Supporting Information

Discovery of L-threonine transaldolases for enhanced biosynthesis of beta-hydroxylated amino acids

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I. Supplementary Methods:

In vitro TTA-ADH-PTDH Assay

To improve product yields, we coupled the TTA with ScADH as well as an engineered phosphite dehydrogenase (PTDH). The assay was performed as described in the main text with 100 μ L reaction volumes in a 96-well plate for the TTA-ADH coupled assay with 10 mM **3** and the addition of PTDH to a final concentration of 0.1 mg/mL and phosphite to a final concentration of 20 mM. The reaction was left shaking at 1000 RPM with an orbital radius of 1.25 mm at 30 °C overnight. The reactions were quenched after 20 h with a final concentration of 1% TFA. Supernatant was collected following centrifugation and submitted to HPLC as reported in the main text.

Timed quench assay for HPLC analysis

Confirmation of the rates from the ADH assay were performed using the TTA-ADH coupled in vitro assay using a reaction mixture as reported in the main text in a 96-well plate shaking at 1000 RPM with an orbital radius of 1.25 mm at 30 °C. We chose to quench with 1% TFA at approximately 0, 1, 2, 5, 10, 20, and 40 minutes to measure reaction kinetics. The samples were then collected and submitted to the HPLC for analysis as reported in the main text.

Amino acid substrate Assay

Reaction mixtures were prepared in a 96-well plate with 100 μ L of 100mM phosphate buffer pH 7.5, 0.4 mM PLP, 15 mM MgCl₂, and 100 mM of the specified amino acid substrate with the addition of 1.5 mM **3**, and 0.25 μ M purified TTA. The plate was incubated shaking at 1000 RPM with an orbital radius of 1.25 mm at 30 °C overnight. The reactions were quenched after a 20 h with a final concentration of 1% TFA. Supernatant was collected following centrifugation and submitted to HPLC as reported in the main text.

Synthesis of 2-nitro-β-OH-phenylalanine

Synthesis of a racemic mixture of 2-nitro- β -OH-phenylalanine was performed according to a procedure described previously for phenylserines¹. Triethylamine (3.07 mL, 22 mmol, 4.4 equiv) was added to a solution of glycine (375 mg, 5.0 mmol, 1.0 equiv) in water (4.0 mL). 2-Nitrobenzaldehyde (1.51 g, 10 mmol, 2.0 equiv) was added portion-wise to this solution, and the mixture was stirred overnight at ~25 °C. The color of the reaction mixture gradually changed from clear and colorless to yellow-brown. Toluene (10 mL) was added, and the triethylamine was evaporated under vacuum. The crude product was diluted with water (15 mL), and the mixture was acidified to pH 2 with HCl (6 M). The acidified solution was stirred at ~25 °C for 3 h and partitioned against ethyl acetate (2 × 15 mL) to remove the unreacted 2-nitrobenzaldehyde. The aqueous layer was separated and neutralized to pH 6.0 with a saturated NaHCO₃ solution to precipitate the product. The mixture was stirred for 1 h at 0 °C, and the 2-nitro- β -OH-phenylalanine was triturated with methanol followed by methanol/dichloromethane (50%, v/v), and dried under vacuum to yield 2-nitro- β -OH-phenylalanine (221 mg, 20%, off-white solid) as a mixture of diastereomers (*anti:syn* = 4:1). ¹H NMR (400 MHz, D₂O) *anti*-isomer: δ 8.26 (d, *J* = 8.1 Hz, 1H), 8.03-7.87 (m, 2H), 7.75-7.67 (m, 1H), 5.86 (d, *J* = 3.8 Hz, 1H), 4.30 (d, *J* = 3.8 Hz, 1H), 4.24 (d, *J* = 4.4 Hz, 1H).

LC-MS method for standard: Waters ACQUITY Premier column, 3.0 min run, flow rate=0.5 mL/min, 95%-5% water/acetonitrile, retention time=0.24 min, ESI.

Mass spectrometry confirmation of β -OH nsAAs using in vitro TTA-ADH coupled assay

Mass spectrometry (MS) measurements for small molecule metabolites were submitted to a Waters AQUITY Arc UPLC H-Class with a diode array coupled to a Waters AQUITY QDa Mass Detector. Metabolite compounds were analyzed using a Waters Cortecs UPLC C18 column with an initial mobile phase of solvent A/B = 95/5 (solvent A, water, 0.1% formic acid; solvent B, acetonitrile, 0.1% formic acid) for 5 min with a gradient elution from (A/B) 95/5 to 10/90 for 5-7 min, an isocratic flow at 10/90 for 7-10

min, then gradient from 10/90 to 95/5 for 10-10.5 min and a final isocratic step for 10-12 min. Flow rate was maintained at 1 mL min⁻¹.

