SUPPLEMENTARY MATERIAL

Paradoxical suppression of small RNA activity at high Hfq concentrations due to random-order binding

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Supplementary Methods

Mathematical model

The differential equations for the system, which are shown below, include the association and dissociation of the sRNAs (S), target mRNAs (T), Hfq (H), sRNA-Hfq (SH), mRNA-Hfq (TH), sRNA-mRNA-Hfq (SHT), duplex (D) and target protein (P).

$$\dot{S} = \alpha_S + k_{-STH}SHT - k_SS \cdot H - k_{STH}S \cdot TH - \beta_SS,$$
^[1]

$$\dot{T} = \alpha_T + k_{-T}TH + k_{-TSH}SHT - k_TT \cdot H - k_{TSH}T \cdot SH - \beta_TT,$$
[2]

$$\dot{H} = \alpha_H + k_{-S}SH + k_{-T}TH + k_{Dup}SHT + \beta_{SH}SH + \beta_{TH}TH + \beta_{SHT}SHT - k_SS \cdot H - k_TT \cdot H - \beta_HH,$$
 [3]

$$\dot{SH} = k_s S \cdot H + k_{-TSH} SHT - k_{-s} SH - k_{TSH} T \cdot SH - \beta_{SH} SH - \beta_H SH,$$
[4]

$$\dot{TH} = k_T T \cdot H + k_{-STH} SHT - k_{-T} TH - k_{STH} S \cdot TH - \beta_{TH} TH - \beta_H TH,$$
[5]

$$S\dot{T}H = k_{STH}S \cdot TH + k_{TSH}T \cdot SH - (k_{-STH} + k_{-TSH} + k_{Dup} + \beta_{SHT} + \beta_H)SHT,$$
[6]

$$\dot{D} = k_{Dup}SHT - \beta_D D$$
, and [7]

$$\dot{P} = \alpha_P T - \beta_P P, \tag{8a}$$

or
$$\dot{P} = \alpha_P (T + TH + SHT) - \beta_P P$$
 [8b]

or
$$\dot{P} = \alpha_P D - \beta_P P.$$
 [8c]

Eq. 8a, 8b or 8c were used when the free mRNA, free and bound mRNA, or duplex was translated.

Where possible the simulations used biologically relevant values obtained from experiments as previously reported (1). $\alpha_{\rm S}$, $\alpha_{\rm T}$ and $\alpha_{\rm H}$ are the production rates for the sRNA, mRNA and Hfq protein (respective values are 1, 1 and 0.3 nM·min⁻¹). $\alpha_{\rm P}$ is the protein production rate (value = 5 nM·(mRNA nM)⁻¹·min⁻¹). $\beta_{\rm S}$, $\beta_{\rm T}$, $\beta_{\rm SH}$, $\beta_{\rm TH}$, $\beta_{\rm SHT}$, and $\beta_{\rm D}$ are the degradation rate constants for the sRNA, mRNA, sRNA in SH, mRNA in TH, sRNA and mRNA in SHT, and duplex respectively (all values = 0.14 min⁻¹). $\beta_{\rm H}$ and $\beta_{\rm P}$ are the

degradation rate constants for Hfq (free and bound forms) and target protein (both values = 0.03 min⁻¹). $k_{\rm S}$, $k_{\rm T}$, $k_{\rm SH}$, $k_{\rm TH}$, $k_{\rm STH}$ and $k_{\rm TSH}$ are the RNA binding rate constants (all values = 1 nM⁻¹·min⁻¹). $k_{\rm -S}$, $k_{\rm -T}$, $k_{\rm -SH}$, $k_{\rm -TH}$, $k_{\rm -STH}$ and $k_{\rm -TSH}$ are the RNA dissociation rate constants (all values = 0.1 min⁻¹). $k_{\rm Dup}$ is the rate constant for duplex formation and release from the SHT complex (value = 1 min⁻¹).

Supplementary References

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Supplementary Figure Legends

Figure S1. Plasmid maps.

Figure S2. Relative strengths of the different promoters and ribosome binding sequences (RBS). Measurements were obtained by placing *gfp* under the control of different promoters and RBS and measuring GFP fluorescence by flow cytometry. Note the measurements were performed on different dates to the measurements in **Figs. S3-S5** and should not be directly compared to them. (**A**) Relative expression of PCon and PConM8 (-35 site is mutated from 5' TTGACA 3' to 5' TTTACA 3' and the -10 site is mutated from 5' TATAAT 3' to 5' TATGGT 3'). Mean expression for PCon and PConM8 are 4.24 ± 0.41 a.u. and 44.83 ± 3.13 a.u. Errors are the SEM. Each promoter was measured in triplicate. Strains: HL2516 (PCon) and HL2916 (PConM8). (**B**) Relative expression of PLtetO-1 and PLtetO-1M9 (-10 site is mutated from 5' GATACT 3' to 5' GAGACT 3'). Mean expression for PLtetO-1 and PLtetO-1M9 are 3.90 ± 0.20 a.u. and 40.57 ± 1.32 a.u. Each promoter was measured in duplicate. Details of the PLtetO-1 and PLtetO-1 monoters are reported elsewhere (2,3). Strains: HL1085 (PLtetO-1) and HL1672 (PLtetO-1M9). (**C**) Relative expression of GFP with the st7 and T710 RBS. The *gfp* was transcribed from the PLlacO-1 promoter at maximum induction (1 mM IPTG). Mean expression with the st7 and T710 RBS are 220.46 ± 5.87 a.u. and 409.19 ± 15.09 a.u. All errors are the SEM. Each RBS was measured in triplicate. Strains: HL6442 (st7 RBS) and HL5189 (T710 RBS).

Figure S3. GFP expression with the st7 and T710 RBS. Measurements were obtained by placing *gfp* under the control of the PLIacO-1 promoter and measuring GFP fluorescence by flow cytometry at different concentrations of IPTG. Error bars are the SEM of triplicate measurements. Total n = 48. Strains: HL5189 (PLIacO-1:T710::*gfp*) and HL6442 (PLIacO-1:st7::*gfp*). Note the measurements were performed on different dates to the measurements in **Figs. S2, S4 and S5** and should not be directly compared to them.

Figure S4. GFP expression and relative induction of PLIacO-1 at different IPTG concentrations measured in parallel with the samples in Fig 4*B*. Measurements were obtained by placing the *gfp* gene under the control of the PLIacO-1 promoter and measuring GFP fluorescence by flow cytometry at different concentrations of IPTG. Error bars are the SEM. Note the measurements were performed on different dates to the measurements in Figs. S2, S3 and S5 and should not be directly compared to them. (A) GFP expression with the st7 RBS in strain HL6582, which has both chr. *hfq* and *ryhB* deleted, as a function of IPTG concentration. Measurements were performed in triplicate at each concentration. Total n = 21. The line is a guide to the eye of the mean GFP expression at each IPTG concentration. (B) Relative induction as a function of IPTG concentration. The relative induction was calculated by subtracting the mean GFP fluorescence value at 0 μ M from the mean values obtained at all IPTG concentrations, and then dividing by the mean GFP fluorescence at 1000 μ M to normalize the values.

Figure S5. Relative strengths of the PLtetO-1, PLlacO-1 and PCon promoters. Measurements were obtained by placing *gfp* with the same RBS from ompC under the control of different promoters and measuring GFP fluorescence by flow cytometry. Strains: HL3167 (PLtetO-1:*ompC*::*gfp*), HL3186 (PLlacO-1:*ompC*::*gfp*) and HL3268 (PLtetO-1Con:*ompC*::gfp). Each strain was measured in duplicate biological replicates. Total n = 6. Note the measurements were performed on different dates to the measurements in **Figs. S2-S4** and should not be directly compared to them.

Figure S6. Additional experiments with varying sRNA and mRNA production for the RyhB and MicC silencing sRNAs. Error bars are the SEM of duplicate measurements (panels A, B, and G) or root mean square error calculated from the SEM (panels C, D and H). (A, B) GFP expression as a function *sodB* and *ompC* transcription in strains with chromosomal *hfq* deleted. These delta chr. *hfq* measurements were performed identically and with the same plasmids as the measurements with chromosomal *hfq* (Fig. 5). Strains: HL3333 (no RyhB, *sodB*), HL2413 (RyhB, *sodB*), HL2411 (MicC, *ompC*) and HL3610 (no MicC, *ompC*). (C, D) RyhB and MicC activity as a function of relative mRNA production in the absence of Hfq. sRNA activity was calculated by subtracting the average GFP fluorescence value with the sRNA from the average value without the sRNA at each level of mRNA

induction. Relative mRNA production at different IPTG concentrations was determined using previously reported data (2). (**E**) Simulation of GFP expression for a target mRNA that is only translated in the free state as a function of sRNA production. (**F**) Genetic circuit used to investigate the effect of varying sRNA production on sRNA activity with constant Hfq and mRNA production. sRNA production was varied by placing the gene under the inducible PLlacO-1 promoter. (**G**, **H**) GFP expression and sRNA activity as a function of sRNA production. Total n = 20 per strain with duplicate measurements for each IPTG concentration. Strains: HL2625 (RyhB, *sodB*) and HL839 (MicC, *ompC*).

