DATASET 1

Combining mutations that inhibit two distinct steps of the ATP hydrolysis cycle restores wild-type function in the lipopolysaccharide transporter and shows that ATP binding triggers transport

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Loss-of-function substitutions at the CTD of LptB confer dominant-negative phenotypes.

lptB alleles (chromosomal/plasmid)	Altered domain	Zone of inhibition[a]			
		Bacitracin	**Novobiocin**	**Erythromycin**	**Rifampin**
lptB[+] (haploid)	None	(10)	(10)	(13)	9 (10)
lptB[+]/*lptB*[+]	None	(8)	(10)	(14)	10
lptB[+]/*lptB(E163Q)*	Walker B	(10)	8 (9)	11 (15)	13
lptB[+]/*lptB(Y234A)*	CTD helix	12 (15)	14	14	20
lptB[+]/*lptB(L235A)*	CTD helix	14 (16)	15	15	21
lptB[+]/*lptB(G236A)*	CTD loop	10	13	11 (15)	17
lptB[+]/*lptB(F239A)*	CTD loop	11	16	11 (15)	16

[a]OM permeability of merodiploid strains carrying native chromosomal *lptB* and various *lptB* alleles in pET23/42 was assessed by disc diffusion assays in LB. Numbers indicate diameter (in mm) of the zone of total growth inhibition or that of partial growth (in parenthesis). Data are representative of at least three independent experiments.

OM-permeability defects of haploid strains with mutations in *lptB* that disrupt the interaction between the switch helix and CTD loop.

lptB allele	Zone of inhibition[a]			
	Bacitracin	Novobiocin	Erythromycin	Rifampin
lptB[+]	(8)	(8)	8 (10)	9 (10)
lptB(ΔL241)	11	14 (21)	13 (16)	12
lptB-EHis$_8$	13	14 (22)	16 (20)	13
lptB(R198A)	15	15 (24)	15 (20)	13

[a]OM permeability of haploid strains carrying various *lptB* alleles in pET23/42 was assessed by disc diffusion assays in LB. Numbers indicate diameter (in mm) of the zone of total growth inhibition or that of partial growth (in parenthesis). Data are representative of at least three independent experiments. Data for *lptB*[+], *lptB(L241Δ)* and *lptB-EHis$_8$* strains are also shown in Fig. S1C.

Genetic interactions between changes in R144, R198, and alterations to the CTD of LptB.

Domains affected	*lptB* allele	Complements Δ*lptB*?[a]		Zone of inhibition[b]			
		LB	Min	Bacitracin	Novobiocin	Erythromycin	Rifampin
None	*lptB*[+]	YES	YES	(8)	(8)	8 (10)	9 (10)
Sig helix	*lptB(R144H)*	NO	YES	N/A	N/A	N/A	N/A
CT loop	*lptB-EHis$_8$*	YES	YES	13	14 (22)	16 (20)	13
Sig helix & CT loop	*lptB(R144H)-EHis$_8$*	YES	YES	11	(9)	(16)	13
CT loop	*lptB(F239A)*	NO	NO	N/A	N/A	N/A	N/A
Sig helix & CT loop	*lptB(R144H/F239A)*	YES	YES	(8)	(8)	8 (10)	11
CT loop	*lptB(G236A)*	NO	NO	N/A	N/A	N/A	N/A
Sig helix & CT loop	*lptB(R144H/G236A)*	YES	YES	16	(9)	(20)	21
CT helix	*lptB(L235A)*	NO	NO	N/A	N/A	N/A	N/A
Sig helix & CT helix	*lptB(R144H/L235A)*	NO	NO	N/A	N/A	N/A	N/A
CT helix	*lptB(Y234A)*	NO	NO	N/A	N/A	N/A	N/A
Sig helix & CT helix	*lptB(R144H/Y234A)*	NO	NO	N/A	N/A	N/A	N/A
Switch helix	*lptB(R198E)*	NO	NO	N/A	N/A	N/A	N/A
Sig helix & Switch helix	*lptB(R144H/R198E)*	YES	YES	12	(9)	9 (16)	14

[a]Ability to complement a chromosomal Δ*lptB* allele on rich (LB) and minimal (Min) media.