II. Supplementary Tables

Aldehyde	Abs at 1mM	Final concentration
	(340 nm)	in ADH assay (mM)
1	0.2452	1
2	0.3799	1
3	0.4418	1
4	0.3092	1
5	4	0.25
6	0.2291	1
7	0.2612	1
8	0.2796	1
9	0.2412	1
10	0.6106	1
11	0.2952	1
12	0.7088	1
13	0.2328	1
14	0.244	1
15	0.3858	1
16	0.4201	1
Compound	Abs at 340 nm	Final concentration
		in ADH assay (mM)
PLP	0.4273	0.4
NADH	0.9133	0.5
L-Thr	0.2233	100

Table S1: Absorbance of investigated aldehydes at 340 nm in phosphate buffer.

Threonine transaldolase	Accession Number	Host Organism	Class	Host Genome Assembly for antiSMASH	antiSMASH BGC Type	antiSMASH Most similar known cluster (% similarity)
ObiH	ARJ35753.1	Pseudomonas fluorescens	Bacteria	KX931446.1*	Obafluorin	100%
PiTTA	WP_095149064.1	Pseudomonas_spIrchel_s3a18	Bacteria	NZ_FYDV01000019.1	Obafluorin	85%
BsTTA	WP_060149112.1	Burkholderia stagnalis	Bacteria	NZ_QTPN01000035.1	Obafluorin	71%
CsTTA	WP_018749561.1	Chitiniphilus shinanonensis DSM 23277	Bacteria	NZ_KB895358.1	Obafluorin	85%
BuTTA	WP_080410754.1	Burkholderia ubonensis	Bacteria	NZ_MECN01000006.1	N/A	
StTTA	WP_101279775.1	Streptomyces (multi-species)	Bacteria	NZ_CP031742.1	N/A	
TmTTA	WP_188596100	Thermocladium modestius	Archaea	NZ_BMNL0100002.1	N/A	
RaTTA	GIH11859	Rugosimonospora africana	Bacteria	BONZ01000001.1	Spicamycin	27%
SNTTA	ADZ45329	Streptomyces sp. NRRL 30471	Bacteria	HQ257512.1	Muraymycin	100%
NoTTA	WP_052373448	Nocardia otitidiscaviarum	Bacteria	JADLPU010000004.1	N/A	
KaTTA	WP_033354341	Kitasatospora aureofaciens	Bacteria	NZ_JNWR01000048.1	Valclavam	64%
PbTTA	MBN2478762.1	Parachlamydiales bacterium	Bacteria	JAFGQY010000010.1	N/A	
DbTTA	MBI5609283	Deltaproteobacteria bacterium	Bacteria	JACRCU010000288.1	N/A	

Table S2. Predicted attributes of selected threonine transaldolases screened in this study.