Supplementary Table Legends

Table S1. Plasmids and strains.

†Note: For brevity the absence of the Hind III restriction enzyme site in the PCon and PConM8 promoters was not stated in **Fig. S5** and the main text. That is, PConNoHind = PCon and PConNoHindM8 = PConM8 except where otherwise indicated (*e.g.* pHL533 and pHL671). * Reported in (2). # Reported in (1). ‡ Reported in (4). † Reported in (5) as K1 fw or K1 rev.

Table S2. Oligonucleotides.

* Reported in (2). ‡ Reported in (4). ◊ Reported in (6). § Reported in (7). qRT-PCR = quantitative reverse transcriptase polymerase chain reaction.



* PCon with HindIII site (pHL671) or PConM8 (pHL1017)

Figure S1. Plasmid maps.



Figure S2. Relative strengths of the different promoters and ribosome binding sequences (RBS).



Figure S3. GFP expression with the st7 and T710 RBS.



Figure S4. GFP expression and relative induction of PLIacO-1 at different IPTG concentrations measured in parallel with the samples in Fig 4B.



Figure S5. Relative strengths of the PLtetO-1, PLIacO-1 and PCon promoters.



Figure S6. Additional experiments with varying sRNA and mRNA production for the RyhB and MicC silencing sRNAs.

Table S1.	Plasmids	and strains.
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Plasmid (pHL)/ Strain (HL)	Description†	Antibiotic Resistance
pHL108*	AmpR + PLlacO-1:: <i>micC</i> :: <i>mCherry</i> ::T1 terminator + PLtetO-1:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL269*	AmpR + PLtetO-1:: <i>micC::mCherry</i> ::T1 terminator + PLlacO-1:: <i>ompC::gfp</i> ::T1T2 terminator + CoIE1	amp
pHL282*	AmpR + PLtetO-1:: <i>mCherry</i> ::T1 terminator + PLlacO-1:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL391	AmpR + PLtetO-1::RBS (st7) <i>hfq::mCherry:</i> :T1 terminator + PLlacO-1:: <i>ompC::gfp</i> ::T1T2 terminator + CoIE1	amp
pHL417	AmpR + PLtetO-1:: <i>micC</i> ::Asp terminator + PLlacO-1:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + PLtetO-1::RBS (st7) <i>hfq</i> ::T1 terminator + ColE1	amp
pHL518	AmpR + PLlacO-1:: <i>micC</i> :: <i>mCherry</i> ::T1 terminator + PLtetO-1m9:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL533	KanR + PCon::RBS(st7) <i>tetR</i> + p15a. Used to integrate PCon::RBS (<i>st7</i>) <i>tetR</i> into the chromosome at <i>galK</i> .	kan
pHL600‡	KanR + PLtetO-1::csrB::T1 terminator + PLlacO-1::RBS (st7) csrA::Asp terminator + p15a	kan
pHL671	AmpR + PCon::g/gC::gfp::T1T2 terminator + CoIE1	amp
pHL720*	AmpR + PLtetO-1:: <i>mCherry</i> ::T1 terminator + PLlacO-1:: <i>sodB</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL745*	AmpR + PLtetO-1:: <i>ryhB</i> :: <i>mCherry</i> ::T1 terminator + PLlacO-1:: <i>sodB</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL841*	AmpR + PLtetO-1:: <i>ryhB</i> :: <i>mCherry</i> ::T1 terminator + PLlacO-1:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL908*	AmpR + PLlacO-1::ryhB::mCherry::T1 terminator + PLtetO-1m9::sodB::gfp::T1T2 terminator + CoIE1	amp
pHL1009*	AmpR + PLtetO-1::RBS (st7) gfp::T1T2 terminator + PLlacO-1::micC + ColE1	amp
pHL1011*	AmpR + PLtetO-1m9::RBS (st7) gfp::T1T2 terminator + PLlacO-1::ryhB + ColE1	amp
pHL1017	AmpR + PConNoHindM8::glgC::gfp::T1T2 terminator + ColE1	amp
pHL1228*	AmpR + PLtetO-1:: <i>dsrA</i> :: <i>mCherry</i> ::T1 terminator + PLlacO-1:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL1632	AmpR + PLlacO-1::RBS (st7) gfp::Asp terminator + ColE1	amp
pHL1633	AmpR + PLlacO-1::T710 gfp::Asp terminator + CoIE1	amp
pHL1884	AmpR + PLlacO-1::glmS::gfp::T1T2 terminator + Asp terminator + ColE1	amp
pHL1954	AmpR + PConNoHindM8:: <i>ryhB</i> ::Asp terminator + PLlacO-1::RBS (st7) <i>hfq</i> ::T1 terminator + PLtetO-1m9:: <i>sodB</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL1969	AmpR + PConNoHindM8:: <i>ryhB</i> ::Asp terminator + PLlacO-1::T710 <i>hfq</i> ::T1 terminator + PLtetO-1m9:: <i>sodB</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL1979	AmpR + PCon::glmZ::T1T2 terminator + ColE1	amp
pHL2021	AmpR + PLlacO-1::T710 <i>hfq</i> ::T1 terminator + PLtetO-1m9:: <i>sodB</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL2026	AmpR + PLlacO-1::T710 <i>hfq</i> ::T1 terminator + PLtetO-1m9:: <i>glmS</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL2027	AmpR + PLlacO-1::T710 <i>hfq</i> ::T1terminator + PLtetO-1:: <i>glmS</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL2053	AmpR + PLIacO-1::T710:: <i>hfq</i> ::T1 termintor + PLtetO-1m9:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + CoIE1	amp
pHL2073	AmpR + PConShortNoHind::g/mZ::Asp terminator + PLIacO-1::T710 hfq::T1 terminator + PLtetO-1m9::g/mS::gfp::T1T2 terminator + CoIE1	amp
pHL2075	AmpR + PConShortNoHind::glmZ::Asp terminator + PLlacO-1::T710 hfq::T1 terminator + PLtetO-1::glmS::gfp::T1T2 terminator + CoIE1	amp
pHL2084	AmpR + PConShortNoHindM8::glmZ::Asp terminator + PLlacO-1::T710 hfq::T1 terminator + PLtetO-1m9::glmS::gfp::T172 terminator + ColE1	amp
pHL2085	AmpR + PConShortNoHindM8::g/mZ::Asp terminator + PLIacO-1::T710 hfq::T1 terminator + PLtetO-1::g/mS::gfp::T1T2 terminator + ColE1	amp
pHL2107	AmpR + PConNoHindM8:: <i>micC</i> ::Asp terminator + PLlacO-1::T710:: <i>hfq</i> ::T1 terminator + PLtetO-1m9:: <i>ompC</i> :: <i>gfp</i> ::T1T2 terminator + ColE1	amp
pHL2117	AmpR + PConNoHindM8:: <i>ryhB</i> ::Asp terminator + T1 terminator + PLtetO- 1m9::sodB::gfp::T1T2 terminator + CoIE1	amp
HL716*	MG1655 + pKD46 + <i>laclq</i> inserted into the chromosome at <i>intS</i>	none
HI 770*	HL716 + Δhfg	none

