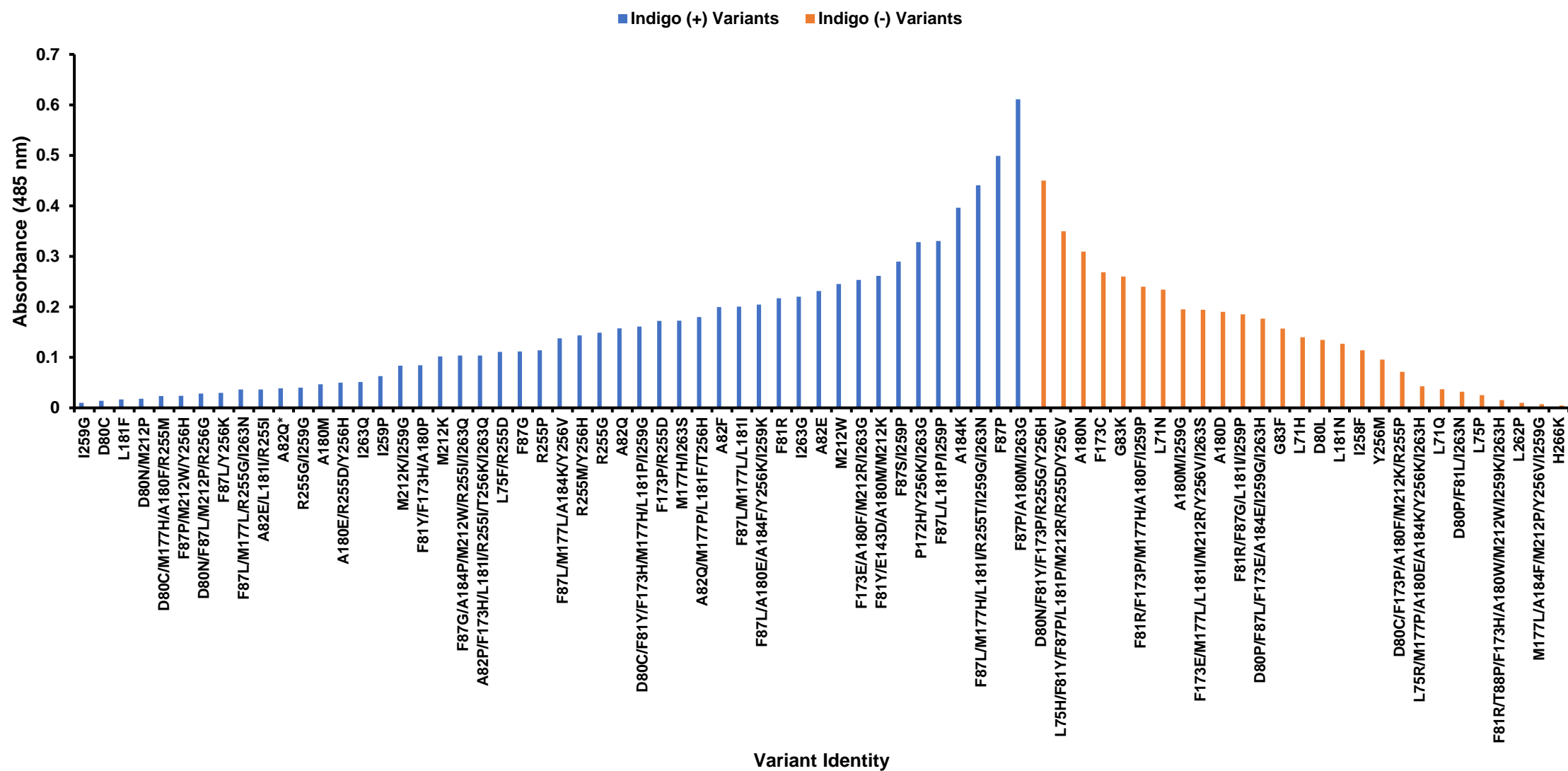
Supplementary Figure 1. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **2**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



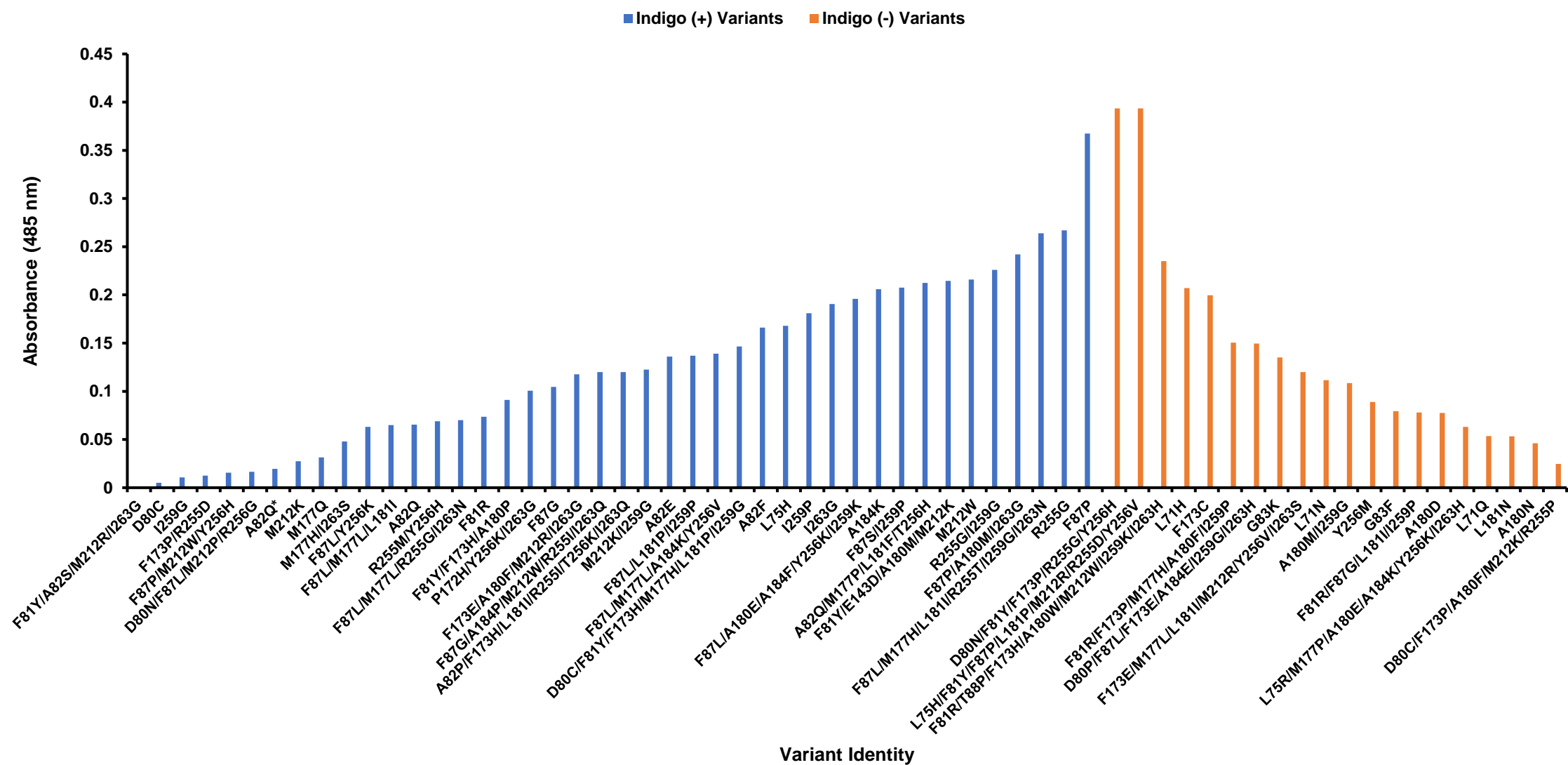
Supplementary Figure 2. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **3**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