*Accession number for the obafluorin biosynthesis gene cluster

Number	Name	Relevant genotype	Source
E. coli strains			
	DH5a	F- Φ80lacZΔM15 Δ(lacZYA-argF) U169 recA1 endA1 hsdR17 (rK-,	NEB
		mK+) phoA supE44 λ– thi-1 gyrA96 relA1	
	MG1655	F- λ - ilvG- rfb-50 rph-1	ATCC 700926
	MG1655 (DE3)	F- λ - <i>ilv</i> G- <i>rfb-50 rph-1</i> (λ DE3)	Previous study ²
		λ DE3 = λ sBamHIo Δ EcoRI-B int::(<i>lac</i> I::PlacUV5::T7 gene1) i21 Δ <i>nin</i> 5	
	RARE	MG1655(DE3) $\Delta dkgB \Delta yeaE \Delta (yqhC-dkgA) \Delta yahK \Delta yjgB$	Previous study ²
	BL21 (DE3)	$fhuA2 [lon] omp \Gamma gal (\lambda DE3) [dcm] \Delta hsdS$	NEB
1.13	MA I01 MA I13	DH5g harboring TTA expression plasmids D1 D13	This study
14-26	MAJ01-MAJ15 MA I14-MA I26	BL 21 (DF3) harboring TTA expression plasmids P1-P13	This study
27-39	MAI27-MAI39	MG1655 (DE3) harboring TTA expression plasmids P1-P13	This study
40-52	MAJ40-MAJ52	DH5 α harboring SUMO-tagged TTA expression plasmids P14-P26	This study
53-65	MAJ53-MAJ65	BL21 (DE3) harboring SUMO-tagged TTA expression plasmids P14-P26	This study
66-78	MAJ66-MAJ78	MG1655 (DE3) harboring SUMO-tagged TTA expression plasmids P14-	This study
		P26	-
79-91	MAJ79-MAJ91	RARE harboring SUMO-tagged TTA expression plasmids P14-P26	This study
92	MAJ92	DH5a harboring TTA expression plasmid P27	This study
93-96	MAJ93-96	DH5a harboring CAR expression plasmids P28-P31	Previous studies ^{2,3}
97	MAJ97	RARE harboring pACYC-niCAR-sfp (P28) and pZE-SUMO-PbTTA(P25)	This study
98	MAJ98	RARE harboring pACYC-SUMO-PbTTA (P27)	This study
99	MAJ99	RARE harboring pZE-mavCAR-sfp (P29) and pACYC-SUMO-PbTTA	This study
100		(P27)	
100	MAJ100	RARE harboring pZE-mmCAR-stp (P30) and pACYC-SUMO-PbTTA	This study
101		(P2/)	751 1
101	MAJ101	RARE harboring pZE-trCAR-sip (P31) and pACYC-SUMO-Pb11A (P2/)	This study
102-105	MAJ102-105	BL21 (DE3) harboring CAR expression plasmids P28-51	Previous study
100-109	MAJ100-109	DH3a harboring ADH expression plasmids P32-P35	This study
110-113	MAJ110-113	BL21 (DE3) narboring ADH expression plasmids P32-35	Pursieurs etc. h-4
114	MAJ114	a gift from Wilfred van der Donk (Addgene plasmid # 166786:	Previous study
		http://n2t.net/addgene:166786 : RRID:Addgene 166786)	
115	MAJ115	BL21 (DE3) harboring PTDH expression plasmid P36	This study
Plasmids		[()	
P1	pZE-ObiH	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>obiH</i> gene	This study
		bearing an N-terminal hexahistidine tag.	
P2	pZE-PiTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>piTTA</i> gene	This study
D 2		bearing an N-terminal hexahistidine tag.	
P3	pZE-BSI IA	ColE1 ori, Kan", 1etR, 1et promoter with a codon optimized <i>bs11A</i> gene bearing on N terminal havehistiding tog	This study
P4	pZE-CsTTA	ColE1 ori Kan ^R Tet R. Tet promoter with a codon ontimized $csTTA$ gene	This study
	pee comm	bearing an N-terminal hexahistidine tag.	This study
P5	pZE-BuTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>buTTA2</i> gene	This study
	-	bearing an N-terminal hexahistidine tag.	-
P6	pZE-StTTA-Δ36	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized stTTA-Δ36	This study
		gene bearing an N-terminal hexahistidine tag.	
P7	pZE-TmTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>tmTTA</i> gene	This study
D 0		bearing an N-terminal hexahistidine tag.	
P8	pZE-RallA	ColE1 ori, Kan ^k , 1etR, 1et promoter with a codon optimized <i>ral1A</i> gene bearing on N terminal havehistiding tog	This study
PQ	pZE SNTTA	ColE1 ori Kan ^R Tet P. Tet promoter with a codon optimized sn TTA gene	This study
19	pze-SivitA	bearing an N-terminal hexabistidine tag	This study
P10	pZE-NoTTA	ColE1 ori, Kan ^R , TetR. Tet promoter with a codon optimized <i>noTTA</i> gene	This study
110	p=== 1.01111	bearing an N-terminal hexahistidine tag.	The stady
P11	pZE-KaTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized kaTTA gene	This study
		bearing an N-terminal hexahistidine tag.	
P12	pZE-PbTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>pbTTA</i> gene	This study
		bearing an N-terminal hexahistidine tag.	
P13	pZE-DbTTA	ColE1 ori, Kan ^k , TetR, Tet promoter with a codon optimized <i>dbTTA</i> gene	This study
D14	"ZE SUMO Obju	ColE1 ori Kon ^R TotP. Tot promotor with a codon ontimized abiH conc.	This study.
r 14	pze-sowo-obiii	bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV	This study
		protease cleavage site	
P15	pZE-SUMO-PiTTA	ColE1 ori, Kan ^R , TetR. Tet promoter with a codon optimized <i>niTTA</i> gene	This study
	r	bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV	
		protease cleavage site.	
P16	pZE-SUMO-BsTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized bsTTA gene	This study
	_	bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV	
		protease cleavage site.	
P17	pZE-SUMO-CsTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>csTTA</i> gene	This study
		bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV	
		protease cleavage site.	

Table S3. Strains and Plasmids used in this study.