[b]Antibiotic sensitivity was assessed by disc-diffusion assay on LB plates. Numbers represent the diameter (in mm) of partial (in parenthesis) or total zone of inhibition around the disc. Data is representative of at least three independent assays. N/A, not applicable because strain does not grow in LB.

Genetic interactions between changes in Walker A residue T45 and alterations to the CTD of LptB.

lptB allele	Complements ΔlptB?[a]		Zone of inhibition (mm)[b]			
	LB	Min	Bacitracin	Novobiocin	Erythromycin	Rifampin
lptB+	YES	YES	(8)	(8)	8 (12)	8
lptB(T45A)	YES	YES	(8)	(8)	8 (12)	8
lptB(F239A)	NO	NO	N/A	N/A	N/A	N/A
lptB(T45A/F239A)	YES	YES	14	13 (22)	14 (19)	12 (17)
lptB(Y234A)	NO	NO	N/A	N/A	N/A	N/A
lptB(T45A/Y234A)	NO	NO	N/A	N/A	N/A	N/A

[a]Ability to complement a chromosomal ΔlptB allele on rich (LB) and minimal (Min) media.

[b]Antibiotic sensitivity of viable haploid strains grown in LB using a disc diffusion assay. Numbers represent the diameter (in mm) of the zone of inhibition or that of partial growth (parenthesis). N/A, not applicable because strain does not grow in LB. Data are representative of at least three independent experiments.

Strains used in this study.

Strain	Genotype	Source
DH5α	F⁻ φ80lacZΔM15 Δ(lacZYA-argF)U169 recA1 endA1 hsdR17 (r_K^-, m_K^+) phoA supE44 λ⁻ thi-1	Life Technologies
MC4100	F⁻ araD139 Δ(argF-lac)U169 rpsL150 relA1 flbB5301 deoC1 ptsF25 rbsR	(3)
NR754	MC4100 ara⁺	(4)
NR760	NR754 lptD4213	(4)
NR1768	NR754 lptB1-kan	(5)
NR1962	NR754 lptB1(G33C)-kan	(5)
NR1963	NR754 lptB1(R144H)-kan	(5)
NR2974	NR754 lptB1(T43S)-kan	This study
NR2975	NR754 lptB1(G33A)-kan	This study
NR2976	NR754 lptB1(I148T)-kan	This study
NR3025	NR754 lptB1(T45A)-kan	This study
NR3026	NR754 lptB1(L35Q)-kan	This study
NR3733	NR754 lptB1(S243Stop)-kan	This study
NR1872	NR754 (pET23/42LptB-EHis8)	(6)
NR2583	NR754 (pET23/42LptB)	(6)
NR2918	NR754 (pET23/42LptBR198A-EHis8)	This study
NR3085	NR754 (pET23/42LptBR144A)	This study
NR3086	NR754 (pET23/42LptBR144A-EHis8)	This study
NR3087	NR754 (pET23/42LptBR144F)	This study
NR3088	NR754 (pET23/42LptBR144F-EHis8)	This study
NR3314	NR754 (pET23/42LptBR145A-EHis8)	This study
NR3486	NR754 (pET23/42LptBY234A)	This study
NR3487	NR754 (pET23/42LptBT45A/Y234A)	This study
NR3488	NR754 (pET23/42LptBR144H/Y234A)	This study
NR4328	NR754 (pET23/42LptBL235A)	This study
NR4329	NR754 (pET23/42LptBL235S)	This study
NR4330	NR754 (pET23/42LptBG236A)	This study
NR4331	NR754 (pET23/42LptBG236S)	This study
NR4846	NR754 (pET23/42LptBK177E)	This study
NR4861	NR754 (pET23/42LptBR198E)	This study
NR4862	NR754 (pET23/42LptBK177E-EHis8)	This study