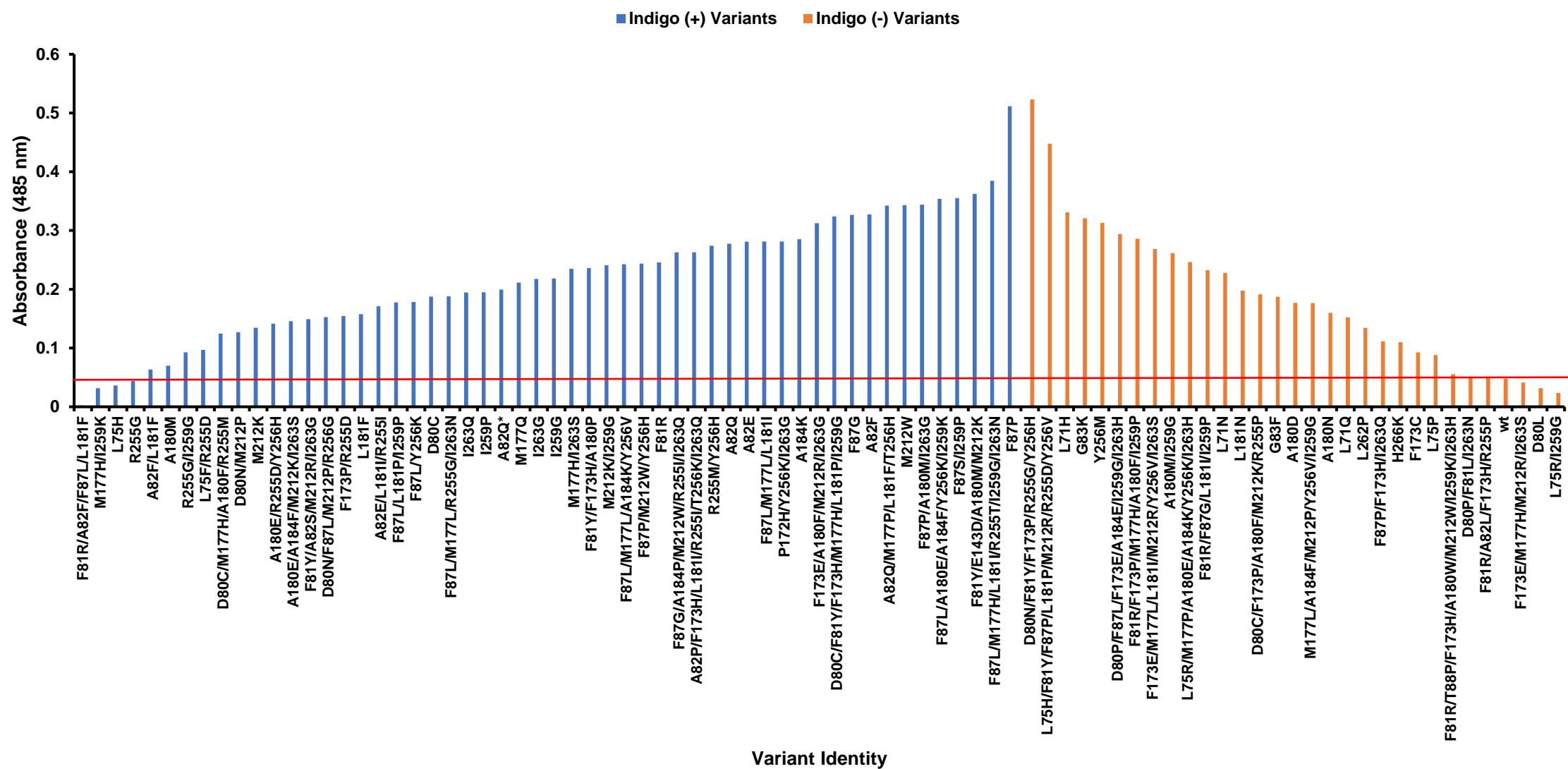
Supplementary Figure 3. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **4**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



