SUPPLEMENTARY TEXT S2

The Kinetic Model

$$\frac{d[NH_{4(ext)}^{+}]}{dt} = L - c_{ax}\left(\frac{[NtcA^{(a)}]}{k_1 + [NH_{4(ext)}^{+}]} + \frac{[NtcA^{(a)}\text{-}PipX]}{k_2 + [NH_{4(ext)}^{+}]}\right)[NH_{4(ext)}^{+}] - d_N[NH_{4(ext)}^{+}]$$

$$\frac{d[Glu]}{dt} = l_{gl} + V_{GOGAT} - V_{GS} + V_{GDH} - f_{mg}\frac{[Mcy][Glu]}{k_3 + [Glu]} - d_{gl}[Glu]$$

$$\frac{d[Gln]}{dt} = l_{gn} + V_{GS} - V_{GOGAT} - d_{gn}[Gln]$$

$$\frac{d[2\text{-}OG]}{dt} = l_{og} - V_{GOGAT} - V_{GDH} - f_{aa}[NtcA][2\text{-}OG] + b_{aa}[NtcA^{(a)}] - d_{og}[2\text{-}OG]$$

$$\frac{d[NH_4^{+}]}{dt} = l_{nh} - V_{GS} - V_{GDH} + c_{ax}\left(\frac{[NtcA^{(a)}]}{k_1 + [NH_{4(ext)}^{+}]} + \frac{[NtcA^{(a)}\text{-}PipX]}{k_2 + [NH_{4(ext)}^{+}]}\right)[NH_{4(ext)}^{+}] - d_n[NH_4^{+}]$$

$$\frac{d[NtcA]}{dt} = l_a + k_a\left(\frac{[NtcA^{(a)}]^2}{\theta_1 + [NtcA^{(a)}]^2} + \frac{[NtcA^{(a)}\text{-}PipX]^2}{\theta_2 + [NtcA^{(a)}\text{-}PipX]^2}\right) - f_{aa}[NtcA][2\text{-}OG] + b_{aa}[NtcA^{(a)}] - d_a[NtcA]$$

$$\frac{d[NtcA^{(a)}]}{dt} = f_{aa}[NtcA][2\text{-}OG] - b_{aa}[NtcA^{(a)}] - f_{ax}[NtcA^{(a)}][PipX] + b_{ax}[NtcA^{(a)}\text{-}PipX] - d_{aa}[NtcA^{(a)}]$$

$$\frac{d[PII]}{dt} = l_p - f_{px}[PII][PipX] + \frac{b_{px}[2\text{-}OG][PII\text{-}PipX]}{k_4 + [PII\text{-}PipX]} - d_p[PII]$$

$$\frac{d[PipX]}{dt} = l_x - f_{px}[PII][PipX] - f_{ax}[NtcA^{(a)}][PipX] + \frac{b_{px}[2\text{-}OG][PII\text{-}PipX]}{k_4 + [PII\text{-}PipX]} + b_{ax}[NtcA^{(a)}\text{-}PipX] - d_x[PipX]$$

$$\frac{d[NtcA^{(a)}\text{-}PipX]}{dt} = f_{ax}[NtcA^{(a)}][PipX] - (b_{ax} + d_{ax})[NtcA^{(a)}\text{-}PipX]$$

$$\frac{d[PII\text{-}PipX]}{dt} = f_{px}[PII][PipX] - \frac{b_{px}[2\text{-}OG][PII\text{-}PipX]}{k_4 + [PII\text{-}PipX]} - d_{px}[PII\text{-}PipX]$$

$$\frac{d[Mcy]}{dt} = l_{mcy} + k_m\left(\frac{[NtcA^{(a)}]^3}{\theta_3 + [NtcA^{(a)}]^3} + \frac{[NtcA^{(a)}\text{-}PipX]^3}{\theta_4 + [NtcA^{(a)}\text{-}PipX]^3}\right) - d_m[Mcy]$$

$$\frac{d[MC]}{dt} = f_{mg}\frac{[Mcy][Glu]}{k_3 + [Glu]} - d[MC]$$

where,

$$V_{GS} = \frac{v_{max2}[NH_4^+][Glu]}{K_{i(gl)}K_{nh} + K_{nh}[Glu] + K_{gl}[NH_4^+] + [NH_4^+][Glu]},$$

$$V_{GOGAT} = \frac{v_{max1}[Gln][2\text{-}OG]}{K_{i(gn)}K_{2-og} + K_{gn}[2\text{-}OG] + K_{2-og}[Gln] + [Gln][2\text{-}OG]},$$

$$V_{GDH} = \frac{v_{max3}[NH_4^+][2\text{-}OG]}{K''_{i(2-og)}K''_{nh} + K''_{nh}[2\text{-}OG] + K''_{2-og}[NH_4^+] + [NH_4^+][2\text{-}OG]}.$$