P18	pZE-SUMO-BuTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>buTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P19	pZE-SUMO-StTTA-Δ36	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized $stTTA-\Delta 36$ gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P20	pZE-SUMO-TmTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>tmTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P21	pZE-SUMO-RaTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>raTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P22	pZE-SUMO-SNTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>snTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P23	pZE-SUMO-NoTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>noTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P24	pZE-SUMO-KaTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>kaTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P25	pZE-SUMO-PbTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>pbTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P26	pZE-SUMO-DbTTA	ColE1 ori, Kan ^R , TetR, Tet promoter with a codon optimized <i>dbTTA</i> gene bearing an N-terminal hexahistidine tag followed by a SUMO tag and a TEV protease cleavage site.	This study
P27	pACYC-SUMO-PbTTA	P15A ori, Cm ^R , lacI, T7lac with codon optimized SUMO-tagged PbTTA	This study
P28	pACYC-niCAR-sfp	pACYCDuet-1 harboring a codon optimized carboxylic acid reductase from <i>Norcardia iowensis</i> (niCAR) and a codon optimized phosphopantetheinyl transferase from <i>Bacillus subtilis</i> (sfp). P15A ori, Cm ^R , <i>lacI</i> , T7 <i>lac</i>	Previous study ²
P29	pZE-mavCAR-sfp	ColE1 Ori, Kan ^R , TetR, Tet promoter with a codon optimized carboxylic acid reductase from <i>Mycobacterium avium</i> (mavCAR) and a codon optimized phosphopantetheinyl transferase from <i>Bacillus subtilis</i> (sfp).	Previous study ³
P30	pZE-mmCAR-sfp	ColE1 Ori, Kan ^R , TetR, Tet promoter with a codon optimized carboxylic acid reductase from <i>Mycobacterium marinum</i> (mmCAR) and a codon optimized phosphopantetheinyl transferase from <i>Bacillus subtilis</i> (sfp).	Previous study ³
P31	pZE-trCAR-sfp	ColE1 Ori, Kan ^R , TetR, Tet promoter with a codon optimized carboxylic acid reductase from <i>Trichoderma reesei</i> (trCAR) and a codon optimized phosphopantetheinyl transferase from <i>Bacillus subtilis</i> (sfp).	Previous study ³
P32	pZE-eutG-Ctermhis	ColE1 Ori, Kan ^R , TetR, Tet promoter with an alcohol dehydrogenase (eutG) from <i>Escherichia coli</i> .	This study
P33	pZE-adhP-Ctermhis	ColE1 Ori, Kan ^R , TetR, Tet promoter with an alcohol dehydrogenase (adhP) from <i>Escherichia coli</i> .	This study
P34	pZE-adhE-Ctermhis	ColE1 Ori, Kan ^R , TetR, Tet promoter with an alcohol dehydrogenase (adhE) from <i>Escherichia coli</i> .	This study
P35	pZE-fucO-Ctermhis	ColE1 Ori, Kan ^R , TetR, Tet promoter with an alcohol dehydrogenase (fucO) from <i>Escherichia coli</i> .	This study
P36	pET15b-17X-PTDH	pBR322 ori, AmpR, LacI, T7 promoter with a phosphite dehydrogenase (PTDH) from <i>Pseudomonas stutzeri</i> containg the following mutations for activity: A196R, T201S, A328T, E352N, C356D,	Previous study ⁴

Table S4. Oligonucleotides used in this study.

All primers denoted FWD and REV were used for cloning whereas any primers containing SEQ were used for sequencing the associated plasmid.