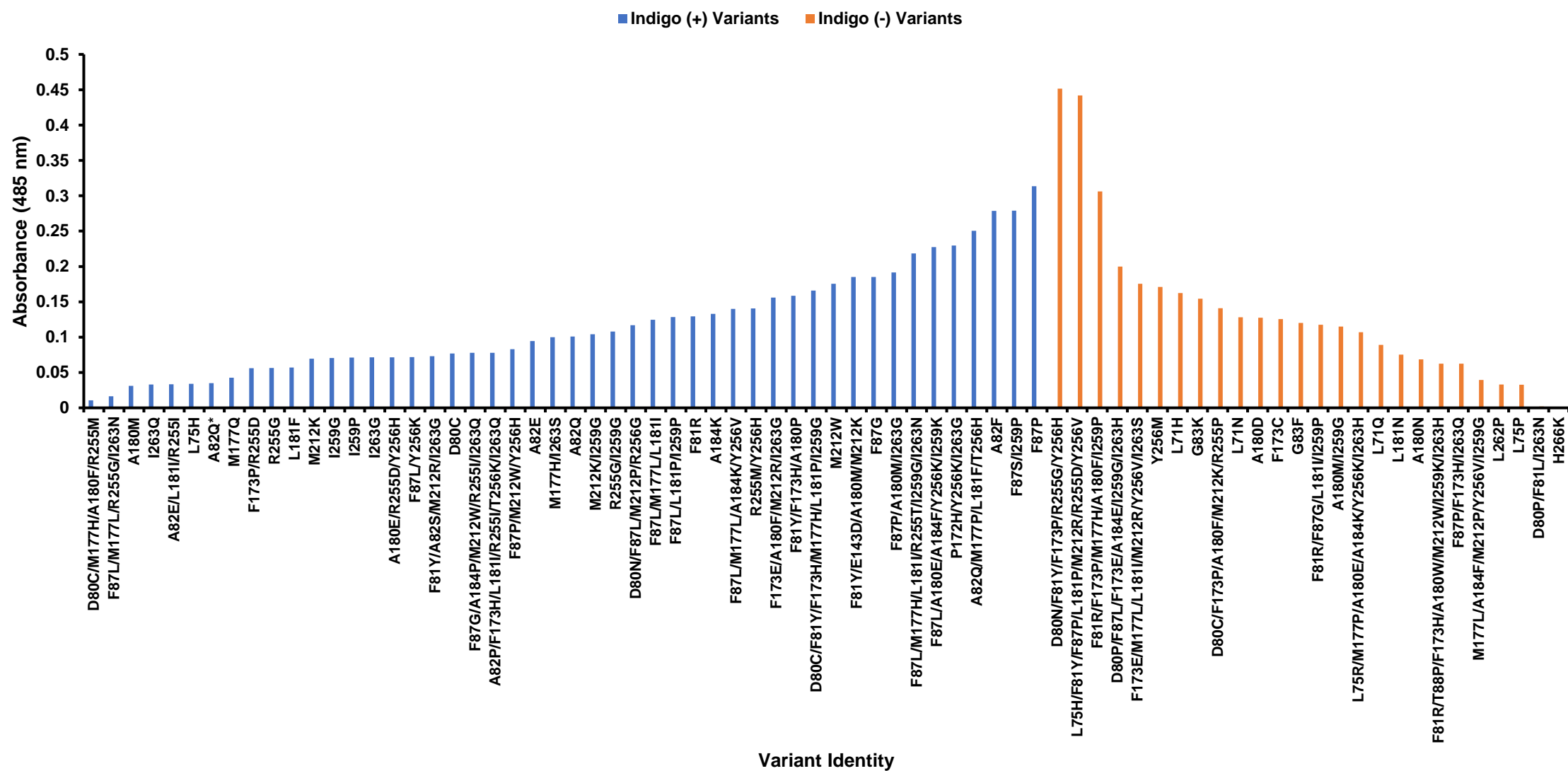
Supplementary Figure 4. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **5**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



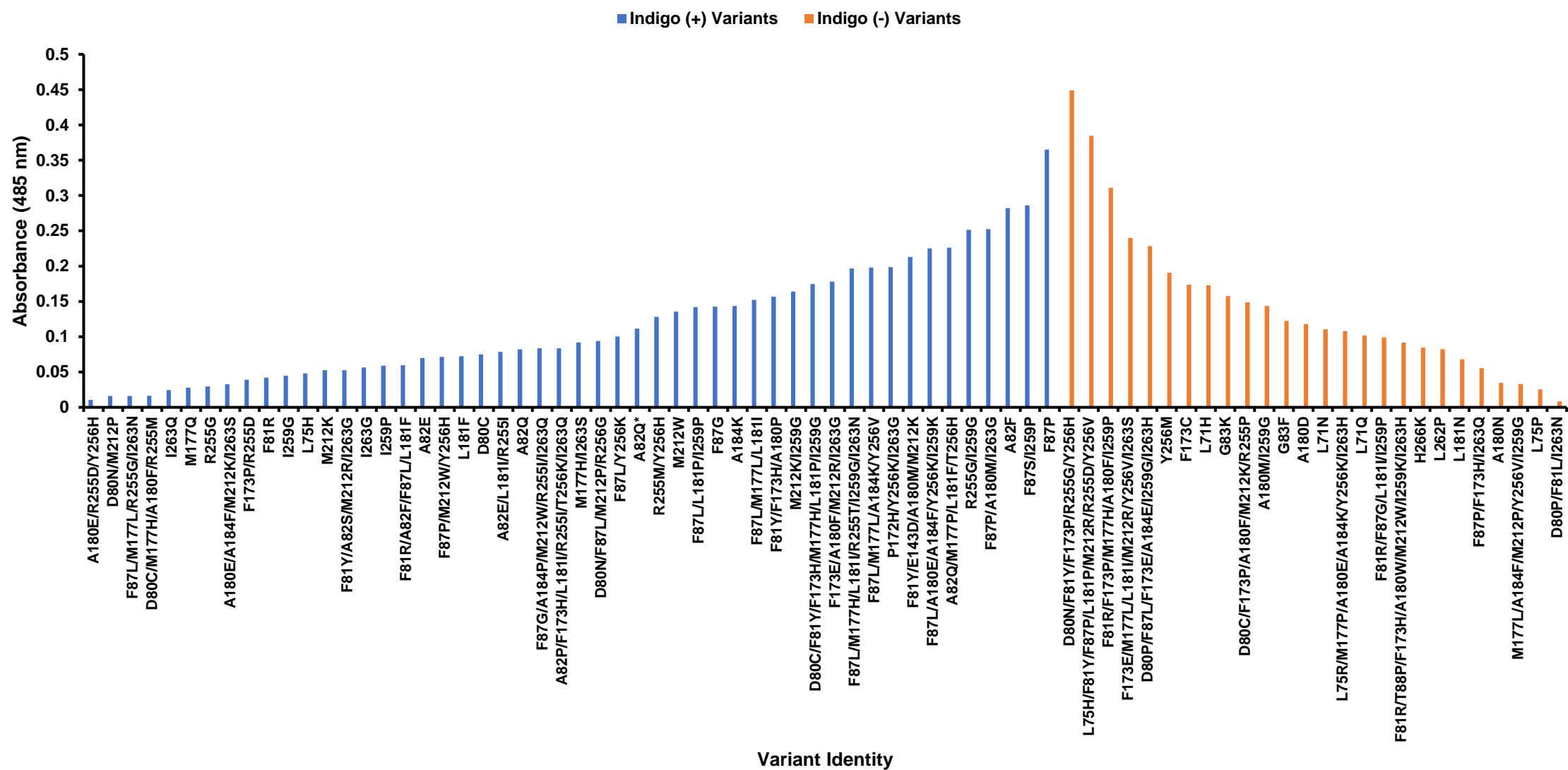
Supplementary Figure 5. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **6**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q* = C-terminal His-tag. All experiments were performed in at least duplicate.