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HL1706HL716 + $hCSTC$ noneHL1752HL1752 + PCon:tetR inserted into the chromosome at galKnoneHL2300HL716 + pHL745ampHL2304HL716 + pHL745ampHL2305HL716 + pHL745ampHL2325HL716 + pHL269ampHL2326HL716 + pHL269ampHL2317HL707 + pHL745ampHL2411HL770 + pHL745ampHL2431HL770 + pHL745ampHL256HL716 + pHL200ampHL257HL716 + pHL200ampHL256HL716 + pHL200ampHL2825HL716 + pHL200ampHL2839HL772 + pHL720ampHL2839HL776 + pHL201ampHL2843 + pHL600 + pHL617ampHL2839HL776 + pHL20ampHL2843 + pHL600 + pHL720ampHL2843 + pHL600 + pHL101ampHL2843 + pHL600 + pHL101ampHL2843 + pHL600 + pHL101ampHL2843 + pHL600 + pHL101ampHL2843 + pHL600 + pHL101ampHL3864HL776 + pHL282ampHL3865HL776 + pHL282ampHL3865HL776 + pHL282ampHL3864HL766 + pHL1831ampHL3864HL776 + pHL282ampHL3865HL766 + pHL1824ampHL3867HL776 + pHL282ampHL3867HL766 + pHL183ampHL3868HL766 + pHL1841ampHL3869	HL1672	HL862 + pHL518	amp
HL1752HL1706 + $harcologicalnoneHL1933HL1752 + PCom: idR inserted into the chromosome at galKnoneHL2300*HL1716 + pHL269ampHL2325HL1716 + pHL417ampHL2327HL1716 + pHL417ampHL2328HL1716 + pHL789ampHL2413HL770 + pHL785ampHL2413HL770 + pHL785amp, kanHL2516HL2483 + pHL800 + pHL671amp, kanHL2572HL1716 + hpH.2785ampHL2584HL716 + hpH.2780ampHL2585HL716 + hpH.2780ampHL2584HL276 + hpH.2780ampHL2585HL716 + hpH.2780ampHL2584HL276 + hpH.2780ampHL2817*HL716 + hpH.2780ampHL2833HL770 + hpH.270ampHL2333HL770 + hpH.282ampHL3386*HL770 + hpH.282ampHL3387HL770 + hpH.282ampHL3388HL770 + hpH.282ampHL3611HL716 + pHL381ampHL5189HL716 + pHL1282ampHL5189HL716 + pHL1841ampHL5189HL716 + pHL1841ampHL5189HL716 + pHL1841ampHL5189HL716 + pHL1782ampHL5189HL716 + pHL1782ampHL5189HL716 + pHL1782ampHL5189HL716 + pHL1782ampHL5189HL716 + pHL1782ampHL5189HL716 + pHL1782amp<$	HL1706	HL716 + ∧csrB	none
HL1933 HL1752 + PCon::tetR inserted into the chromosome at galK none HL2304 HL1716 + pHL745 amp HL2325 HL1716 + pHL299 amp HL2325 HL1716 + pHL299 none HL231 HL770 + pHL269 amp HL2411 HL770 + pHL745 amp HL2433 HL276 + pHL908 amp, kan HL2516 HL2438 + pHL600 + pHL671 none HL2526 HL716 + pHL700 amp, kan HL2752 + HL716 + pHL700 amp HL2839 HL2762 + pHL700 amp HL2839 HL2762 + pHL700 amp HL2833 HL770 + pHL720 amp HL2816 HL716 + pHL720 amp HL2833 HL770 + pHL720 amp HL333 HL770 + pHL720 amp HL3834 HL770 + pHL720 amp HL3835 HL664 + pHL10017 amp HL3838 HL770 + pHL720 amp HL3836 HL770 + pHL720 amp HL3836 HL770 + pHL720 amp HL3838 HL770 + pHL720 amp </td <td>HL1752</td> <td>H 1706 + AcsrC</td> <td>none</td>	HL1752	H 1706 + AcsrC	none
HL2300*HL716 + pHL745ampHL2304*HL716 + pHL269ampHL2325HL716 + pHL417ampHL2378HL716 + pHL417ampHL2413HL770 + pHL269ampHL2413HL770 + pHL269ampHL2413HL770 + pHL269noneHL2516HL2438 + bpHL600 + pHL671amp, kanHL2625*HL716 + apHL708ampHL275*HL716 + apHL709ampHL275*HL716 + apHL700ampHL275*HL716 + apHL700ampHL2817*HL716 + pHL203ampHL2817*HL716 + pHL700ampHL2818*HL770 + pHL700ampHL333*HL770 + pHL720ampHL333*HL770 + pHL720ampHL333*HL770 + pHL720ampHL338*HL770 + pHL720ampHL3395*HL662 + pHL1001ampHL3395*HL662 + pHL1011ampHL3395*HL662 + pHL1020ampHL3610HL770 + pHL321ampHL5180HL716 + pHL381ampHL519*HL716 + pHL1633ampHL520HL716 + pHL1633ampHL519HL716 + pHL1633ampHL637HL338 + pHL1909ampHL637HL338 + pHL1909ampHL637HL338 + pHL1904ampHL636HL530 + pHL1632ampHL636HL540 + pHL2026ampHL636HL540 + pHL2026ampHL636HL540 + pHL2026amp </td <td>HI 1933</td> <td>HI 1752 + PCon: <i>tetR</i> inserted into the chromosome at aa/K</td> <td>none</td>	HI 1933	HI 1752 + PCon: <i>tetR</i> inserted into the chromosome at aa/K	none
HL2304*HL716 + pHL289ampHL2325HL716 + pHL417ampHL2378HL1333 + $A_{SIG}CAP$ noneHL2411HL770 + pHL269ampHL2413HL770 + pHL745ampHL2433HL2378 + $A_{SIG}O$ noneHL2463HL2378 + $A_{SIG}O$ noneHL2475HL716 + pHL801 + pHL671amp, kanHL2526*HL716 + pHL808ampHL2752 *HL716 + pHL70ampHL2752 *HL716 + pHL70ampHL2839*HL2752 + pHL720ampHL2333HL770 + $AyAB$ noneHL3333HL770 + $AyAB$ ampHL3333HL770 + $AyAB$ noneHL333*HL770 + $AyAB$ ampHL333*HL770 + $AyAB$ ampHL386*HL716 + pHL282ampHL381*HL716 + pHL281ampHL381*HL770 + $AyAB$ ampHL381*HL770 + $AyAB$ ampHL382*HL109ampHL384*HL716 + PHL81ampHL385*HL1716 + PHL81ampHL381*HL776 + PHL81amp	HI 2300*	HI 716 + pHI 745	amp
HL2325HL716 + pHL417ampHL2378HL1933 + $dygCAP$ noneHL2413HL770 + pHL269ampHL2413HL770 + pHL745noneHL2413HL770 + pHL745noneHL2413HL770 + pHL745noneHL2516HL2483 + pHL600 + pHL671amp, kanHL252*HL716 + $AyhB$ noneHL2517HL716 + $AyhB$ noneHL2817*HL776 + $AyhB$ noneHL2817*HL776 + $AyhB$ ampHL2817*HL776 + $PHL720$ ampHL2817*HL776 + $PHL720$ ampHL2817*HL776 + $PHL720$ ampHL386*HL770 + $PHL720$ ampHL333*HL770 + $PHL720$ ampHL333*HL770 + $PHL720$ ampHL3395*HL862 + $PHL1011$ ampHL395*HL862 + $PHL1011$ ampHL3910HL776 + $PHL321$ ampHL3911HL776 + $PHL31$ ampHL392*HL776 + $PHL31$ ampHL394*HL716 + $PHL41$ ampHL395*HL862 + $PHL1011$ ampHL3910HL770 + $PHL282$ ampHL392*HL776 + $PHL31$ ampHL394*HL776 + $PHL31$ ampHL395*HL862 + $PHL1011$ ampHL396*HL776 + $PHL281$ ampHL395*HL862 + $PHL1011$ ampHL394*HL776 + $PHL281$ ampHL395*HL862 + $PHL91128$ ampHL396*HL776 + $PHL281$ ampHL399	HI 2304*	HI 716 + pHI 269	amp
HL2376HL1333 + $\Delta glgCAP$ noneHL2411HL770 + pHL269ampHL2413HL770 + pHL745ampHL2413HL770 + pHL745noneHL2463HL2378 + $\Delta sxrD$ noneHL2516HL2483 + pHL600 + pHL671amp, kanHL2527HL716 + pHL008ampHL2752HL716 + pHL200ampHL2839HL2752 + pHL720ampHL2839HL2752 + pHL720ampHL2333HL776 + pHL282ampHL3333HL770 + ΔyhB noneHL3335HL770 + ΔyhB noneHL3337HL776 + pHL282ampHL3338HL770 + ΔyhB noneHL3337HL776 + pHL282ampHL3316HL716 + pHL282ampHL3311HL776 + pHL282ampHL3611HL716 + pHL31ampHL3619HL716 + pHL31ampHL3619HL716 + pHL31ampHL512HL716 + pHL328ampHL5130HL716 + pHL1633ampHL5141HL5390 + pHL184ampHL5155HL716 + pHL1633ampHL6193HL5390 + pHL184ampHL6357HL3338 + pHL1954ampHL6357HL3338 + pHL1954ampHL6357HL3338 + pHL1954ampHL6357HL3338 + pHL1954ampHL6357HL3338 + pHL1954ampHL6356HL1184 + pHL2075ampHL6555HL5140 + pHL2085ampHL6565HL1128 + pHL2053 <td>HI 2325</td> <td>HI 716 + pHI 417</td> <td>amp</td>	HI 2325	HI 716 + pHI 417	amp
HL2411HL770 + pHL269ampHL2413HL770 + pHL269anp,HL2413HL770 + pHL745anp,HL2416HL2378 + AcsrDnoneHL2516HL2438 + pHL600 + pHL671anp, kanHL2627HL716 + pHL720anpHL2752HL716 + pHL720anpHL2817*HL716 + pHL720anpHL2817*HL716 + pHL720anp, kanHL339*HL2752 + pHL701anp, kanHL338*HL770 + pHL720anpHL333*HL770 + pHL720anpHL333*HL770 + pHL720anpHL333*HL770 + pHL720anpHL333*HL770 + pHL720anpHL333*HL770 + pHL720anpHL3610HL774 + pHL82anpHL3611HL764 + pHL82anpHL3612HL716 + pHL82anpHL3613*HL716 + pHL841anpHL519*HL716 + pHL128anpHL519*HL716 + pHL1931anpHL526 + AhfqnoneHL540HL530 + pHL194anpHL540HL530 + pHL194anpHL540HL530 + pHL194anpHL526 + AhfqnoneHL540HL716 + pHL194anpHL540HL716 + pHL283anpHL540HL716 + pHL284anpHL540HL716 + pHL284anpHL540HL716 + pHL284anpHL540HL716 + pHL284anpHL540HL540 + pHL2021anpHL6561HL540 + pHL204	HL2378	HI 1933 + $\Lambda a a CAP$	none