Parameters Table:

Parameters	***Description***	***Unit***	***Value***
v_{max1}	Maximal rate of GOGAT activity	$\mu M\ min^{-1}$	326
K_{gn}	Equilibrium dissociation constant for the dissociation of Gln from the ternary enzyme substrate complex	μM	173
K_{2-og}	Equilibrium dissociation constant for the dissociation of 2-OG from the ternary enzyme substrate complex	μM	10
$K_{i(gn)}$	Equilibrium dissociation constant for the dissociation of Gln from the binary enzyme substrate complex	μM	104
v_{max2}	Maximal rate of GS activity	$\mu M\ min^{-1}$	150
K_{nh}	Equilibrium dissociation constant for the dissociation of NH_4^+ from the ternary enzyme substrate complex	μM	60

K_{gl}	Equilibrium dissociation constant for the dissociation of Glu from the ternary enzyme substrate complex	μM	4500
$K_{i(gl)}$	Equilibrium dissociation constant for the dissociation of Glu from the binary enzyme substrate complex	μM	37200
v_{max3}	Maximal rate of GDH activity	$\mu M\ min^{-1}$	55
K''_{nh}	Equilibrium dissociation constant for the dissociation of NH_4^+ from the ternary enzyme substrate complex	μM	5800
K''_{2-og}	Equilibrium dissociation constant for the dissociation of 2-OG from the ternary enzyme substrate complex	μM	260
$K''_{i(2-og)}$	Equilibrium dissociation constant for the dissociation of 2-OG from the binary enzyme substrate complex	μM	720
f_{ax}	Rate constant of formation of NtcA-PipX complex	$\mu M^{-1}min^{-1}$	0.1
b_{ax}	Rate constant of disscociation of NtcA-PipX complex	min^{-1}	0.0085
f_{px}	Rate constant of formation of PII-PipX complex	$\mu M^{-1}min^{-1}$	0.0001
l_a	Basal production rate of NtcA	$\mu M\ min^{-1}$	0.39
d_a	Natural degradation of NtcA	min^{-1}	0.2
l_p	Basal production rate of PII	$\mu M\ min^{-1}$	0.25
d_p	Natural degradation of PII	min^{-1}	0.2
l_x	Basal production rate of PipX	$\mu M\ min^{-1}$	0.08
d_x	Natural degradation of PipX	min^{-1}	0.1
d_{px}	Natural degradation of PII-PipX complex	min^{-1}	0.005
f_{aa}	Rate constant of formation of NtcA-2OG complex	$\mu M^{-1}min^{-1}$	0.0001
b_{aa}	Rate constant of dissociation of NtcA-2OG complex	min^{-1}	0.008
d_{aa}	Natural degradation of NtcA-2OG complex	min^{-1}	0.2
l_{nh}	Rate of internal ammonium ion influx from other intracellular sources	$\mu M\ min^{-1}$	0.06
l_{og}	Rate of 2-OG influx from TCA cycle	$\mu M\ min^{-1}$	53