Oligo Name	Sequence
pZE backbone FWD	CTTGATGGGGGATCCCATGGTA
pZE backbone REV	GTGGTGATGATGGTGATGGCTGCCCATGGTACCTTTCTCCTCTTTAATGAATTCG
StTTA REV	CCATGGGATCCCCCATCAAGTTAACGAAAGACCTCACCCAACA
BuTTA REV	CCATGGGATCCCCCATCAAGTTAAGCGATTACTTCCTCCATCAA
PiTTA REV	CCATGGGATCCCCCATCAAGTTAGCGTTGAATTCCACGCTC
ObiH-REV	CCATGGGATCCCCCATCAAGTTAACGTTGGGCTCCTTGG
BsTTA REV	CCATGGGATCCCCCATCAAGTTAACGCATCACGCCTTGG
CsTTA REV	CCATGGGATCCCCCATCAAGTTAGCGTAACGCCTCCCCAATA
StTTA FWD	GCCATCACCATCACCACATGGGAGTTTGGGCAGGC
BuTTA FWD	GCCATCACCATCACCACATGATGACGGACTTCGCA
PiTTA FWD	GCCATCACCATCACCACATGAAACAAGACGAATCGAATG
ObiH-FWD	GCCATCACCATCACCACATGTCCAATGTCAAGCAACA
BsTTA FWD	GCCATCACCATCATCACCACATGAAACAGGAACCTACGGG
CsTTA FWD	GCCATCACCATCACCACATGACGCGCACGACCC
BsTTA SEQ	GTGCCCGAACATTCAGAG
StTTA SEQ	GCGTATATTGCGTTCCG
BuTTA SEQ	ACCATCCTGCGATGAAG
PiTTA SEQ	AAAGGGGTTTATTGCGTTCA
CsTTA SEQ	GCGGGTCATTTACATCGT
PiTTA SUMO FWD	GAAAATCTGTATTTTCAGGGCAAACAAGACGAATCGAAT
TEV SUMO REV	GCCCTGAAAATACAGATTTTCTG
BsTTA SUMO FWD	GAAAATCTGTATTTTCAGGGCAAACAGGAACCTACGGGC
StTTA SUMO FWD	AAAATCTGTATTTTCAGGGCGGAGTTTGGGCAGGCGAC
pZE split REV V1	CCTGGTATCTTTATAGTCCTGTCGG
CsTTA SUMO FWD	AAAATCTGTATTTTCAGGGCACGCGCACGACCCCCCAG
pZE split REV V2	GGGAAACGCCTGGTATCTTTATAGTCCTGTCGG
ObiH SUMO FWD	AAAATCTGTATTTTCAGGGCTCCAATGTCAAGCAACAGAC
PbTTA SUMO FWD	AAAATCTGTATTTTCAGGGCGAAACCTCCCTGAAGGATTTTG
BuTTA SUMO FWD	AAAATCTGTATTTTCAGGGCACGGACTTCGCACAGGC
BuTTA SUMO REV	ACGCCTGGTATCTTTATAGTCCTGTC
RaTTA gene fwd	GCCATCACCATCATCACCACATGTTGGAAATTGTGGGGGG
RaTTA gene rev	CCATGGGATCCCCCATCAAGTTAACGATAAAGCCACGCAG
pZE bbone fwd	CTTGATGGGGGATCCCATG
pZE bbone rev	GTGGTGATGATGGTGATGG
TmTTA gene fwd	GCCATCACCATCACCACATGCGCGAGGAAGAAGC
TmTTA gene rev	CCATGGGATCCCCCATCAAGTTACAGTAACGGAAGACAAGGG
SnTTA gene fwd	GCCATCACCATCACCACATGACATCAAGCGACGATTG
SnTTA gene rev	CCATGGGATCCCCCATCAAGTTACCCATGAAAAAGTCCCG
NoTTA gene fwd	GCCATCACCATCACCACATGAATACGTTCGATATCTTAGAAC
NoTTA gene rev	CCATGGGATCCCCCATCAAGTTATGCGACTGATACCTCC
PbTTA gene fwd	GCCATCACCATCACCACATGGAAACCTCCCTGAAGG
PbTTA gene rev	CCATGGGATCCCCCATCAAGTTAGAATAACTTCTCGTAGATCTCG
DbTTA gene fwd	GCCATCACCATCACCACTTGACGAATAATCGCGAGC
DbTTA gene rev	CCATGGGATCCCCCATCAAGTTAAGAGGCATAGACCGCC
KaTTA gene fwd	GCCATCACCATCACCACATGGATGTGTTGGCTGC
KaTTA gene rev	CCATGGGATCCCCCATCAAGTTAGGCTACTGCCAAGGG
SUMO tag fwd	ATGTCCCTGCAGGACTC
SUMO tag rev	GCCCTGAAAATACAGATTTTCTGAACCTCCACCTCCCGACCACCACCGCCGCCACCAATCTGTTCGC
pZE-SWNB bbone rev	TCCGAGTCCTGCAGGGACATGTGGTGATGATGGTGATGG
pZE- TmTTA bbone fwd	AAAATCTGTATTTTCAGGGCATGCGCGAGGAAGAAGC
pZE- RaTTA bbone fwd	AAAATCTGTATTTTCAGGGCATGTTGGAAATTGTGGGGGG
pZE- SnTTA bbone fwd	AAAATCTGTATTTTCAGGGCATGACATCAAGCGACGATTG
pZE- NoTTA bbone fwd	AAAATCTGTATTTTCAGGGCATGAATACGTTCGATATCTTAGAAC
pZE- TmTTA bbone rev	TCCGAGTCCTGCAGGGACATGTGGTGATGATGGTGATGGC
pZE- DbTTA bbone fwd	AAAATCTGTATTTTCAGGGCTTGACGAATAATCGCGAGC
pZE- KaTTA bbone fwd	AAAATCTGTATTTTCAGGGCATGGATGTGTTGGCTGC
pACYC bbone fwd	AAGCTTGATGGGGGATC
pACYC bbone rev	GGTATATCTCCTTATTAAAGTTAAAC
pACYC SUMO-PbTTA12	
ins fwd	CTTTAATAAGGAGATATACCATGGGCAGCAGCAATCA
pACYC SUMO-PbTTA12	
ins rev	GGATCCCCCATCAAGCTTTTAGAATAACTTCTCGTAGATCTCGT
pZE-cterm-his bbone fwd	GGCAGCCATCACCATC
pZE-cterm-his bbone rev	GGTACCTTTCTCCTCTTTAATGAA
pZE eutG fwd	TTAAAGAGGAGAAAGGTACCATGCAAAATGAATTGCAGACC
pZE eutG rev	TGATGGTGATGGCTGCCTTGCGCCGCTGCGTACAG
pZE adhP fwd	TTAAAGAGGAGAAAAGGTACCATGAAGGCTGCAGTTGTTAC