NR4863	NR754 (pET23/42LptBR198E-EHis8)	This study
NR4864	NR754 (pET23/42LptB-RHis8)	This study
NR5070	NR754 (pET23/42LptBE199R)	This study
NR5100	NR754 (pET23/42LptBE199R-EHis8)	This study
NR5153	NR754 (pET23/42LptBF239A)	This study
NR5235	NR754 (pET23/42LptBD175A-EHis8)	This study
NR2050	NR754 Δ*lptB*::*frt tet2* (pRC7KanLptB)	(6)
NR2093	NR754 Δ*lptB*::*frt tet2* (pET23/42LptB-EHis8)	(6)
NR2101	NR754 Δ*lptB*::*frt tet2* (pET23/42LptB)	(6)
NR2952	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR198A)	This study
NR3003	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBG33C)	This study
NR3005	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBG33C-EHis8	This study
NR3290	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBL35Q-EHis8)	This study
NR3291	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBT43A-EHis8)	This study
NR3292	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBT45A-EHis8)	This study
NR3032	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR144H-EHis8)	This study
NR4511	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBI148T-EHis8)	This study
NR3234	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR198A-EHis8	This study
NR3294	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBLptBΔL241)	This study
NR3302	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBI148S-EHis8)	This study
NR3303	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR144Q)	This study
NR3304	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR144Q-EHis8)	This study
NR5243	NR754 ΔlptB::frt tet2 (pET23/42LptBG33A)	This study
NR3315	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBL35Q)	This study
NR3316	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBT43S)	This study
NR3317	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBT45A)	This study
NR3324	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR145A)	This study
NR3325	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBI148S)	This study
NR3533	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBT45A/F239A)	This study
NR3534	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR144H/F239A)	This study
NR3657	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBS172A)	This study
NR3658	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBS172A-EHis8)	This study
NR4226	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBY234F)	This study
NR4227	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBF239Y)	This study

NR4345	NR754 Δ*lptB::frt tet2* (pRC7KanLptB, pET23/42LptBR144H/L235A)	This study
NR4388	NR754 Δ*lptB::frt tet2* (pET23/42LptBR144H/G236A)	This study
NR3174	NR754 Δ*lptB::frt tet2* (pET23/42LptBR144H)	This study
NR4512	NR754 Δ*lptB::frt tet2* (pET23/42LptBI148V-EHis8)	This study
NR4532	NR754 Δ*lptB::frt tet2* (pET23/42LptBI148T)	This study
NR4533	NR754 Δ*lptB::frt tet2* (pET23/42LptBV230S)	This study
NR4534	NR754 Δ*lptB::frt tet2* (pET23/42LptBK231A)	This study
NR4535	NR754 Δ*lptB::frt tet2* (pET23/42LptBR232A)	This study
NR4537	NR754 Δ*lptB::frt tet2* (pET23/42LptBV233T)	This study
NR4844	NR754 Δ*lptB::frt tet2* (pET23/42LptBI148V)	This study
NR4847	NR754 Δ*lptB::frt tet2* (pET23/42LptBR240E)	This study
NR4848	NR754 Δ*lptB::frt tet2* (pET23/42LptB-R)	This study
NR4849	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBI176T-EHis8)	This study
NR4908	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBK177A)	This study
NR4912	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBK177A-EHis8)	This study
NR4913	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBE199A)	This study
NR4914	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBR144H/R198)	This study
NR4915	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBE199A-EHis8)	This study
NR4916	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBE237A)	This study
NR4918	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBD238A)	This study
NR5059	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBI176T)	This study
NR5233	NR754 Δ*lptB*::*frt tet2* (pET23/42LptBD175A)	This study
NR5110	NR754 Δ*lptB*::*frt tet2* (pRC7KanLptB, pET23/42LptBR144H/E163Q)	This study
NR5969	NR754 Δ*lptB*::*frt tet2* (pRC7KanLptB, pET23/42LptBR144H/E163Q/F239A)	This study
NR5112	NR754 ΔlptB:frt tet2 (pRC7KanLptB, pET23/42LptBE163Q/F239A)	This study
NR2723	NR754 (pET23/42LptBE163Q)	(6)

Primers used in this study.