d_{og}	Depletion of 2-OG due to consumption in other reactions	min^{-1}	0.12
d_n	Natural depletion of intracellular ammonium ion or consumption into other reactions	min^{-1}	0.23
b_{px}	Rate constant of 2-OG dependent dissociation of PII-PipX	min^{-1}	0.001
k_4	Half saturation constant of 2-OG dependent PII-PipX dissociation	μM	0.5
k_a	Maximal rate of synthesis of NtcA	$\mu M\ min^{-1}$	0.17
θ_1	Half saturation constant for synthesis of NtcA due to NtcA[(a)]	μM^2	0.42
θ_2	Half saturation constant for synthesis of NtcA due to NtcA[(a)]-PipX	μM^2	0.11
c_{ax}	rate constant of nitrogen uptake under the influence of NtcA[(a)] and NtcA[(a)]-PipX	min^{-1}	12.57
k_1	Half saturation constant of nitrogen uptake due to NtcA[(a)]	μM	30
k_2	Half saturation constant of nitrogen uptake due to NtcA[(a)]-PipX	μM	7
k_m	Maximal rate of synthesis of Mcy protein	$\mu M\ min^{-1}$	0.2030 (batch 1) 0.6632 (batch 2)
θ_3	Half saturation constant for synthesis of Mcy due to NtcA[(a)]	μM^3	0.625
θ_4	Half saturation constant for synthesis of Mcy due to NtcA[(a)]-PipX	μM^3	0.325
d_m	Natural degradation of Mcy protein	min^{-1}	0.1425
f_{mg}	Rate constant of intracellular microcystin production	min^{-1}	14.8675
k_3	Half saturation constant of intracellular microcystin production	μM	1183.7
d	depletion of intracellular microcystin due natural degradation or transport to extracellular environment	min^{-1}	0.0111

l_{mcy}	Basal production rate of Mcy	$\mu M\ min^{-1}$	0.2931
L	Rate of formation of external nitrogen in the growing medium	$\mu M\ min^{-1}$	250
d_N	natural depletion of the external nitrogen	min^{-1}	0.9
d_{ax}	Natural degradation of NtcA-PipX complex	min^{-1}	0.01
l_{gl}	Rate of glutamate influx from other intracellular sources	$\mu M\ min^{-1}$	24.6664
l_{gn}	Rate of glutamine influx from other intracellular sources	$\mu M\ min^{-1}$	16
d_{gl}	depletion of glutamate into other reactions	min^{-1}	0.0253
d_{gn}	depletion of glutamine into other reactions	min^{-1}	0.08

Initial values:

Variables	***Symbols***	***Initial values***
External ammonium ion	$[NH_4^+{}_{(ext)}]$	10000
Glutamate	[Glu]	600
Glutamine	[Gln]	11000
2-oxoglutarate	[2-OG]	10
Internal ammonium ion	$[NH_4^+]$	200
NtcA	[NtcA]	0.2
PII	[PII]	2
PipX	[PipX]	0.25
NtcA-2-OG complex	$[NtcA^{(a)}]$	0.05
NtcA-2-OG-PipX complex	$[NtcA^{(a)}$-PipX]	1
PII-PipX complex	[PII-PipX]	1
Mcy enzyme	[Mcy]	0.1
Microcystin	[MC]	1600 (batch 1) 2600 (batch 2)