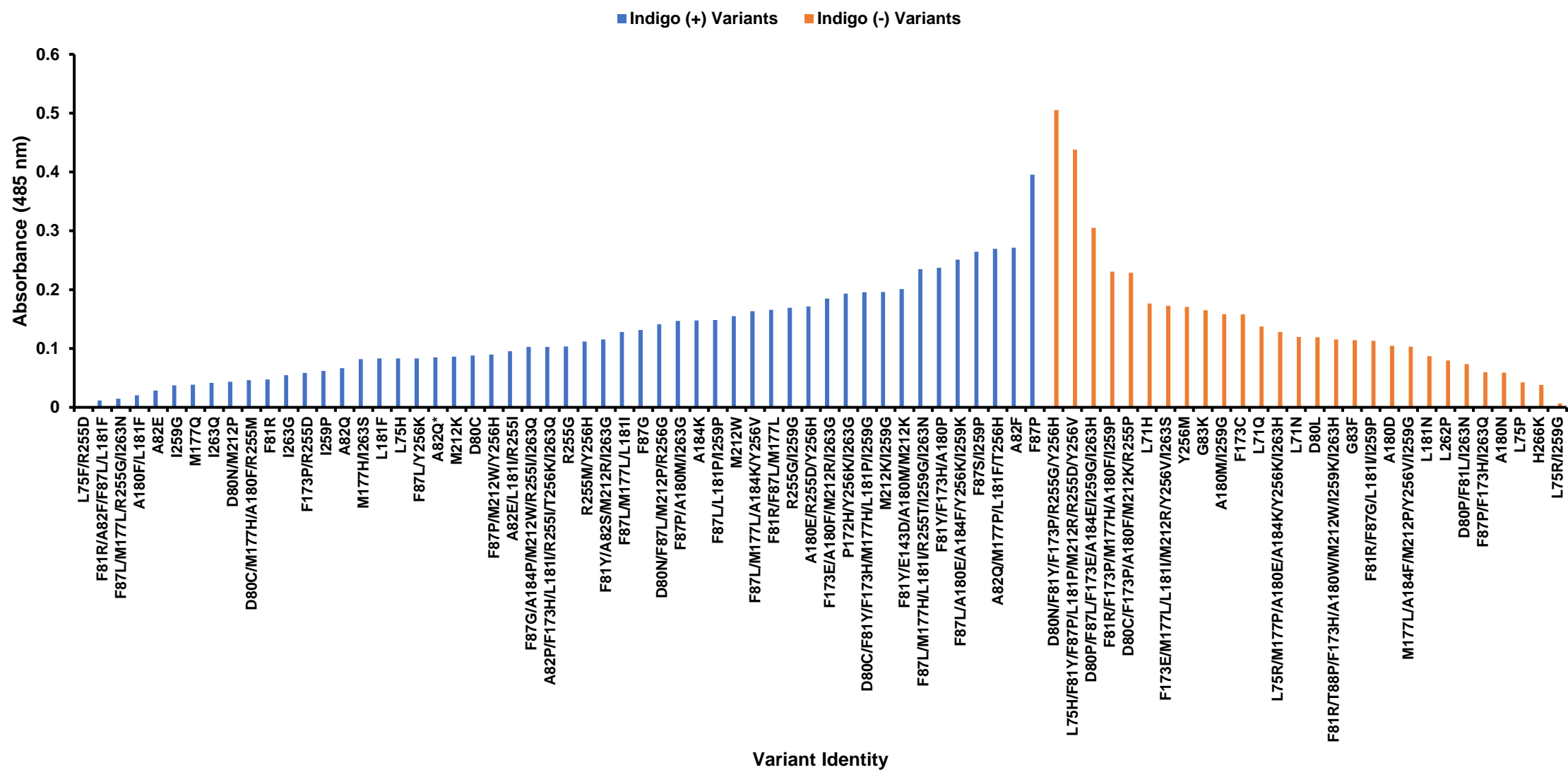
Supplementary Figure 6. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **7**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. Activity of wild-type P450 BM3 is displayed with a red line. Note: A82Q* = C-terminal His-tag. All experiments were performed in at least duplicate.



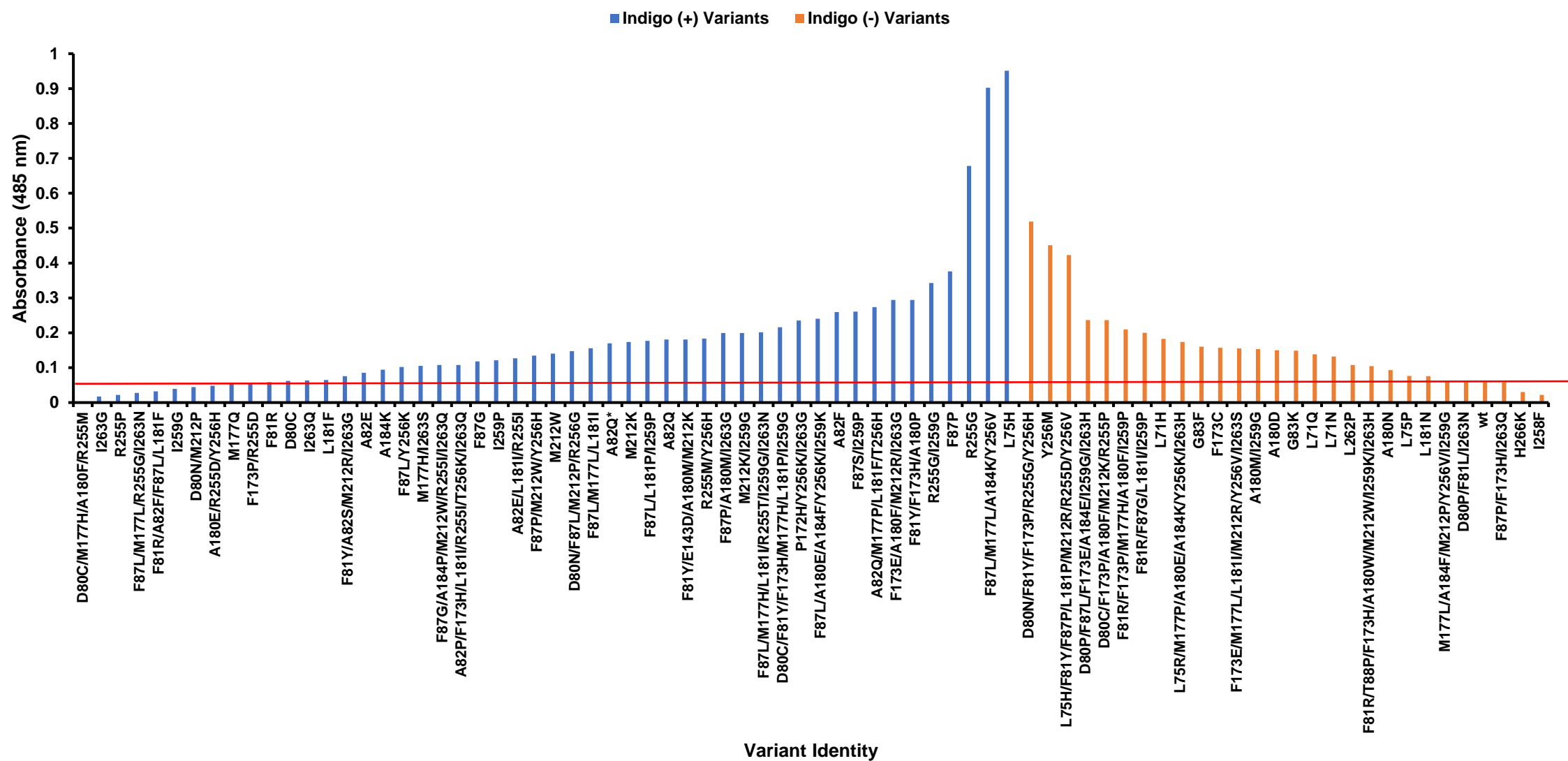
Supplementary Figure 7. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **8**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