pZE adhP rev	TGATGGTGATGGCTGCCGTGACGGAAATCAATCACCA
pZE adhE fwd	TTAAAGAGGAGAAAGGTACCATGGCTGTTACTAATGTCGC
pZE adhE rev	TGATGGTGATGGCTGCCAGCGGATTTTTTCGCTTTT
pZE fucO fwd	TTAAAGAGGAGAAAGGTACCATGGCTAACAGAATGATTCTG
pZE fucO rev	TGATGGTGATGGCTGCCCCCAGGCGGTATGGTAAAG

Table S5. DNA G-Blocks/Twist gene fragments for cloning in this study. Start codons for each gene are underlined.

Oligo Name	Protein Accession	Sequence
ОыН	ARJ35753.1	ATGTCCAATGTCAAGCAACAGACAGCTCAGATCGTGGATTGGTTATCAAGCACTTTAGGTAAAGACCATCAG TATCGTGAAGATAGCTTGAGTCTTTACAGCGAACGAACGA
PiTTA	WP_095149064.1	ATGAAACAAGACGAATCGAATGTTGGTCCTGTCATTGACTGGCTGG
BsTTA	WP_060149112.1	ATGAAACAGGAACCTACGGGCGCCTTCGAGGTTGCCACGGTGCTGAACGACATTTTTCTTGCTGACCATCG CTACCGCGAGGTAACTCTTAGTCTTACCGCTAATGAAAATTATCCTTCAGAGCTTGTACGTGTTACGTCCGG AAGTACCGCCGGGGCTTTTTATCATGTGAGCTTCCCGTTCGATGTACCGCGAGGAGAATGGCACTTCCCCG AACCCGGACATAGCACGCGGTGGCGGGATAAAGTTCGTAGTTGGGGAAGTCATTGCTGCATGCA
CsTTA	WP_018749561.1	ATGACGCGCACGACCCCCCAGGCACGTCATGTCGTGGAGCGCCTGAATTCAGTTTTAGGACAAGACTACC GCTATCGTGAGGATTGTCTGAGCCTTACCGCGCAATGAGAACTATCCTTCCGCATTAGTGCGCTTAGCGGGG AGTGCCACAGCTGGAGGCCTTCTACCACTGTAGCTTTCCGTTTGAGGTGCCACCGGGAGAATGGTATTTTCC TGAGAGCGGTCGTATGGGGGAACTTGCTCAACAGCTGAATGAA