*All the initial values are taken in μM

MATLAB script for the kinetic model

Definition of function for ode15s

```
function zdot=microcystin_ode(t,z)

global v_max1 K_gn K_og v_max2 K_nh K_gl l_nh l_og d_gl d_gn
global l_a k_a theta1 k1 d_a l_p d_p l_x d_x c_ax k2 d_og d_n l_mcy d_ax
global f_ax b_ax f_px b_px theta2 k_m d_m d v_max3 l_gl l_gn L d_N d_px
K1_nh K1_og f_mg
global f_aa b_aa d_aa Ki_gn Ki_gl K1_i_og theta3 theta4 k3 k4

s1=l_gl+(v_max1*z(2)*z(3))/(Ki_gn*K_og+K_og*z(2)+K_gn*z(3)+z(2)*z(3))-
(v_max2*z(1)*z(4))/(Ki_gl*K_nh+K_gl*z(4)+K_nh*z(1)+z(1)*z(4))-
f_mg*(z(10)*z(1))/(k3+z(1))-
d_gl*z(1)+(v_max3*z(3)*z(4))/(K1_i_og*K1_nh+K1_nh*z(3)+K1_og*z(4)+z(3)*z(4
));
% d[Glu]/dt

s2=l_gn+(v_max2*z(1)*z(4))/(Ki_gl*K_nh+K_gl*z(4)+K_nh*z(1)+z(1)*z(4))-
(v_max1*z(2)*z(3))/(Ki_gn*K_og+K_og*z(2)+K_gn*z(3)+z(2)*z(3))-d_gn*z(2);
% d[Gln]/dt

s3=l_og-(v_max1*z(2)*z(3))/(Ki_gn*K_og+K_og*z(2)+K_gn*z(3)+z(2)*z(3))-
d_og*z(3)-f_aa*z(3)*z(5)+b_aa*z(13)-
(v_max3*z(3)*z(4))/(K1_i_og*K1_nh+K1_nh*z(3)+K1_og*z(4)+z(3)*z(4));
% d[2-OG]/dt

s4=l_nh-(v_max2*z(1)*z(4))/(Ki_gl*K_nh+K_gl*z(4)+K_nh*z(1)+z(1)*z(4))-
d_n*z(4)+c_ax*(z(8)/(k2+z(12))+z(13)/(k1+z(12)))*z(12)-
(v_max3*z(3)*z(4))/(K1_i_og*K1_nh+K1_nh*z(3)+K1_og*z(4)+z(3)*z(4));
% d[NH4+]/dt


s5=l_a-f_aa*z(5)*z(3)+b_aa*z(13)-
d_a*z(5)+(k_a*z(13)^2)/(theta1+z(13)^2)+(k_a*z(8)^2)/(theta2+z(8)^2);
% d[NtcA]/dt

s6=l_p-f_px*z(6)*z(7)-d_p*z(6)+b_px*z(3)*z(9)/(k4+z(9));
% d[PII]/dt

s7=l_x-f_px*z(6)*z(7)-f_ax*z(13)*z(7)+b_ax*z(8)-
d_x*z(7)+b_px*z(3)*z(9)/(k4+z(9));
% d[PipX]/dt

s8=f_ax*z(13)*z(7)-b_ax*z(8)-d_ax*z(8);
% d[NtcA-PipX-2OG]/dt

s9=f_px*z(6)*z(7)-b_px*z(3)*z(9)/(k4+z(9))-d_px*z(9);
% d[PII-PipX]/dt
```

```
s10=l_mcy+(k_m*z(13)^3)/(theta3+z(13)^3)+(k_m*z(8)^3)/(theta4+z(8)^3)-
d_m*z(10);
% d[Mcy]/dt

s11=f_mg*(z(10)*z(1))/(k3+z(1))-d*z(11);
% d[MC]/dt

s12=L-c_ax*(z(8)/(k2+z(12))+z(13)/(k1+z(12)))*z(12)-d_N*z(12);
% d[NH4+_ext]/dt

s13=f_aa*z(5)*z(3)-b_aa*z(13)-f_ax*z(13)*z(7)+b_ax*z(8)-d_aa*z(13);
% d[NtcA-2OG]/dt

zdot=[s1;s2;s3;s4;s5;s6;s7;s8;s9;s10;s11;s12;s13];

end
```

Calling the function

```
global v_max1 K_gn K_og v_max2 K_nh K_gl l_nh l_og d_og d_n k_m theta2
global l_a k_a theta1 f_ax k1 b_ax d_a l_p f_px b_px d_p l_x d_x c_ax k2
d_m d
global v_max3 l_gl l_gn d_gl d_gn l_mcy L d_N d_ax d_px f_mg K1_nh K1_og
global f_aa b_aa d_aa Ki_gn Ki_gl K1_i_og theta3 theta4 k3 k4

k_m=0.6632;
f_mg=14.8675;
k3=1183.7;          % estimated parameters
l_mcy=0.2931;
l_gl=24.6664;
d_gl=0.0253;
d_m=0.1425;
d=0.0111;


v_max1=326;
K_gn=173;
K_og=10;
Ki_gn=104;

v_max2=150;
K_nh=60;
K_gl=4500;
Ki_gl=37200;

v_max3=500;
K1_nh=5800;
K1_og=260;
K1_i_og=720;

f_ax=0.1;
b_ax=0.0085;

f_px=0.0001;
```

```
l_a=0.39;
d_a=0.2;
l_p=0.25;
d_p=0.2;
l_x=0.08;
d_x=0.1;

f_aa=0.1;
b_aa=0.008;
d_aa=0.2;

d_px=0.005;

l_nh=0.06;
l_og=53;
d_og=0.12;
d_n=0.23;

b_px=0.001;
k4=0.5;


k_a=0.17;
theta1=0.42;
theta2=0.11;
c_ax=12.57;
k2=7;
k1=30;

theta3=0.625;
theta4=0.325;


L=250;
d_N=0.9;
d_ax=0.01;

l_gn=16;
d_gn= 0.08;

z0=[600,11000,10,200,0.2,2,0.25,1,1,0.1,1600,10000,0.05];
tspan=[0 3600000];


[t,z]=ode15s('microcystin_ode',tspan,z0);
```