Table S1. Parameters of 5 Models

Parameter	Run number					Parameter	Run number				
	1	2	6	7	4cs_7		1	2	6	7	4cs_7
RMS	2.27	2.33	2.40	5.29	1.48	A^P_{Bcd}	1.36	0.69	0.03	0.08	3.99
$S^R_{\mathrm{M3\_2}}$†	1	1	1	1	1	A^P_{Cad}	0.02	0.01	0.05	0.03	0.05
S^R_{M32}†	1	1	1	1	1	$A^P_{\mathrm{D-STAT}}$	3.98	3.98	1.09	3.99	3.98
$S^R_{\mathrm{M2\_3}}$†	1	1	1	1	1	A^P_{Dichaete}	3.85	0.41	3.89	0.18	0.09
S^R_{M23}†	1	1	1	1	1	A^P_{Hb}	0.82	2.73	2.72	0.04	0.09
$S^R_{\mathrm{1.7kb}}$	0.3	0.3	0.2	1.41	N/A	A^P_{Kr}	0.07	0.13	0.03	2.95	0.1
S^R_{MSE2}	0.2	0.2	0.2	0.2	N/A	A^P_{Kni}	2.58	3.99	2.23	0.27	2.8
S^R_{MSE3}	0.8	0.8	0.8	0.8	N/A	A^P_{Gt}	3.99	2.07	2.53	0.04	0.02
R_{max}†	255	255	255	255	255	A^P_{Tll}	2.88	3.96	0.02	1.95	0.004
Θ	6.7	6.4	6.1	5.96	10.6	λ_{Bcd}	1.53	1.99	4.99	2.16	1.68
$E^C_{\mathrm{B-H}}$	0.34	0.44	0.21	0.35	0.35	λ_{Cad}	4.98	4.98	4.97	3.18	4.99
$E^C_{\mathrm{C-H}}$	0.66	0.99	0.33	0.88	0.88	$\lambda_{\mathrm{D-STAT}}$	1.62	1.98	2.58	0.69	0.89
$K^{\mathrm{coop}}_{\mathrm{B-B}}$	52	982	189	127	86	$\lambda_{\mathrm{Dichaete}}$	0.91	2.33	1.98	4.54	3.49
$D^C_{\mathrm{B-H}}$	165	161	158	150	150	λ_{Hb}	1.93	1.5	1.83	4.99	4.25
$D^C_{\mathrm{C-H}}$	57	58	70	22	28	λ_{Kr}	3.08	2.31	4.04	0.98	4.99
$D^{\mathrm{coop}}_{\mathrm{B-B}}$†	60	20	60	60	60	λ_{Kni}	1.6	1.17	2.48	1.56	1.82
E^A_{Bcd}	0.5	0.5	0.06	0.0001	0.001	λ_{Gt}	1.25	1.47	1.71	4.99	4.63
E^A_{Cad}	0.0001	0.0001	0.0001	0.0001	0.39	λ_{Tll}	0.87	1.26	4.98	0.96	4.99
$E^A_{\mathrm{D-STAT}}$	19.9	19.9	0.0001	19.9	16.6	T_{Bcd}†	1.71	1.71	1.71	1.71	1.71
E^A_{Dichaete}	0.0001	0.0001	0.0001	0.45	0.004	T_{Cad}	2.53	2.22	3.06	2.06	3.0
E^A_{Hb}	14.4	13.5	20.41	29.9	19.1	$T_{\mathrm{D-STAT}}$	2.21	2.19	2.83	3.63	2.83
E^Q_{Hb}	0.99	0.99	0.99	0.99	0.99	T_{Dichaete}	2.22	4.92	4.79	2.96	2.08
E^Q_{Kr}	0.99	0.99	0.9	0.99	0.51	T_{Hb}†	0.63	0.63	0.63	0.63	0.63
E^Q_{Kni}	0.54	0.75	0.06	0.99	0.26	T_{Kr}	0.009	0.02	2.11	0.07	2.06
E^Q_{Gt}	0.75	0.43	0.72	0.74	0.99	T_{Kni}	2.2	2.48	2.23	4.85	2.46
E^Q_{Tll}	0.99	0.14	0.99	0.99	0.81	T_{Gt}	0.6	0.59	0.59	0.50	0.71
E^D_{Hb}	0.53	0.31	0.32	0.58	0.37	T_{Tll}	1.83	1.82	1.97	1.97	1.97
E^D_{Kr}	0.99	0.73	0.99	0.99	0.6						
E^D_{Kni}	0.24	0.14	0.12	0.99	0.05						
E^D_{Gt}	0.87	0.99	0.17	0.99	0.51						
E^D_{Tll}	0.0001	0.0001	0.0002	0.0001	0.98						
D^Q_{all}†	100	100	100	100	100						
D^D_{all}†	100	100	100	100	100						

These parameters are inferred from the observed expression patterns by fitting transcription models to quantitative data. Daggers indicate parameters held fixed during the training process. $S^R_{\mathrm{construct}}$ is the positional effect scale factor for each reporter construct. R_{max} is the maximum rate of transcription. S^P_{ligand} is the scale factor for protein concentration. Other parameters are described in the main text.