		ATGATTTTGAGCAGGTGGCGCGTTTTATCGCGGACTTGCACTTCCGCAAAGCAGACCCAGCCGGAGTCGCA GCACAAGTAGCGGAATTTCTTCGTGCTTTTCCTTTGGCACCATTACATTACTCATTTGATCAGGAACTGGATC
		ATGAGTTATTGCAGTCCCTTATTGGGGAGGCGTTACGCTAA
BuTTA	WP_080410754.1	AAAATCTCAAACATCTTCGATAGTCTTCATAGCGATTTGCCTTGGATAATTTATACCGCGCAAGCCACTTA AGTCTGACCGCCTCTGAGAATTATCCATCCCGCTTTGTGCGCACGCTGGGAGCCGGTATGCAAGGCGGTTT CTATGAATTCGCGCCCACCTTACGCCGCTAACCCGGGAGAGTGGTACTTCCCTGACAGTGGCGCGCGC
StTTA- ∆36	WP_101279775.1	ATGGGAGTTTGGGCAGGCGACCGTGTTGCCCAAGTTTTGGAACGCTTAGCGTCGGATTTTGTTTAGACAA CACTTATCGCGAACAACACCTGAGCTTGACGGCTTCTGAGAACTATCCTTCAAAACTGGTACGCATGTGGG AGCGGGATTACAGGGGGGTTTCTATGAGGTTGCCCGCCCATTCCGGCAGAAGACAGGAGAATGGGCATTC CCGGACTCCGGACGGCGCCCTTGTAGGGAAGCTGACTGGCCAAAGCAGGAGAATGGGCATTC CCGGACTCCGGACGGCGCCCTTGTAGGGAAGCTGACTGGCCAAACTGTCCGAGGGACGTGTGGAC GCGGGGATGGTTTTGTGCACTCGCGCGAACGCGGCCGAGCAAGCA
TmTTA	WP_188596100	CCATCACCATCATCACCACATGCGCGCGGGGGGGGGGGG
RaTTA	GIH11859	CCATCACCATCATCACCACATGTTGGAAATTGTGGGGGACCATGAACGCAAAATGGCGAGTGCAGTGAATC TTATCCCCAGCGAGAATTTATTAACACCCGCCGCACGTTTAGCCTACCTTTCAGATGCGTATTCGCGTTATTT TTTCGATGAGCGTGACGGTGTTCGGAAAGTGGTCTTTCCAGGGGGGAGCATTGTGGGCGAAGTACAACGT GAGGTTTTAGTGCCTCTGGTACAAAGGTAACTGGGGCACGCCATGTGGACGTCCGTGGGATTAGTGGCC TGAATGCCATGACCGTGGCTCTGGCAGCGTTTGGCGCCCGTGACCGCGTTACAATTACAGTACCGCCCCG CCACGGAGGCCATCCAGCTACCGCAGCTTTGGCCGGACACTTTGGGCACGCGCTTACAATTACAGTACCGCCCCG CCACGGAGGCCATCCAGCTACCGCAGTTGTGGCCGGACACTTTGGGCATCGTGCAGAGGCTTTACCTTTC CGTGATGAAGCCTGGTGGGAGGTTGACTTGCCCGCCTGCCT

SnTTA	ADZ45329	CCATCACCATCATCACCACATGACATCAAGCGACGATTGTGCTGCGAGTCGTACGGCTCCCGTCGCTGGCC GCGCAGAACTTTTGCCGCTGTTGGGAGAATCGAGAAGCAGCAGCGCATCAACGAGGCCGCGTGAACTT AGTGCCTTCAGAGAATCGCATTAGTCCCTGGGCTGGG
NoTTA	WP_052373448	CCATCACCATCACCACACATGACATACGTTCGATATCTTTGAACAACTTGCACGTTATGAGGAGGACATC GCGCCGTTTGCACTTACACCACATGAATACGTTCGATATCTTTGAACAACTTGCACGTTATGAGGAGGCACATC GCGCCGTTTGCATTTAATTGCGTCTGAGAATCCCCTGGACTCAGACAACTTGCACGTTATGCTGGAGGACTCT GATTGACCTGGAAGCTGACGCATTGGGGAGCCCTTGGGGCCTAGGCCAGGCCGGGCAGGACTCT GATTGACCTGGAAGCTGACGCATGGGCGCTTGCCGGCCTTGGCCGAACTGGGGCCCGTGGAGACTCT GATTGACCTGGAAGCTACGGCGTAGGCCTTGTCCGCCCTGGGCCCGACATGCTGGGGACCGTGCAACT GTTTTATCGCTTGCAGAATCAGATGGTGGCCCTGGTCCGCCTGGCCGAACTGGGCCCGTCGGGCCGTGGAACCG GCGGTCGCGCGGGGCCTTGGTGGCCATGGATCGGCGCGCTCGGCCGTCAGGCCGG CAGTGCCCGCGGTGGCTCGGTCTTATATCTGGATGCGTTCATGGCGCGGCTTTGCGCTTTTAGCGCGGGAG GCCGTTTCCAAAATCCGTTAGCTGAAGGCGCCGATTCGCTTGGAGGCTCTGTAACCCAAAACCTGGCCGGGG GCGGTTCCCAAAATCCGTTAGCTGAAGGCGCCGATTCGCTTGGAGGGTCCACACAAAACCTGGCCGGGG GCGGTTCCCAAAATCCGTTAGCTGCAAAGGCGCCGCTTAGCACCGCCTGGATACTCACGCCGGGG TTGGACTCCCCACCATCACCGTGGCAACTGGCTGCACTGGCGCTTAGACCAAAACCTGGCCGCGGG TGGGCGACTACGCGACAGCGGTGGTCACGGCGCAATTAGCTGGAGCAACATG CTGGCGACTACGCGACAGCGGTGCACAGGCGCCAATTAGCTGGAGCAACATG CTGGCGACTACGCGCACAGGGATCTGGCTGCACTGGCGCTTAGACCGCCGGAGGGCGGCTT GAGCATCTGCCGACAGCGGTGGTGCAACGCGGCATTAGCTGGAGCAACTGCCAGGCGGCTT GAGCATCTGTCGCGGCTCAGCGTTTGGATGCGCGCAAATGCGGGGGTTGGAATTGCCCCAGGGCTT GAGCCTCGTCGCGGCCTGGGCGTTCAGGCGGCTTAGACCGGGGCTTGGAACTCCCAGGGCTT GCCGAACCCGGCTCAGCGTTTGTATGATGCTGGCTGGCGCCGGGGGTTGGAATTGCCAGGCGGCTT GCCGAACCCGGCTCAGCGCTTCGGCGCCGCGCGCGCGCGGGGGTTGGAACCCGGGCTTGGAACCGGGCCTGGCGCTCAGGCGTTCGGCGGCGCTCAGGCGGCTTCGGCGGGGGCTTCGGCGGCGGCTCCGGGGGCTTCGGGGGG
KaTTA	WP_033354341	CCATCACCATCATCACCACATGG <u>ATG</u> TGTTGGCTGCCCTGGAACGTAAGCACAGTTTAAACTTGTTTCCGAT TGAAAATCGCTTGTCACCCCGTGCTGCCGCCGCCGCTCTGGCATCCCGATGCCGTAACCGTTATCCGTACAGTG AGACGGATGTGGCGCGGTACGGAGACGTTAGTGATCTGAATGCTGTATATGACCATTGCGTCAGTCTTACC AAGGAATTTTATGGCGCCGCCATGCATATGTTCAGTTTCTTTC
РЬТТА	MBN2478762.1	CCATCACCATCACCACACGGGAAACCTCCCTGAAGGATTTTGAAACTATCCTTCACTTAATTAA
DbTTA	MBI5609283	CCATCACCATCATCACCACCTCGACGAATAATCGCGAGCTTATGGACCGTATCGGTTATAATCTTTCACAAGG TTTAGTTTCAAGCCAGCATACCGCAAGTCTGGTCGCTTTATTTA