HL2113HL70 + pHL745anpHL2413HL278 + $\Delta csrD$ noneHL2413HL278 + $\Delta csrD$ noneHL266HL248 + pHL600 + pHL671amp, kanHL2625'HL716 + pHL908ampHL2752'HL716 + pHL720ampHL2817'HL716 + pHL720ampHL2839'HL2752 + pHL720ampHL2333'HL770 + λphB noneHL3335'HL770 + λphB noneHL3335'HL770 + λphB noneHL3335'HL770 + λphB noneHL3395'HL862 + pHL1019ampHL3610HL770 + λphB ampHL3611HL76 + pHL382ampHL3612'HL76 + pHL381ampHL3619'HL76 + pHL381ampHL3619'HL76 + pHL382ampHL3619'HL716 + pHL482ampHL3619'HL716 + pHL1633ampHL5189HL716 + pHL184ampHL5189HL716 + pHL184ampHL5189HL716 + pHL197ampHL6370HL716 + pHL1984ampHL6381HL5384 + pHL1964ampHL6370HL6384 + pHL1974ampHL6370HL716 + pHL1974ampHL6371HL538 + pHL1974ampHL6371HL538 + pHL1974ampHL6371HL538 + pHL1974ampHL6371HL538 + pHL1974ampHL6371HL5410 + pHL2075ampHL6371HL5410 + pHL2075ampHL6572HL6410 + pHL2	HI 2411	HI 770 + pHI 269	amn
HL2483HL2378 + $\Delta csrD$ noneHL2483HL2378 + $\Delta csrD$ noneHL2516HL2483 + pHL600 + pHL671amp, kanHL2527HL716 + $\Delta nyhB$ noneHL2752HL716 + $\Delta nyhB$ noneHL2317HL716 + $\Delta nyhB$ noneHL2317HL716 + $\Delta nyhB$ noneHL2317HL716 + $\Delta nyhB$ noneHL2317HL716 + pHL720ampHL2318HL770 + pHL720ampHL3333HL770 + $\lambda nyhB$ noneHL3334HL770 + $\lambda nyhB$ noneHL3335*HL662 + pHL1011ampHL3395*HL662 + pHL1019ampHL3610HL776 + pHL282ampHL3611HL716 + pHL391ampHL3612*HL716 + pHL391ampHL3619*HL716 + pHL183ampHL563HL5226 + Δhfq noneHL5410HL5226 + Δhfq noneHL5457HL539 + pHL1844ampHL6199HL2752 + pHL1964ampHL6370HL338 + pHL2021ampHL6371HL338 + pHL2021ampHL6371HL538 + pHL2021ampHL6371HL5410 + pHL2073ampHL6371HL6410 + pHL2075ampHL6555HL1184 + pHL2075ampHL6561HL2754 + pHL075ampHL6561HL2754 + pHL2075ampHL6565HL1128 + pHL2073ampHL6565HL1128 + pHL2075ampHL6565HL1128 + pHL2075ampHL6566	HI 2413	$H_{1}770 + pH_{1}745$	amp
HL2516 HL2483 + pHL500 + pHL671 amp, kan HL2516 HL716 + Ay/nB none HL2752* HL716 + Ay/nB none HL2817* HL716 + Ay/nB amp HL2817* HL716 + Ay/nB amp HL2819* HL2752 + pHL720 amp HL2819* HL2752 + pHL600 + pHL1017 amp, kan HL3186* HL770 + pHL720 amp HL3333* HL770 + Ay/nB none HL3335* HL770 + Ay/nB none HL3305* HL62 + pHL1011 amp HL3610 HL770 + pHL720 amp HL3611 HL716 + pHL81 amp HL3612* HL716 + pHL81 amp HL3611 HL716 + pHL82 amp HL3612* HL716 + pHL81 amp HL3619* HL716 + pHL81 amp HL526 HL716 + pHL728 amp HL519 HL716 + pHL728 amp HL526 HL716 + pHL728 amp HL527 HL5300 + HL71628 amp HL5391 HL5390 + HL71633 amp <t< td=""><td>HI 2483</td><td>HI 2378 $\pm \Lambda c c r D$</td><td>none</td></t<>	HI 2483	HI 2378 $\pm \Lambda c c r D$	none
H12625'H1716 + pHL908ampH12752'H1716 + pHL700moneH12839'H12752 + pHL720ampH12839'H12752 + pHL720amp, kanH12816'H12762 + pHL700amp, kanH1386'H1716 + pHL282ampH13333'H1770 + pHL720ampH13333'H1770 + pHL720ampH13333'H1770 + pHL720ampH13335'H1862 + pHL10109ampH13395'H1862 + pHL1019ampH13610'H1770 + pHL282ampH13611'H1716 + pHL311ampH13612'H1716 + pHL321ampH13613'H1716 + pHL31ampH1589'H176 + pHL183ampH1589'H176 + pH1282ampH1589'H176 + pH1282ampH1589'H1580ampH1589'H1580ampH16370'H1338 + pH1989ampH16370'H1338 + pH1969ampH16370'H1338 + pH1969ampH16370'H1338 + pH1969ampH16370'H15300H1540H16370'H15400 + pH2027ampH16380'H15400 + pH2075ampH16555'H1	HI 2516	H 2483 + nH 600 + nH 671	amp kan
H122752'H1716 + ΔyhB noneH12817'H1716 + ΔyhB ampH12817'H1716 + ΔyhB ampH12839'H12752 + β H1720ampH12816'H12483 + β H1600 + β H11017amp, kanH13186'H1716 + β H1282ampH13333'H1770 + β H1720ampH13338'H1770 + λyhB noneH13338'H12752 + β H1101ampH13335'H12752 + β H1011ampH1331'H12752 + β H1101ampH1331'H1770 + β H282ampH13610H1770 + β H282ampH13611H1716 + β H1281ampH13612'H1716 + β H1281ampH1526H1716 + β H1281ampH1527H1716 + β H1283ampH1528H1716 + β H11633ampH1539H12752 + β H1984ampH15363H15300 + β H199ampH15364H1530 + β H199ampH16200H12752 + β H1984ampH16361H1338 + β H1969ampH16361H1338 + β H1969ampH16361H1338 + β H1969ampH16361H1338 + β H1969ampH16361H1338 + β H1964ampH16361H1338 + β H1964ampH16361H1338 + β H1963ampH16370H1632ampH16580H15410 + β H12027ampH16581H1284 + β H12073ampH16581H12782 + β H12075amp <t< td=""><td>HI 2625*</td><td>HI 716 + pHI 908</td><td>amp, kan</td></t<>	HI 2625*	HI 716 + pHI 908	amp, kan
HL2817HL716 + pHL720ampHL2817HL2752 + pHL720ampHL2839HL2752 + pHL600 + pHL1017amp, kanHL3186*HL716 + pHL282ampHL3333HL770 + pHL720ampHL3338*HL770 + pHL720ampHL337*HL2752 + pHL1011ampHL339*HL770 + pHL282ampHL339*HL2752 + pHL1011ampHL3610HL770 + pHL282ampHL3611HL716 + pHL282ampHL3612*HL716 + pHL282ampHL3612*HL716 + pH1282ampHL5189HL716 + pH1282ampHL5189HL716 + pH1282ampHL526HL716 + pH1282ampHL519HL716 + pH1282ampHL526HL716 + pH1282ampHL527HL716 + pH1282ampHL528HL716 + pH1282ampHL527HL5300 + pH1884ampHL637HL338 + pH1954ampHL637HL338 + pH1954ampHL637HL338 + pH1969ampHL6370HL538 + pH1969ampHL6380HL5410 + pH2027ampHL6380HL5410 + pH2075ampHL6527HL540 + pH2075ampHL6526HL5410 + pH2075ampHL6551HL2762 + pH2107ampHL6561HL2762 + pH2107ampHL6561HL2762 + pH2107ampHL6561HL2762 + pH2107ampHL6561HL2762 + pH2075amp <t< td=""><td>HI 2752*</td><td>HI 716 $\pm \Delta n/bB$</td><td>none</td></t<>	HI 2752*	HI 716 $\pm \Delta n/bB$	none
HL2839* HL2752 + pHL720 amp HL2839* HL2752 + pHL720 amp HL3186* HL716 + pHL282 amp HL3333 HL770 + pHL720 amp HL3338* HL770 + AyhB none HL3338* HL770 + pHL720 amp HL3335* HL2752 + pHL1011 amp HL3612 HL716 + pHL282 amp HL3614 HL716 + pHL282 amp HL3615* HL716 + pHL391 amp HL5614 HL716 + pHL133 amp HL526 HL716 + pHL1633 amp HL526 HL716 + pHL184 amp HL526 HL716 + pHL184 amp HL526 HL716 + pHL184 amp HL527 pHL1984 amp HL526 HL716 + pHL79 amp HL627 HL5300 + pHL9199 amp HL6267 HL5300 + pH	HI 2817*	$HI 716 \pm pHI 720$	amp