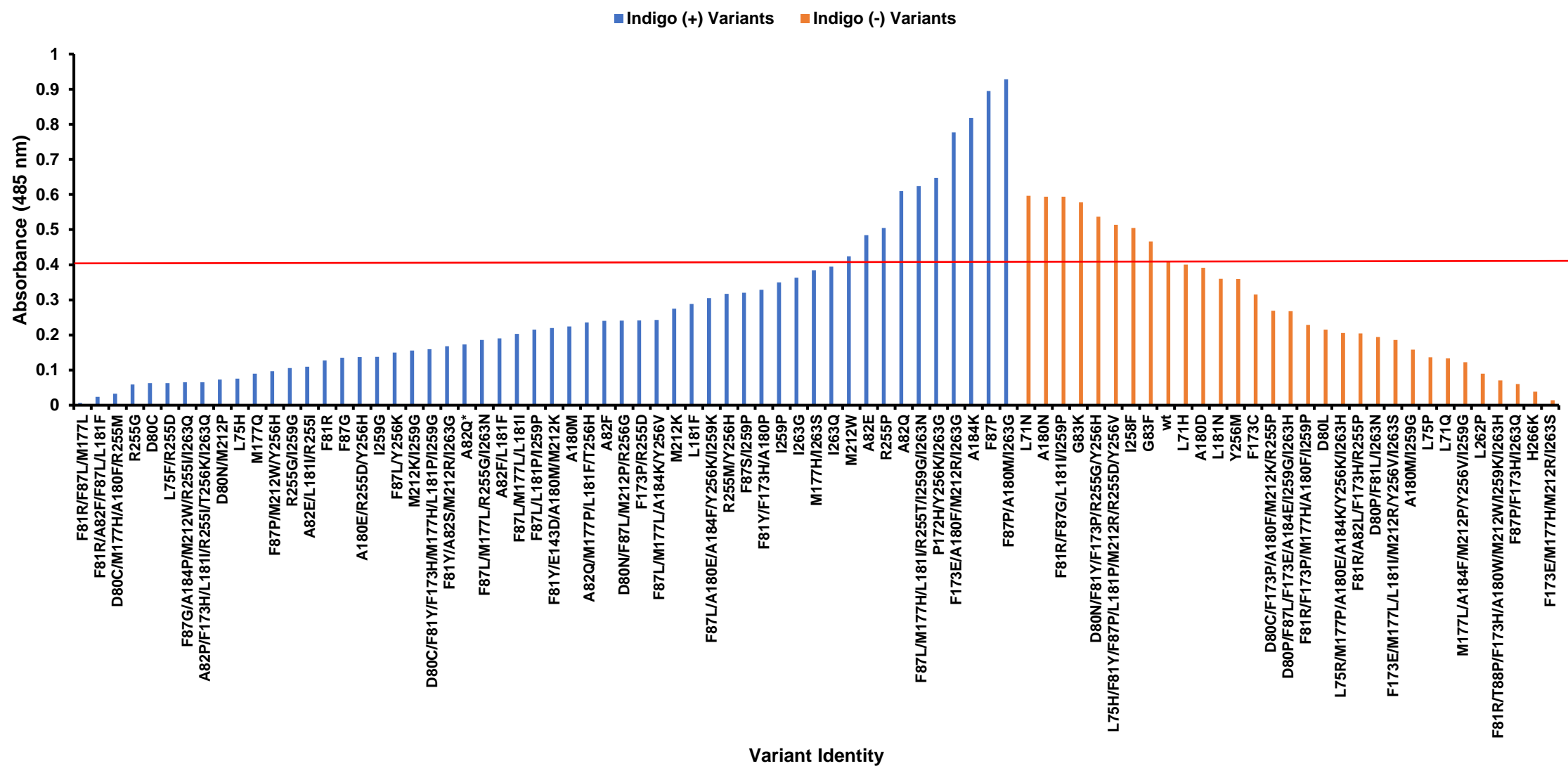
Supplementary Figure 8. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **9**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q* = C-terminal His-tag. All experiments were performed in at least duplicate.