Primer name	Change	Primer sequence 5' to 3'
T7 seq	N/A	TAA TAC GAC TCA CTA TAG
5LptB77up	N/A	GTT CTG GTG CCG TCG CAG
3LptB50down	N/A	CAT GTT CAG AAT CGT ACT CTC CTG C
LptBG33Asense	G33A	GGG GAA ATT GTC GCT CTG CTG GGG C
LptBG33Aanti	G33A	GCC CCA GCA GAG CGA CAA TTT CCC C
5LptBG33C	G33C	CGG GGA AAT TGT CTG TCT GCT GGG G
3LptBG33C	G33C	CCC CAG CAG ACA GAC AAT TTC CCC G
LptB_L35Q	L35Q	CAC CGT TTG GCC CCT GCA GAC CGA C
LptB_L35Q_antisense	L35Q	GTC GGT CTG CAG GGG CCA AAC GGT G
LptB_T43S	T43S	CAT GTA GAA AGT GGT GCT CTT ACC GGC ACC G
LptB_T43S_antisense	T43S	CGG TGC CGG TAA GAG CAC CAC TTT CTA CAT G
LptB_T45A	T45A	GTG CCG GTA AGA CCA CCG CTT CT ACA TGG TTG
LptB_T45A_antisense	T45A	CAA CCA TGT AGA AAG CGG TGG TCT TAC CGG CAC
lptB R144A sense	R144A	GGG GTG AAC GTG CCC GTG TAG AAA T
lptB R144A anti	R144A	ATT TCT ACA CGG GCA CGT TCA CCC C
lptB R144F sense	R144F	CTC CGG GGG TGA ACG TTT CCG TGT AGA A
lptB R144F anti	R144F	TTC TAC ACG GAA ACG TTC ACC CCC GGA G
5LptBR144H	R144H	GGG TGA ACG TCA CCG TGT AGA AAT TG
3LptBR144H	R144H	CAA TTT CTA CAC GGT GAC GTT CAC CC
lptBR144Q sense	R144Q	GGG GGT GAA CGT CAA CGT GTA GAA ATT GCC
lptBR144Q anti	R144Q	GGC AAT TTC TAC ACG TTG ACG TTC ACC CCC
LptB_R145A	R145A	GGT GAA CGT CGC GCT GTA GAA ATT GCC CG
LptB_R145A_antisense	R145A	CGG GCA ATT CTA CAG CGC GAC GTT CA CC
LptB_I148S	I148S	GTC GCC GTG TAG AAA GTG CCC GCG C
LptB_I148S_antisense	I148S	GCG CGG GCA CTT TCT ACA CGG CGA C
LptBI148Tsense	I148T	GTC GCC GTG TAG AAA CTG CCC GCG CAC TGG