HL2916HL243 + pHL50 + pHL501amp, kanHL3186*HL716 + pHL282ampHL3333HL770 + pHL720ampHL3333*HL770 + pJL720ampHL3333*HL770 + pJL720ampHL333*HL770 + pJL720ampHL333*HL770 + pJL720ampHL333*HL2752 + pJL1011ampHL339*HL862 + pJL1009ampHL3610HL770 + pJL282ampHL3611HL716 + pJL391ampHL3612*HL716 + pJL391ampHL5189HL716 + pJL481ampHL5189HL716 + pJL1633ampHL526HL716 + AgImZnoneHL5963HL5300 + pJL1884ampHL5963HL5300 + pJL1884ampHL6200HL2752 + pJL1954ampHL6371HL338 + pJL2021ampHL6361HL3338 + pJL2021ampHL6361HL338 + pJL2021ampHL6370HL338 + pJL1954ampHL6380HL5410 + pJL2026ampHL6476HL5410 + pJL2027ampHL6476HL5410 + pJL2026ampHL6476HL5410 + pJL2027ampHL6526HL110 + pJL2053ampHL6526HL110 + pJL2053ampHL6566HL1128 + pJL2053ampHL6566HL1128 + pJL2053ampHL6566HL128 + pJL2053ampHL6566HL128 + pJL2053ampHL6581HL2752 + pJL107ampHL6582HL3338 + pJL1632 <td>HI 2830*</td> <td>$H_{2752 \pm nH_{1720}}$</td> <td>amp</td>	HI 2830*	$H_{2752 \pm nH_{1720}}$	amp
HL3186*HL716 + pHL282ampHL3333HL770 + $\Delta nyhB$ noneHL3333*HL770 + $\Delta nyhB$ noneHL337*HL2752 + pHL1011ampHL339*HL862 + pHL1009ampHL3610HL770 + pHL82ampHL3611HL716 + pHL811ampHL5612*HL716 + pHL814ampHL5614*HL716 + pHL814ampHL5626HL716 + pHL1633ampHL526HL716 + pHL844ampHL563HL5300 + pHL844ampHL563HL5300 + pHL844ampHL563HL5300 + pHL884ampHL6563HL2752 + pHL1954ampHL6370HL338 + pHL2021ampHL6370HL338 + pHL2026ampHL6370HL338 + pHL2026ampHL6370HL338 + pHL2026ampHL6370HL5301ampHL6370HL5302ampHL6370HL5302ampHL6370HL5302ampHL6370HL5302ampHL6370HL5410 + pHL2026ampHL6476HL5410 + pHL2073ampHL6476HL5410 + pHL2073ampHL6527HL5410 + pHL2074ampHL6526HL1128 + pHL2053ampHL6526HL1128 + pHL2053ampHL6566HL1128 + pHL2053ampHL6566HL128 + pHL2053ampHL6561HL2752 + pHL1632ampHL6561HL2752 + pHL1632ampHL6561HL2752 + pH	HI 2916	H 2483 + pH 600 + pH 1017	amp kan
HLS303HL70 + pHL720ampHL3333HL770 + $\Delta \eta / B$ noneHL3338*HL770 + $\Delta \eta / B$ noneHL3373*HL2752 + pHL1011ampHL3395*HL862 + pHL1009ampHL3610HL770 + pHL282ampHL3611HL716 + pHL391ampHL3612*HL716 + pHL841ampHL512*HL716 + pHL6133ampHL540HL526HL716 + $\Delta g / mZ$ noneHL5410HL5226 + $\Delta h f q$ noneHL5963HL5390 + pHL1884ampHL6257HL5390 + pHL1954ampHL6257HL5390 + pHL1969ampHL6361HL3338 + pHL2021ampHL6370HL338 + pHL2026ampHL6370HL338 + pHL1954ampHL6380HL5410 + pHL2026ampHL6370HL3410 + pHL2027ampHL6476HL5410 + pHL2028ampHL6476HL5410 + pHL2073ampHL6476HL5410 + pHL2073ampHL6476HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2085ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL	HL 3186*	HI 716 + pHI 282	amp, Kan
HL333HL70+ $AyhB$ noneHL3338*HL70+ $AyhB$ ampHL339*HL2752 + pHL1011ampHL339*HL62 + pHL1009ampHL3610HL70+ pHL282ampHL3611HL716 + pHL391ampHL3612*HL716 + pHL441ampHL519HL716 + pHL1633ampHL526HL716 + pHL1633ampHL5276HL716 + pHL1633ampHL6277HL5390 + pHL1984ampHL6257HL338 + pHL2021ampHL6370HL338 + pHL1969ampHL6370HL338 + pHL1969ampHL6370HL5380 + pHL2026ampHL6370HL5410 + pHL2027ampHL6442HL716 + pHL1632ampHL6476HL5410 + pHL2073ampHL6477HL5410 + pHL2073ampHL6526HL5410 + pHL2053ampHL6555HL128 + pHL2053ampHL6566HL128 + pHL2053ampHL6581HL2752 + pHL2117ampHL6582HL338 + pHL1632amp	HI 3333	$H = 770 \pm 0$ H = 720	amp
HL3373'HL2752 + pHL1011ampHL3373'HL2752 + pHL1009ampHL3395'HL862 + pHL1009ampHL3610HL770 + pHL282ampHL3611HL770 + pHL382ampHL3612'HL716 + pHL391ampHL3619'HL716 + pHL128ampHL5189HL716 + pHL1633ampHL5266HL716 + pHL1633ampHL5933HL5390 + pHL1633ampHL5940HL5226 + Δhfq noneHL5953HL5390 + pHL1854ampHL6200HL2752 + pHL1954ampHL6257HL3338 + pHL969ampHL6357HL3338 + pHL969ampHL6370HL3338 + pHL969ampHL6370HL3338 + pHL1954ampHL6476HL5410 + pHL2027ampHL6477HL5410 + pHL2075ampHL6476HL5410 + pHL2075ampHL6526HL5410 + pHL2075ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2075ampHL6526HL5410 + pHL2075ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2075ampHL6526HL5410 + pHL2075ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2084ampHL6581HL2752 +	HI 3338*	$H = 770 \pm \Lambda n/B$	none
HLB373HLB272 + pHL1019ampHLB374HLB272 + pHL1019ampHL3610HL770 + pHL282ampHL3611HL716 + pHL841ampHL3612*HL716 + pHL841ampHL3619*HL716 + pHL1228ampHL5189HL716 + pHL1633ampHL5266HL716 + AgmZnoneHL5963HL5226 + AhfqnoneHL5963HL5226 + pHL1954ampHL6199HL2752 + pHL1954ampHL6257HL5390 + pHL1979ampHL6367HL3338 + pHL2021ampHL6361HL3338 + pHL2026ampHL6370HL5410 + pHL2026ampHL6380HL5410 + pHL2026ampHL6442HL716 + pHL2027ampHL6476HL5410 + pHL2026ampHL6477HL5410 + pHL2075ampHL6566HL128 + pHL2075ampHL6555HL5410 + pHL2075ampHL6566HL128 + pHL2075ampHL6566HL128 + pHL2075ampHL6566HL128 + pHL2075ampHL6566HL128 + pHL2075ampHL6566HL128 + pHL2075ampHL6566HL128 + pHL2075ampHL6561HL275 + pHL2075ampHL6562HL3338 + pHL1632ampHL6563HL128 + pHL2075ampHL6564HL128 + pHL2075ampHL6565HL128 + pHL2075ampHL6561HL275 + pHL2075ampHL6562HL3338 + pHL632a	HI 3373*	$H_{2752 \pm nH_{1011}}$	amp
HE335HE305HE305ampHL3610HL70 + pHL282ampHL3611HL716 + pHL391ampHL3612*HL716 + pHL128ampHL5189HL716 + pHL1633ampHL526HL716 + pHL1633ampHL526HL716 + pHL1633ampHL5963HL5300 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL338 + pHL2021ampHL6357HL338 + pHL2021ampHL6370HL338 + pHL2026ampHL6370HL338 + pHL2026ampHL6442HL716 + pHL2027ampHL6476HL5410 + pHL2073ampHL6477HL5410 + pHL2073ampHL6555HL128 + pHL2073ampHL6555HL128 + pHL2073ampHL6555HL128 + pHL2073ampHL6555HL128 + pHL2063ampHL6555HL128 + pHL2063ampHL6566HL1128 + pHL2063ampHL6561HL2752 + pHL2107ampHL6562HL3338 + pHL2063ampHL6562HL3338 + pHL2063 <td>HL3375</td> <td>$H_{262} + pH_{1000}$</td> <td>amp</td>	HL3375	$H_{262} + pH_{1000}$	amp
H1301H170 + pH232ampH13611HL716 + pH1391ampH13612*HL716 + pH1228ampH13619*HL716 + pH1228ampH15189HL716 + pH1633ampH15226HL716 + AgimZnoneH15963HL2526 + Δhfq noneH1599HL2752 + pH1954ampH16200HL2752 + pH1969ampH16357HL3338 + pH2021ampH16357HL338 + pH1202ampH16361HL338 + pH12026ampH16370HL5410 + pH2026ampH16476HL5410 + pH2073ampH16476HL5410 + pH2075ampH16526HL5410 + pH2075ampH16526HL5410 + pH2053ampH16555HL1128 + pH2053ampH16566HL1128 + pH2107ampH16566HL1128 + pH2107ampH16581HL2752 + pH1632ampH16582HL338 + pH1632amp	HL3610	$H = 770 \pm nH = 282$	amp
HL3011HL716 + pHL301ampHL3012*HL716 + pHL1228ampHL3619*HL716 + pHL128ampHL5189HL716 + pHL1633ampHL526HL716 + $\Delta glmZ$ noneHL5210HL5226 + Δhfq noneHL5933HL5390 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL338 + pHL2021ampHL6357HL338 + pHL1969ampHL6370HL338 + pHL1969ampHL6370HL338 + pHL1964ampHL642H.716 + pHL2027ampHL642H.716 + pHL2073ampHL6476HL5410 + pHL2075ampHL6556HL5410 + pHL2085ampHL6557HL2085ampHL6557HL2085ampHL6477HL5410 + pHL2073ampHL6557HL5410 + pHL2085ampHL6557HL5410 + pHL2085ampHL6557HL5410 + pHL2085ampHL6557HL5410 + pHL2085ampHL6557HL5410 + pHL2085ampHL6555HL148 + pHL2107ampHL6556HL1128 + pHL2107ampHL6581HL2752 + pHL2117ampHL6582HL338 + pHL1632amp	HL3611	$H = 716 \pm pH = 301$	amp