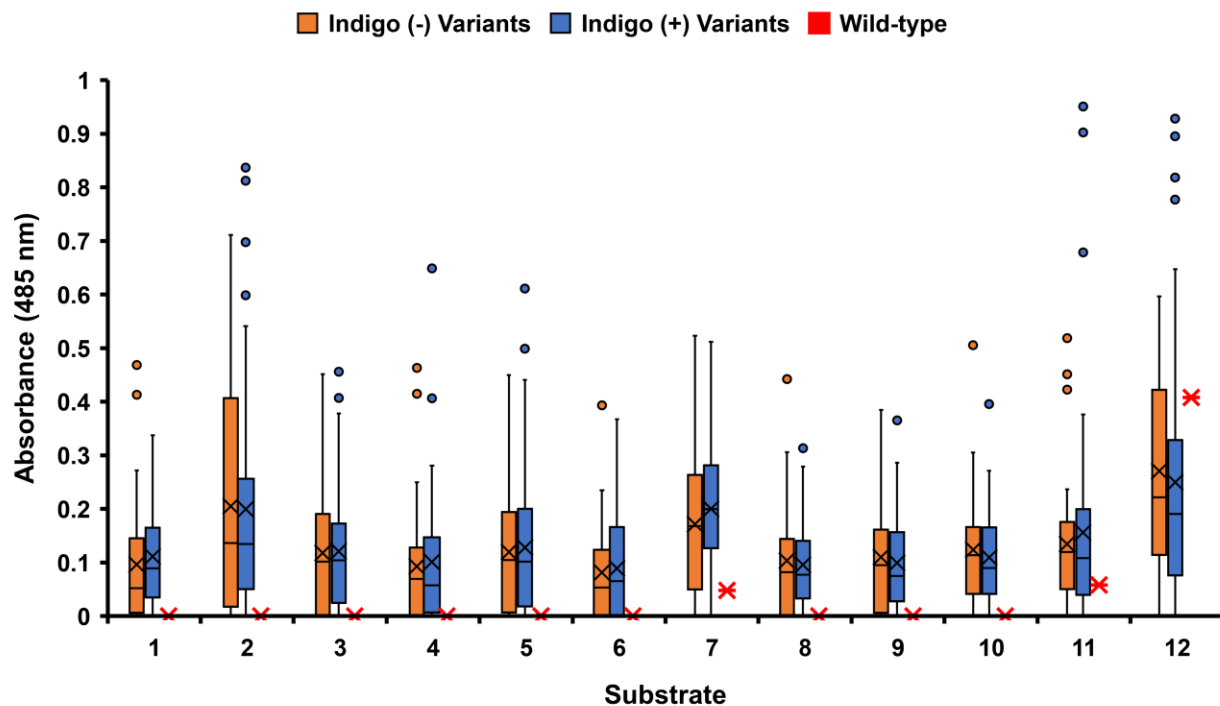
Supplementary Figure 9. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **10**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. No wild-type P450 BM3 activity was observed with this substrate. Note: A82Q*= C-terminal His-tag. All experiments were performed in at least duplicate.



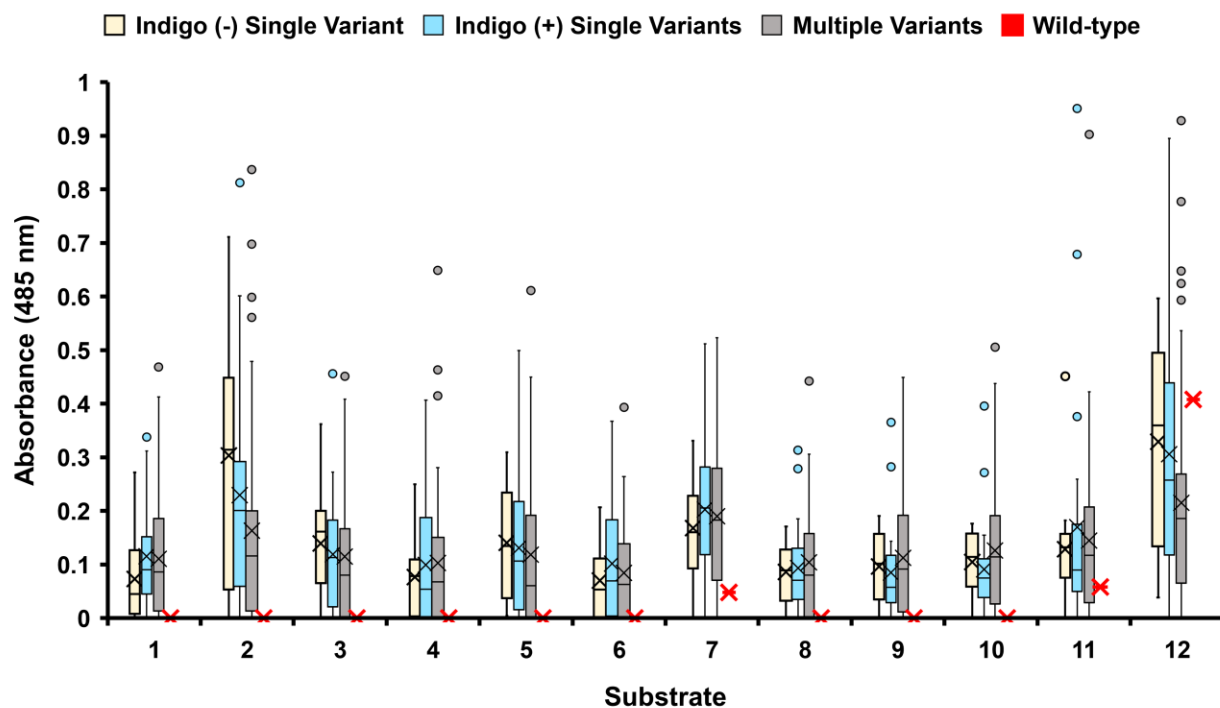
Supplementary Figure 10. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **11**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. Activity of wild-type P450 BM3 is displayed with a red line. Note: A82Q* = C-terminal His-tag. All experiments were performed in at least duplicate.



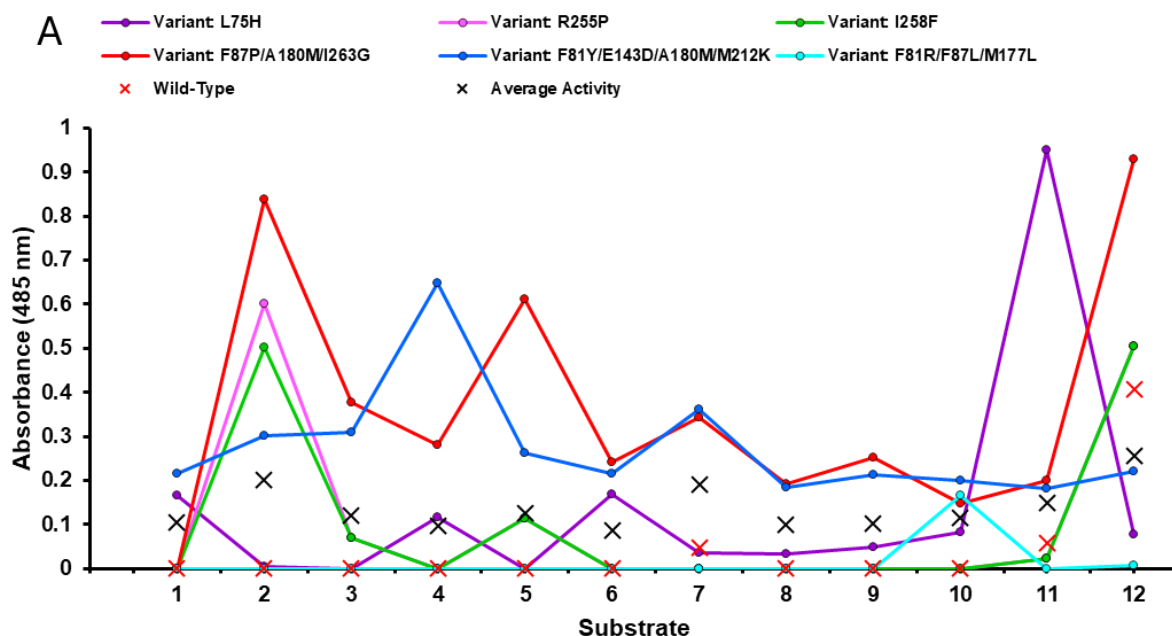
Supplementary Figure 11. Activity of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants towards hydroxylation of **12**. The conjugation of phenolic products to 4-aminoantipyrene was measured at 485 nm. For clarity, only the variants showing activity are represented. Activity of wild-type P450 BM3 is displayed with a red line. Note: A82Q* = C-terminal His-tag. All experiments were performed in at least duplicate.