LptBI148Tanti	I148T	CCA GTG CGC GGG CAG TTT CTA CAC GGC GAC
LptBI148Vsense	I148V	GTC GCC GTG TAG AAG TTG CCC GCG CAC TGG
LptBI148Vanti	I148V	CCA GTG CGC GGG CAA CTT CTA CAC GGC GAC
LptBS172Asense	S172A	GGG TTG ACC CGA TCG CAG TTA TCG ACA TTA AAC
LptBS172Aanti	S172A	GTT TAA TGT CGA TAA CTG CGA TCG GGT CAA CCC
LptBD175Asense	D175A	CCG ATC TCG GTT ATC GCC ATT AAA CGC ATC
LptBD175Aanti	D175A	GAT GCG TTT AAT GGC GAT AAC CGA GAT CGG
LptB I176T Sense	I176T	CTC GGT TAT CGA CAC TAA ACG CAT C
LptB I176T Anti	I176T	GAT GCG TTT AGT GTC GAT AAC CGA G
LptBK177Asense	K177A	CGG TTA TCG ACA TTG CAC GCA TCA TTG AGC
LptBK177Aanti	K177A	GCT CAA TGA TGC GTG CAA TGT CGA TAA CCG
LptBK177Esense	K177E	CGG TTA TCG ACA TTG AAC GCA TCA TTG AGC
LptBK177Eanti	K177E	GCT CAA TGA TGC GTT CAA TGT CGA TAA CCG
5LptBR198A	R198A	CTG ACC ACA ACG TGG CGG AAA CAC TGG CG
3LptBR198A	R198A	CGC CAG TGT TTC CGC CAC GTT GTG GTC AG
LptBR198Esense	R198E	CTG ACC ACA ACG TGG AGG AAA CAC TGG CGG
LptBR198Eanti	R198E	CCG CCA GTG TTT CCT CCA CGT TGT GGT CAG
LptBE199Asense	E199A	CCA CAA CGT GCG TGC TAC ACT GGC GG
LptBE199Aanti	E199A	CCG CCA GTG TAG CAC GCA CGT TGT GG
LptBE199Rsense	E199R	CCA CAA CGT GCG TCG TAC ACT GGC GG
LptBE199Ranti	E199R	CCG CCA GTG TAC GAC GCA CGT TGT GG
LptBV230Ssense	V230S	CAA GAC GAA CAC AGC AAG CGT GTA TAC CTT GGG G
LptBV230Santi	V230S	CCC CAA GGT ATA CAC GCT TGC TGT GTT CGT CTT G
LptBK231Asense	K231A	CAA GAC GAA CAC GTT GCC CGT GTA TAC CTT GGG
LptBK231Aanti	K231A	CCC AAG GTA TAC ACG GGC AAC GTG TTC GTC TTG

LptBR232Asense	R232A	GAC GAA CAC GTT AAG GCT GTA TAC CTT GGG G
LptBR232Aanti	R232A	CCC CAA GGT ATA CAG CCT TAA CGT GTT CGT C
LptBV233T	V233T	CAA GAC GAA CAC GTT AAG CGT ACC TAC CTT GGG GAA GAC TTC AGA
LptBV233T_antisense	V233T	TCT GAA GTC TTC CCC AAG GTA GGT ACG CTT AAC GTG TTC GTC TTG
5LptB77up	N/A	GTT CTG GTG CCG TCG CAG
3LptB50down	N/A	CAT GTT CAG AAT CGT ACT CTC CTG C
LptBG33Asense	G33A	GGG GAA ATT GTC GCT CTG CTG GGG C
LptBG33Aanti	G33A	GCC CCA GCA GAG CGA CAA TTT CCC C
5LptBG33C	G33C	CGG GGA AAT TGT CTG TCT GCT GGG G
3LptBG33C	G33C	CCC CAG CAG ACA GAC AAT TTC CCC G
LptB_L35Q	L35Q	CAC CGT TTG GCC CCT GCA GAC CGA C
LptB_L35Q_antisense	L35Q	GTC GGT CTG CAG GGG CCA AAC GGT G
LptB_T43S	T43S	CAT GTA GAA AGT GGT GCT CTT ACC GGC ACC G
LptB_T43S_antisense	T43S	CGG TGC CGG TAA GAG CAC CAC TTT CTA CAT G
LptB_T45A	T45A	GTG CCG GTA AGA CCA CCG CTT TCT ACA TGG TTG
LptB_T45A_antisense	T45A	CAA CCA TGT AGA AAG CGG TGG TCT TAC CGG CAC
lptB R144A sense	R144A	GGG GTG AAC GTG CCC GTG TAG AAA T
lptB R144A anti	R144A	ATT TCT ACA CGG GCA CGT TCA CCC C
lptB R144F sense	R144F	CTC CGG GGG TGA ACG TTT CCG TGT AGA A
lptB R144F anti	R144F	TTC TAC ACG GAA ACG TTC ACC CCC GGA G
5LptBR144H	R144H	GGG TGA ACG TCA CCG TGT AGA AAT TG
3LptBR144H	R144H	CAA TTT CTA CAC GGT GAC GTT CAC CC
lptBR144Q sense	R144Q	GGG GGT GAA CGT CAA CGT GTA GAA ATT GCC
lptBR144Q anti	R144Q	GGC AAT TTC TAC ACG TTG ACG TTC ACC CCC
LptB_R145A	R145A	GGT GAA CGT CGC GCT GTA GAA ATT GCC CG
LptB_R145A_antisense	R145A	CGG GCA ATT TCT ACA GCG CGA CGT TCA CC
LptB_I148S	I148S	GTC GCC GTG TAG AAA GTG CCC GCG C