HL5012HL716 + pHL1228ampHL5189HL716 + pHL1228ampHL5189HL716 + pHL1228ampHL5266HL716 + $\Delta glmZ$ noneHL5261HL5300 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL338 + pHL2021ampHL6361H.3338 + pHL2021ampHL6379HL5410 + pHL2026ampHL6379HL5410 + pHL2026ampHL6380HL5410 + pHL2027ampHL6442HL716 + pHL2073ampHL6476HL5410 + pHL2073ampHL6527HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6526HL5410 + pHL2073ampHL6527HL5410 + pHL2085ampHL6526HL5410 + pHL2073ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2084ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL128 + pHL2053ampHL6581HL2752 + pHL2117ampHL6582HL338 + pHL1632amp	HL3612*		amp
HL5013HL716 + pHL1633ampHL5189HL716 + pHL1633ampHL5226HL716 + $\Delta glmZ$ noneHL5410HL526 + Δhfq noneHL5963HL5390 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL3338 + pHL2021ampHL6361HL3338 + pHL1969ampHL6370HL338 + pHL1969ampHL6370HL5410 + pHL2026ampHL6380HL5410 + pHL2027ampHL6442HL716 + pHL1632ampHL6476HL5410 + pHL2073ampHL6527HL5410 + pHL2075ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6526HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6526HL5410 + pHL2085ampHL6527HL5410 + pHL2085ampHL6526HL5410 + pHL2085ampHL6526HL5410 + pHL2085ampHL6526HL128 + pHL2053ampHL6581HL2752 + pHL2117ampHL6582HL338 + pHL1632amp	HI 3619*	$H = 716 \pm pH = 1228$	amp
HLS100HLF101 pHL1033annpHLS226HL716 + $\Delta glmZ$ noneHL5226HL716 + $\Delta glmZ$ noneHL5410HL5226 + Δhfq noneHL5963HL5390 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL5390 + pHL1979ampHL6361HL3338 + pHL2021ampHL6370HL3338 + pHL2026ampHL6370HL338 + pHL1954ampHL6370HL5410 + pHL2026ampHL6476HL5410 + pHL2027ampHL6476HL5410 + pHL2073ampHL6527HL5410 + pHL2075ampHL6527HL5410 + pHL2085ampHL6555HL1128 + pHL2085ampHL6566HL1128 + pHL2053ampHL6581HL2752 + pHL2107ampHL6582HL338 + pHL1632amp	HI 5189		amp
HESESHE 10 + Hgm2HoreHL5410HL526 + Δhfq noneHL5963HL5390 + pHL1884ampHL6199HL2752 + pHL1954ampHL6200HL2752 + pHL1969ampHL6357HL338 + pHL2021ampHL6361HL3338 + pHL1954ampHL6370HL3338 + pHL1954ampHL6379HL5410 + pHL2026ampHL6442HL716 + pHL1632ampHL6476HL5410 + pHL2073ampHL6526HL5410 + pHL2075ampHL6527HL5410 + pHL2084ampHL6527HL5410 + pHL2085ampHL6526HL5410 + pHL2085ampHL6527HL5410 + pHL2084ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6527HL5410 + pHL2084ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6527HL5410 + pHL2083ampHL6526HL5410 + pHL2084ampHL6526HL5410 + pHL2083ampHL6526HL5410 + pHL2083ampHL6526HL128 + pHL2107ampHL6526HL128 + pHL2107ampHL6526HL128 + pHL2107ampHL6526HL338 + pHL1632ampHL6526HL338 + pHL1632amp	HI 5226	$HI 716 \pm \Lambda dmZ$	none
HL5910 HL5326 + AMq amp HL5963 HL5390 + pHL1884 amp HL6199 HL2752 + pHL1954 amp HL6200 HL2752 + pHL1969 amp HL6357 HL5300 + pHL1979 amp HL6361 HL3338 + pHL2021 amp HL6361 HL3338 + pHL1969 amp HL6370 HL3338 + pHL1954 amp HL6370 HL3338 + pHL2026 amp HL6370 HL3338 + pHL2026 amp HL6370 HL3338 + pHL2027 amp HL6442 HL716 + pHL2026 amp HL6442 HL716 + pHL2073 amp HL6476 HL5410 + pHL2073 amp HL6526 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2085 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2053 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 5410	H = 526 + A = 66	none
HL3935 HL3534 amp HL6199 HL2752 + pHL1954 amp HL6200 HL2752 + pHL1969 amp HL6257 HL3308 + pHL2021 amp HL6361 HL3338 + pHL2021 amp HL6370 HL3338 + pHL1969 amp HL6370 HL3338 + pHL1954 amp HL6370 HL5410 + pHL2026 amp HL6379 HL5410 + pHL2026 amp HL6476 HL5410 + pHL2027 amp HL6476 HL5410 + pHL2073 amp HL6476 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2053 amp HL6581 HL2752 + pHL1632 amp HL6581 HL2752 + pHL2107 amp HL6582 HL338 + pHL632 amp		$\Box D D D D + \Delta H Q D$	none
HL6199HL2752 + pHL1934ampHL6200HL2752 + pHL1969ampHL6257HL5390 + pHL1979ampHL6351HL3338 + pHL2021ampHL6361HL3338 + pHL1969ampHL6370HL3338 + pHL1954ampHL6370HL5410 + pHL2026ampHL6380HL5410 + pHL2027ampHL6442HL716 + pHL1632ampHL6476HL5410 + pHL2073ampHL6476HL5410 + pHL2075ampHL6526HL5410 + pHL2084ampHL6555HL1128 + pHL2053ampHL6566HL1128 + pHL207ampHL6581HL2752 + pHL2117ampHL6582HL3338 + pHL1632amp	HL 6100		amp
HL6200HL2702 + pHL1909ampHL6257HL5300 + pHL1979ampHL6357HL3338 + pHL2021ampHL6361HL3338 + pHL1969ampHL6370HL3338 + pHL1954ampHL6379HL5410 + pHL2026ampHL6424HL716 + pHL1632ampHL6475HL5410 + pHL2073ampHL6476HL5410 + pHL2075ampHL6526HL5410 + pHL2084ampHL6555HL1128 + pHL2053ampHL6566HL1128 + pHL2053ampHL6581HL2752 + pHL2117ampHL6582HL3338 + pHL1632amp			amp
HL60237HL20396 + pHL1979ampHL6357HL3338 + pHL2021ampHL6361HL3338 + pHL1969ampHL6370HL3338 + pHL1954ampHL6379HL5410 + pHL2026ampHL6380HL5410 + pHL2027ampHL6442HL716 + pHL1632ampHL6476HL5410 + pHL2073ampHL6526HL5410 + pHL2075ampHL6527HL5410 + pHL2085ampHL6555HL128 + pHL2053ampHL6566HL1128 + pHL2107ampHL6581HL2752 + pHL2117ampHL6582HL3338 + pHL1632amp			amp
HL0337 HL3338 + pHL2021 amp HL6361 HL3338 + pHL1969 amp HL6370 HL3338 + pHL1954 amp HL6379 HL5410 + pHL2026 amp HL6380 HL5410 + pHL2027 amp HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL6301 HL3338 + pHL1954 amp HL6370 HL3338 + pHL1954 amp HL6379 HL5410 + pHL2026 amp HL6380 HL5410 + pHL2027 amp HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6476 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL6370 HL5336 + pHL1334 amp HL6379 HL5410 + pHL2026 amp HL6380 HL5410 + pHL2027 amp HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL6379 HL5410 + pHL2020 amp HL6380 HL5410 + pHL2027 amp HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL5350 HL5410 + pHL2027 amp HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 6390		amp
HL6442 HL716 + pHL1632 amp HL6476 HL5410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL6470 HL2410 + pHL2073 amp HL6477 HL5410 + pHL2075 amp HL6526 HL5410 + pHL2084 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp			amp
HL6526 HL5410 + pHL2073 amp HL6527 HL5410 + pHL2085 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 6477	$H = 5410 \pm pH = 2075$	amp
HL6527 HL5410 + pHL2084 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 6526	HI 5410 + pHI 2084	amp
HL0527 HL0510 + pHL2003 amp HL6555 HL1128 + pHL2053 amp HL6566 HL1128 + pHL2107 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 6527	HI 5/10 + pHI 2085	amp
HL6580 HL1128 + pHL2005 amp HL6581 HL2752 + pHL2117 amp HL6582 HL3338 + pHL1632 amp	HI 6555	HI 1128 ± nHI 2053	amp
HL6581 HL2752 + pHL2107 amp HL6582 HL3338 + pHL1632 amp	HI 6566	нын 20 трн 2000 Н 1128 трн 2107	amp
HL6582 HL3338 + pHL1632 amp	HL 6581	HI 2752 ± nHI 2117	amp
110002 110000 + pricitosz dilip	HI 6582	HI 3338 ± nHI 1632	amp
	1120302		amp