Supplementary Figure 12. Box plot comparing product formation measured at 485 nm, after 4-AAP conjugation, using indigo (+) variants (blue) and indigo (-) variants (orange). Mean absorbance values for each are displayed with an “X”. Balls colored according to either category represent “top” variants as determined by the 4-AAP assay. All experiments were performed at least in duplicate. Wild-type activity is represented with a star (red).



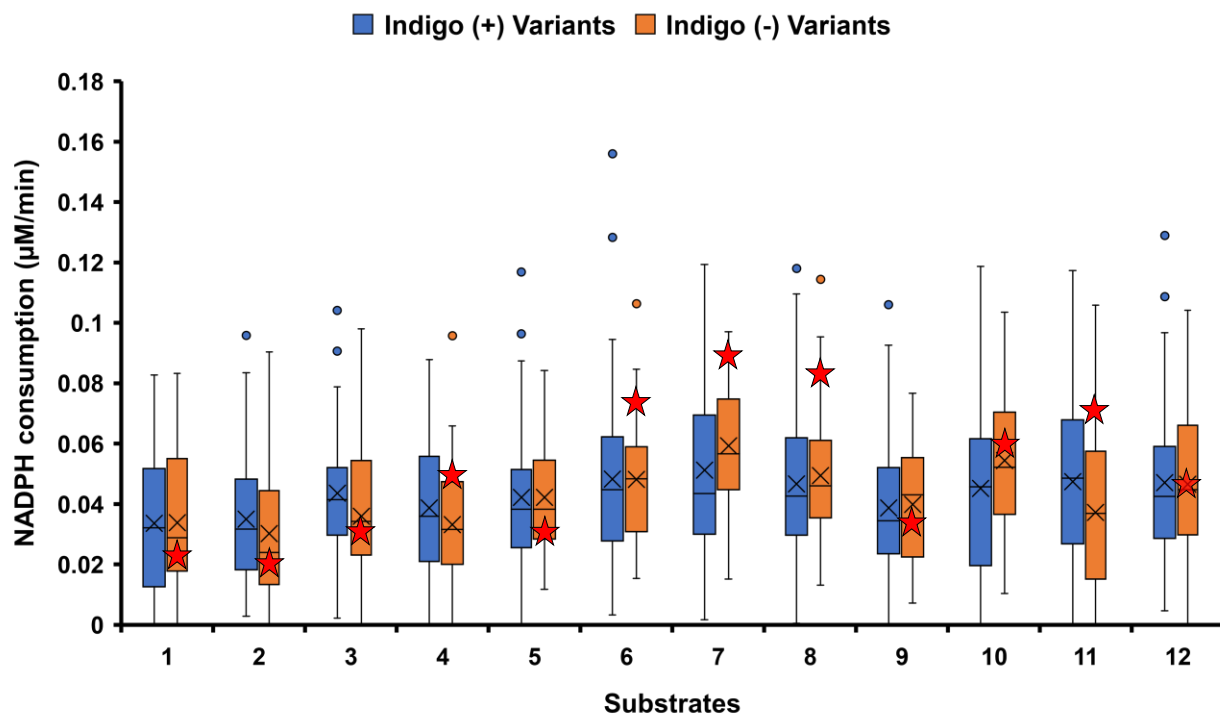
Supplementary Figure 13. Aromatic hydroxylation activity of indigo (+) and indigo (-) P450 BM3 variants as reported with the 4-AAP assay. Activity of P450 BM3 variants towards substituted benzenes (substrates 1-12) is given as absorbance at 485 nm. Average absorbance values for each are displayed with an “X” . Balls colored according to either category represent “top” variants as determined by the 4-AAP assay. All experiments were performed at least in duplicate. Wild-type activity is represented with a star (red).