LptB_I148S_antisense	I148S	GCG CGG GCA CTT TCT ACA CGG CGA C
LptBI148Tsense	I148T	GTC GCC GTG TAG AAA CTG CCC GCG CAC TGG
LptBI148Tanti	I148T	CCA GTG CGC GGG CAG TTT CTA CAC GGC GAC
LptBI148Vsense	I148V	GTC GCC GTG TAG AAG TTG CCC GCG CAC TGG
LptBI148Vanti	I148V	CCA GTG CGC GGG CAA CTT CTA CAC GGC GAC
LptBS172Asense	S172A	GGG TTG ACC CGA TCG CAG TTA TCG ACA TTA AAC
LptBS172Aanti	S172A	GTT TAA TGT CGA TAA CTG CGA TCG GGT CAA CCC
LptBD175Asense	D175A	CCG ATC TCG GTT ATC GCC ATT AAA CGC ATC
LptBD175Aanti	D175A	GAT GCG TTT AAT GGC GAT AAC CGA GAT CGG
LptB I176T Sense	I176T	CTC GGT TAT CGA CAC TAA ACG CAT C
LptB I176T Anti	I176T	GAT GCG TTT AGT GTC GAT AAC CGA G
LptBK177Asense	K177A	CGG TTA TCG ACA TTG CAC GCA TCA TTG AGC
LptBK177Aanti	K177A	GCT CAA TGA TGC GTG CAA TGT CGA TAA CCG
LptBK177Esense	K177E	CGG TTA TCG ACA TTG AAC GCA TCA TTG AGC
LptBK177Eanti	K177E	GCT CAA TGA TGC GTT CAA TGT CGA TAA CCG
5LptBR198A	R198A	CTG ACC ACA ACG TGG CGG AAA CAC TGG CG
3LptBR198A	R198A	CGC CAG TGT TTC CGC CAC GTT GTG GTC AG
LptBR198Esense	R198E	CTG ACC ACA ACG TGG AGG AAA CAC TGG CGG
LptBR198Eanti	R198E	CCG CCA GTG TTT CCT CCA CGT TGT GGT CAG
LptBE199Asense	E199A	CCA CAA CGT GCG TGC TAC ACT GGC GG
LptBE199Aanti	E199A	CCG CCA GTG TAG CAC GCA CGT TGT GG
LptBE199Rsense	E199R	CCA CAA CGT GCG TCG TAC ACT GGC GG
LptBE199Ranti	E199R	CCG CCA GTG TAC GAC GCA CGT TGT GG
LptBV230Ssense	V230S	CAA GAC GAA CAC AGC AAG CGT GTA TAC CTT GGG G
LptBV230Santi	V230S	CCC CAA GGT ATA CAC GCT TGC TGT GTT CGT CTT G