Table S2. Oligonucleotides.

Oligonucleotide	Description	Sequence (5' to 3')
AsptermAvrR	PCR synthesis of Asp terminator from pLEX	agacctaggactgctcacaagaaaaaaggcacg
AsptermEcoRIR*	PCR synthesis of Asp terminator from pLEX	ccggaattcactgctcacaagaaaaaaggcacg
AsptermHindIIIF*	PCR synthesis of Asp terminator from pLEX	ggccaagctttaatcgtacagggtagtacaaata
ColEApalF*	Amplify Ampicillin resistance, CoIE origin with T1 terminator from pZE21	gacgggcccatggtacgcgtgctagagg
csrBKOpKD1F‡	For deletion of <i>csrB</i> using pKD13 as template	agcgccttgtaagacttcgcgaaaaagacgattctatc ttcgtcgacagggtgtaggctggagctgcttc
csrBKOpKD4R‡	For deletion of <i>csrB</i> using pKD13 as template	gtggtcataaagcaacctcaataagaaaaactgccg cqaaqqataqcaqqattccqqqqatccqtcqacc
csrCKOpKD1F‡	For deletion of <i>csrC</i> using pKD13 as template	actgatggcggttgattgtttgtttaaagcaaaggcgta aagtagcacccgtgtaggctggagctgcttc
csrCKOpKD4R‡	For deletion of <i>csrC</i> using pKD13 as template	gccgttttattcagtatagatttgcggcggaatctaacag aaagcaagcaattccggggatccgtcgacc
csrDpKD1F‡	For deletion of <i>csrD</i> using pKD12 as template	atctgatttgctagtatgcccgcttcctcactatcggagtt aacacaagggtgtaggctggagctgcttc
csrDpKD4R‡	For deletion of <i>csrD</i> using pKD12 as template	catgagacgcagcgcgcattattctacgtgaaaacgg attaaacggcaggattccggggatccgtcgacc
gfpRBSSalF*	PCR gfp with RBS7 and Sall site from pTAK 102	cctgtcgactaaggaggaaaaaaaatgcgtaaagga gaagaacttttc
gfpRBSSphF	PCR gfp with RBS7 and SphI site from pTAK 102	tacgcatgctaaggaggaaaaaaaatgcgtaaagg agaagaacttttc
glgCleadSalF‡	PCR 5'UTR of glgC leader for fusion to gfp	cctgtcgactctggcagggacctgcacacggattg
glgCleadSphR‡	PCR 5'UTR of <i>glgC</i> leader for fusion to <i>gfp</i>	tacgcatgctaaccatgactaactccttttttatcatctctg g
glgCpKD1F‡	For deletion of <i>glgCAP</i> using pKD13 as template	cctgcacacggattgtgtgtgtgtgtccagagatgataaaa aaggagttagtcgtgtaggctggagctgcttc
glgPpKD4R‡	For deletion of <i>glgCAP</i> using pKD13 as template	ttacaatctcaccggatcgatatgccagatatgatcggc gtactctttgaattccggggatccgtcgacc
glmSstartSphR§	PCR <i>glmS</i> with <i>Sal</i> l site added at the end of <i>glmU</i> to fuse to <i>gfp</i> and qRT-PCR	ttacgcatgctcgcgccaacaattccacacat
glmSUpSalF	qRT-PCR	ttagtcgaccccggtcacatgggatgaggagat
glmUendSalF§	PCR <i>glmS</i> with <i>Sal</i> I site added at the end of <i>glmU</i> to fuse to <i>gfp</i>	ttagtcgaccgtgtgccgcagactcagaaagaa
gImZ1stMutR	qRT-PCR	acgcctgctcttattacggagcaggcgttaaaacagct ctgtatgagaacaagtgggtgc
gImZHindR◊	PCR glmZ with native terminator	ggccaagcttgggccttcctgatacataaaaaaacgc
glmZKOpKD1F	For deletion of <i>glmZ</i> using pKD13 as template	tagttccttctcacccggaggcaagcacctccggggcc ttcctgatacatgtgtaggctggagctgcttc
glmZKOpKD4R	For deletion of <i>glmZ</i> using pKD13 as template	acaagtgttaagggatgttatttcccgattctctgtggcat aataaacgaattccggggatccgtcgacc
gImZXmaF◊	PCR glmZ and qRT-PCR	cctcccggggtagatgctcattccatctcttat
HfqApaIR*	PCR hfq with RBS (st7)	gacgggcccttattcggtttcttcgctgtcctg
HfqHindR*	PCR hfq with RBS (st7)	ggccaagcttattcggtttcttcgctgtcctg
HfqnoRBSBamF	PCR hfq without RBS	cgcggatccatggctaaggggcaatctttacaag
HfqRBSXmalF*	PCR hfq with RBS (st7)	cctcccgggtaaggaggaaaaaaatggctaaggg gcaatctttacaag
mCherryApaIR*	PCR mCherry	catgggcccttacttgtacagctcgtccatgcc
mCherryRBSBsiWIHindIIIF*	PCR mCherry	tcttaaaagcttattaaagaggagaaacgtacgatggt
-		gagcaagggcgaggagg
MicC1XmalF*	PCR <i>micC</i> and qRT-PCR	tcctcccgggttatatgcctttattgtcacaga
MicC2HindIIIR*	PCR micC with native terminator	ggccaagcttctggataaggattatccaattcta
MicC3NoTermHindIIIR*	qRT-PCR	ggccaagcttgttcgggcttgtctttttatatgt
PConEcoRF*	PCR synthesis of PCon promoter	ccggaattctcgagcaccgtcgttgttgacatttttaagct tggcggttataat
PConGalKR	For integration of PCon:: <i>tetR</i> at <i>galK</i>	gtttgcgcgcagtcagcgatatccattttcgcgaatccg gagtgtaagaatcgagcaccgtcgttgttgac
PConM8NoHindAatF‡	PCR synthesis of PConM8 promoter with no <i>Hind</i> III site	cgcgacgtctcgagcaccgtcgttgtttacatttttatgctt ggcggttatggt