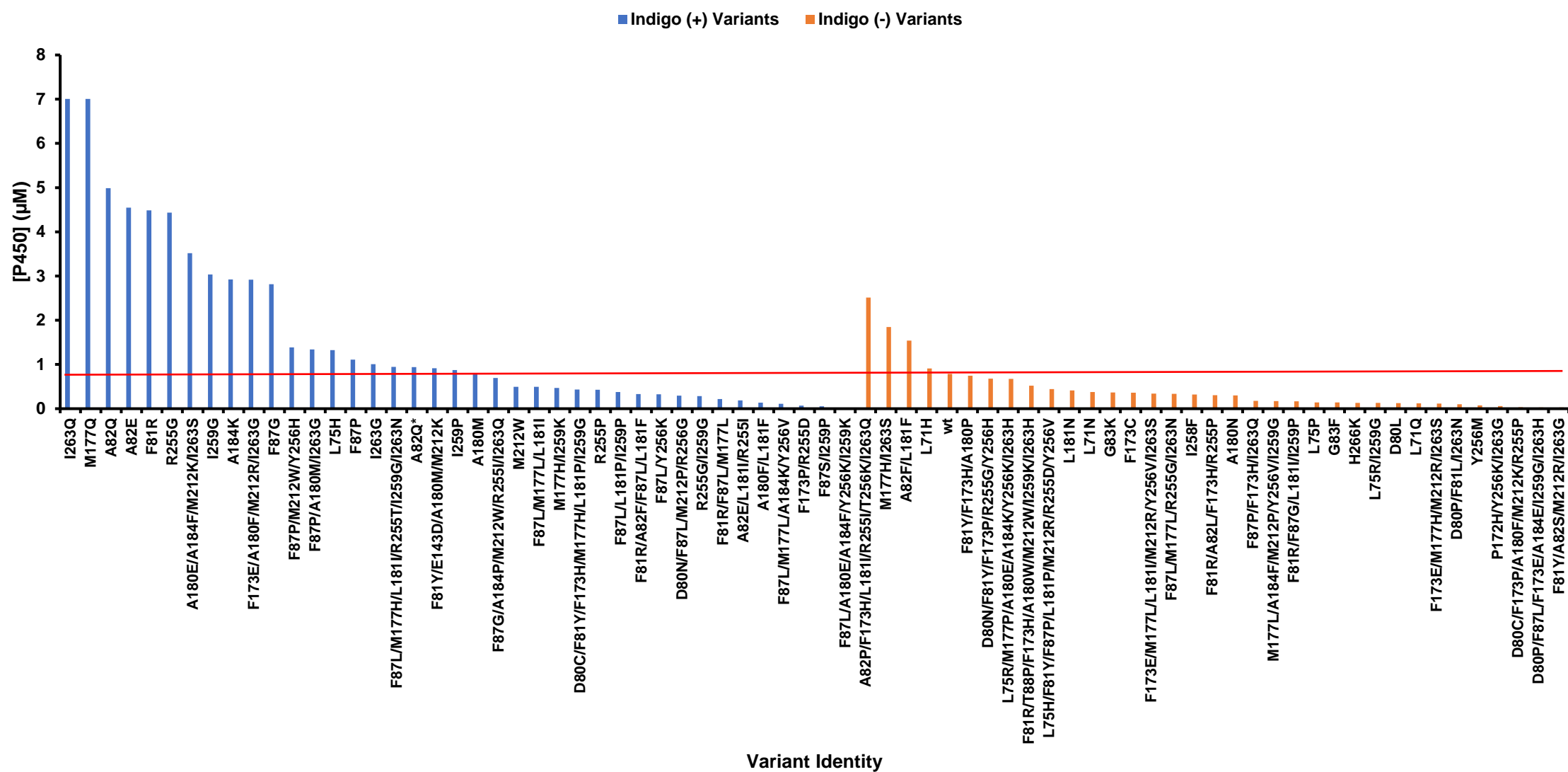
B

	Substrate											
	1	2	3	4	5	6	7	8	9	10	11	12
L75H	22	79	74	28	76	19	81	65	61	55	1	72
R255P	75	6	55	72	41	63	86	75	77	81	75	14
I285F	75	11	56	72	42	63	86	75	77	81	76	15
F87P/A180M/I263G	75	1	5	5	1	6	8	12	7	31	23	1
F81Y/E143D/A180M/M212K	15	22	9	1	12	10	5	13	13	13	27	44
F81R/F87L/M177L	75	80	74	72	76	63	86	75	77	23	79	85

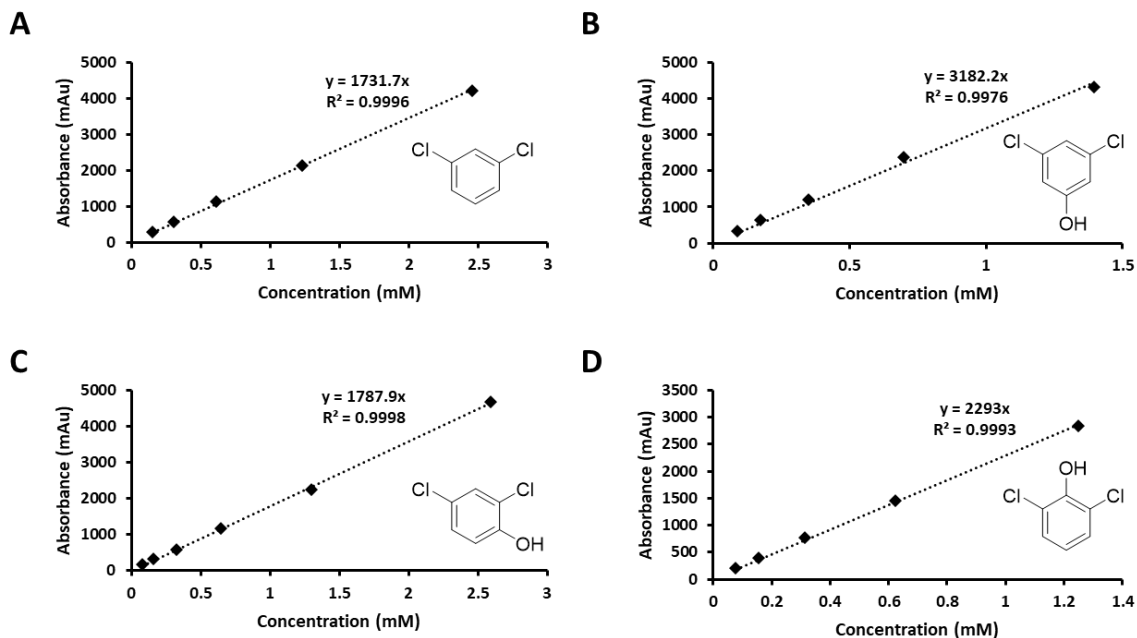
Supplementary Figure 14. Aromatic hydroxylation activity and ranked-based analysis of substrate selective P450 BM3 variants. **(A)** Aromatic hydroxylation activity of representative P450 BM3 variants that are selective for certain substrates. Mean absorbance values for each substrate are displayed with a black "X". Wild-type activity is represented with a red "X". Variants L75H, R255P, I285F, F87P/A180M/I263G, F81Y/E143D/A180M/M212K, and F81R/F87L/M177L all display a preference for certain substrates and are represented with purple, pink, green, red, dark blue and light blue lines, respectively. **(B)** Ranked based analysis of variants with enhanced substrate selectivity. The values in each row represent the activity rank for each variant with the respective substrates. Outliers, which represent a higher rank (lower number) are represented as shaded green boxes. These boxes demonstrate which substrate each variant is more selective for. Note: when comparing ranks for each substrate (column under each substrate) there may be number duplication, and this represents a ranking tie between two variants.



Supplementary Figure 15. NADPH consumption of indigo (+) (blue) and indigo (-) (orange) P450 BM3 variants measured during activity assay. NADPH consumption rates of P450 BM3 variants towards substituted benzenes (substrates 1-12) is given as rate ($\mu\text{M}/\text{min}$) calculated from absorbance at 340 nm over 87 seconds. Average absorbance values for each are displayed with an "X". Balls colored according to either category represent "top" variants. All experiments were performed at least in duplicate. Wild-type consumption rate is represented with a star (red).



Supplementary Figure 16. Enzyme concentration of indigo (+) (blue) or indigo (-) (orange) P450 BM3 variants. Wild-type enzyme concentration is represented with a red line. Expression was determined in at least duplicate; for wild-type, n=8.



Supplementary Figure 17. Calibration curves of 1,3-dichlorobenzene (**12**) (A), 3,5-dichlorophenol (**12a**) (B), 2,4-dichlorophenol (**12b**) (C) and 2,6-dichlorophenol (**12c**) (D). Calibration curves were prepared by LC-MS injection of known concentrations and integration of peaks at 214.4 nm. Integration values were plotted against concentration to generate calibration curves.

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