LptBK231Asense	K231A	CAA GAC GAA CAC GTT GCC CGT GTA TAC CTT GGG
LptBK231Aanti	K231A	CCC AAG GTA TAC ACG GGC AAC GTG TTC GTC TTG
LptBR232Asense	R232A	GAC GAA CAC GTT AAG GCT GTA TAC CTT GGG G
LptBR232Aanti	R232A	CCC CAA GGT ATA CAG CCT TAA CGT GTT CGT C
LptBV233T	V233T	CAA GAC GAA CAC GTT AAG CGT ACC TAC CTT GGG GAA GAC TTC AGA
LptBV233T_antisense	V233T	TCT GAA GTC TTC CCC AAG GTA GGT ACG CTT AAC GTG TTC GTC TTG
LptBY234A_antisense	Y234A	TGA AGT CTT CCC CAA GGG CTA CAC GCT TAA CGT GTT CGT C
LptBY234Fsense	Y234F	CACGTTAAGCGTGTATTCCTTGGGGAAGA CTTC
LptBY234Fanti	Y234F	GAA GTC TTC CCC AAG GAA TAC ACG CTT AAC GTG
LptBL235Asense	L235A	GTT AAG CGT GTA TAC GCA GGG GAA GAC TTC AG
LptBL235Aanti	L235A	CTG AAG TCT TCC CCT GCG TAT ACA CGC TTA AC
LptBL235Ssense	L235S	GTT AAG CGT GTA TAC AGT GGG GAA GAC TTC AG
LptBL235Santi	L235S	CTG AAG TCT TCC CCA CTG TAT ACA CGC TTA AC
LptBG236Asense	G236A	GCG TGT ATA CCT TGC AGA AGA CTT CAG ACT C
LptBG236Aanti	G236A	GAG TCT GAA GTC TTC TGC AAG GTA TAC ACG C
LptBG236Ssense	G236S	GCG TGT ATA CCT TAG CGA AGA CTT CAG ACT C
LptBG236Santi	G236S	GAG TCT GAA GTC TTC GCT AAG GTA TAC ACG C
LptBE237A	E237A	GCG TGT ATA CCT TGG GGC GGA CTT CAG ACT CTG ACC
LptBE237A_antisense	E237A	GGT CAG AGT CTG AAG TCC GCC CCA AGG TAT ACA CGC
5LptBD238A	D238A	GTG TAT ACC TTG GGG AAG CGT TCA GAC TCT GAC CTA GG
3LptBD238A	D238A	CCT AGG TCA GAG TCT GAA CGC TTC CCC AAG GTA TAC AC
LptBF239A	F239A	CTT GGG GAA GAC GCC AGA CTC TGA GAG CAC
LptBF239A_antisense	F239A	GTG CTC TCA GAG TCT GGC GTC TTC CCC AAG

LptBF239Ysense	F239Y	CCT TGG GGA AGA CTA CAG ACT CTG AGA GCA C
LptBF239Yanti	F239Y	GTG CTC TCA GAG TCT GTA GTC TTC CCC AAG G
LptBR240E	R240E	ACC TTG GGG AAG ACT TCG AAC TCT GAC CTA GGC TGC
LptBR240E_antisense	R240E	GCA GCC TAG GTC AGA GTT CGA AGT CTT CCC CAA GGT
LptB_241Amber	ΔL241	GGG AAG ACT TCA GAT AGT GAG AGC ACC AC
LptB_241Amber_antise nse	ΔL241	GTG GTG CTC TCA CTA TCT GAA GTC TTC CC
LptB-R242sense	lptB-R	GGA AGA CTT CAG ACT CCG TTA GCA CCA CCA CCA CCA C
LptB-R242anti	lptB-R	GTG GTG GTG GTG GTG CTA ACG GAG TCT GAA GTC TTC C
LptBR-His8sense	lptB-RHis8	GAA GAC TTC AGA CTC CGT CAC CAC CAC CAC CAC
LptBR-His8anti	lptB-RHis8	GTG GTG GTG GTG GTG ACG GAG TCT GAA GTC TTC
His8TEV-LptB-fwd	His8-LptB	CAT CAC CAT CAC GAA AAC CTG TAC TTC CAG GGC GCA AGC GCA ACA TTA ACT G
His8TEV-LptB-rev	His8-LptB	GCT TGG CCC TGG AAG TAC AGG TTT TCG TGA TGG TGA TGA TGA TGA TGA TGA CCC ATG G