PConM8NoHindBamHF	PCR synthesis of PConM8 promoter with no <i>Hind</i> III site	cgcggatcctcgagcaccgtcgttgtttacatttttatgctt ggcggttatggt
PConM8NoHindSalR	PCR synthesis of PConM8 promoter with no <i>Hind</i> III site	ttagtcgacgaatccaccataaccgccaagcataaaa atgtaaacaac
PConM8NoHindXmaR	PCR synthesis of PConM8 promoter with no <i>Hind</i> III site	cctcccggggaatccaccataaccgccaagcataaa aatgtaaacaac
PConM8ShortNoHindXmaR	PCR synthesis of PConM8 promoter with no <i>Hind</i> III site with deletion of 12 b.p. from 5' end of oligo	cctcccgggaccataaccgccaagcataaaaatgta aacaac
PConAatF	PCR synthesis of PCon promoter	cgcgacgtctcgagcaccgtcgttgttgacatttttaagc ttggcggttataat
PConNoHindBamHF*	PCR synthesis of PCon promoter with no HindIII site	cgcggatcctcgagcaccgtcgttgttgacatttttatgct tggcggttataat
PConSalR	PCR synthesis of PCon promoter	ttagtcgacctgtgtggaatccattataaccgccaagctt aaaaatgtcaacaac
PConNoHindXmaR*	PCR synthesis of PCon promoter with no <i>Hind</i> III site	cctcccgggtgtgtggaatccattataaccgccaagca taaaaatgtcaacaac
PConShortNoHindXmaR2	PCR synthesis of PCon promoter with no <i>Hind</i> III site with deletion of 12 b.p. from 5' end of oligo	cctcccgggattataaccgccaagcataaaaatgtca acaac
PConXmaR*	PCR synthesis of PCon promoter	cctcccgggtgtgtgggaatccattataaccgccaagctt aaaaatgtcaacaac
pKD1FAatII	PCR <i>kanR</i> with FRT sites	ctagacgtcgtgtaggctggagctgcttc
pKD1FGalKF	For integration of PCon:: <i>tetR</i> at GalK	ttcatattgttcagcgacagcttgctgtacggcaggcac cagctcttccggtgtaggctggagctgcttc
pKD4RKpnl	PCR kanR with FRT sites	tgatggtaccattccggggatccgtcgacc
pLacEcoRF	PCR synthesis of PLIacO-1 promoter with EcoRI site	ccggaattcgatccataaatgtgagcggataacattga cattg
pLacNotIF*	PCR synthesis of PLIacO-1 promoter with Notl site	tcctgcggccgcgatccataaatgtgagcggataacat tgacattg
pLacO1BamHIF	PCR synthesis of PLIacO-1 promoter with BamHI site	cgcggatccataaatgtgagcggataacattgacattg
pLacpHNSAatSalF	Fuses PLIacO-1 directly to target mRNA:: <i>gfp</i> , with <i>Aat</i> I and <i>Sal</i> I sites	ctagacgtcataaatgtgagcggataacattgacattgt gagcggataacaagatactgtcgacaacaaaccacc cc
pLacXmaBamHT1T2R*	PCR synthesis of PLIacO-1 promoter with <i>Bam</i> HI and <i>Xma</i> I sites	tcctcccgggagtatcttgttatccgctcacaatgtcaat gttatccgctcacatttatggatcccctaggtcta
PLtetO1m9SalR*	PCR synthesis of PLtetO-1m9 promoter with Sall site	caagtcgacagtctctctatcactgatagggatgtcaat ct
pOmpC1SallF*	PCR ompC sequence to fuse to gfp and qRT-PCR	tactgtcgacttgccgactgattaatgagggtta
pOmpC2SphR*	PCR ompC sequence to fuse to gfp and qRT-PCR	tacgcatgctagctgggaccaggagggacagtac
pTAKtermBamHIR	PCR <i>gfp</i> with T1T2 term with <i>Bam</i> HI site from pTAK102	cgcggatcctgagcggatacatatttgaatgta
pTAKtermNotR	PCR gfp with T1T2 term with Not site from pTAK102	tcctgcggccgctgagcggatacatatttgaatgta
pTetO-1SallR*	PCR synthesis of PLtetO-1 promoter with Sall	tactgtcgacagtatctctatcactgatagggatgtcaat ctctatcactgataggga
pTetOBamHIF*	PCR synthesis of PLtetO-1 promoter with BamHI	cgcggatcctccctatcagtgatagagattgacatccct atcagtgatag
pTetOEcoRIF	PCR synthesis of PLtetO-1 promoter with EcoRI	ccggaattctccctatcagtgatagagattgacatccct atcagtgatag
pTetOXmaIR*	PCR synthesis of PLtetO-1 promoter with Xmal	cctcccgggagtatctctatcactgatagggatgtcaat ctctatcactg
RhyBHindR*	PCR ryhB with native terminator	ggccaagcttgtggataaattgagaacgaaagat
RyhBnotermR*	qRT-PCR	ctaagtaatactggaagcaatgtg
rrnB1361F†	qRT-PCR 16S loading control	gaatgccacggtgaatacgtt
rrnB1475R†	qRT-PCR 16S loading control	acccactcccatggtgtga
RhyBXmaF*	PCR ryhB and gRT-PCR	cctcccggggcgatcaggaagaccctcgcggag
SodBSallF*	PCR sodB sequence to fuse to afp and aRT-PCR	caagtcgaccatacgcacaataaggctattgtacg
SodBSphR*	PCR sodB sequence to fuse to <i>afp</i> and aRT-PCR	tacgcatgctcgcggtacctttaatcaggtatt
T710RBSKpnF	PCR T710 RBS to fuse to <i>afp</i> and <i>hfa</i>	cttaggtacctaggaggaggagatatacatatg
T7codingRBS7BamR	PCR T710 RBS to fuse to gfp and hfq	catggatccgcgacccatttgctgtccaccagtcatgct agccattttttttcctcctta