		GAGTGCTCCTCACCAAATGGAGCGCTTACTTCGTGCCCATTTGGTTGTTCAGCGCGGCATGCCGTTTCGCA
		ACGTTGACGCCTTGCGTGTTGGCGTGCAAGAAGTCACACGCCGCGGTTATGGACCCGGCGAGATGGCGCA
		GCTGGCAGAGTGGATTGCGTCAATCGTCATCGGCGGTGCGGACCCCGAGGTAGTAGCACCTGCCGTGCAA
		GCCATGGCTAAGCGCTTTGACACTATCTATTATACGGGCGAAACGGTGGACGGTAAACTTGATCTTCCAGA
		AATCGCAGCGCCGAGCGCTAAGGGCCGTTGGGTTGACTATCGCCATTTGGGAAATGATTTTGCAATGGACG
		ATACTGAGTTCTCCGAAATTCGCGCCTTGGGTGCTGCCGCGGGAGCCTTCCCAAACCAGACCGACAGTACA
		GGTAACGTCTCGTTACGTTCAGGAGCCCGTGTATTCGTGTCGTCTAGCGGGTCATATATTAAGCACCTGGC
		CGACGGACAGGTCGTCGAGTTGGACGCGGTAGATCCCTCAGGGGAATTGATTG
		TTGCCCAGCAGTGAGAGTCTGATGCACTTCTTAGTTTACCAGAATGTGCCAGCGGGCGCAGTTGTGCACAC
		TCACTATTTATTAACCAACCAAGAGGCTGCCGACTTCGATGTGGCGGTGATCGCTCCTCAGGAATATGCCA
		GTATTGCACTTGCCCGCGCAGTAGCAGAAGCCAGTAAACGCTCCCGTATCGTGTATATTCAAAAACACGGA
		TTAGTGTTTTGGGGTACAGACACTGCAGATTGTCTGTCTCAGGTTCACAACTTTATTCACAACCGTCCAAATC
		GTCGCGCAGCTGAGGCGGTCTATGCCTCTTAACTTGATGGGGGGATCCCATG
		ATGTCCCTGCAGGACTCGGAGGTTAACCAGGAAGCAAAGCCGGAAGTCAAACCCGGAAGTGAAACCCGAAA
SUMO		CTCACATCAATCTGAAGGTAAGTGATGGTTCTTCAGAGATATTCTTTAAAATTAAAAAAACCACGCCTCTGCG
501VIO-		GCGTCTTATGGAAGCGTTCGCCAAACGACAAGGGAAAGAGATGGATAGCTTACGTTTTCTCTATGATGGCA
lay	.	TTCGCATCCAGGCGGATCAAGCTCCAGAGGACTTGGATATGGAAGATAACGACATTATCGAAGCCCATCGC
		GAACAGATTGGTGGC

*For StTTA, we arbitrarily cloned a variant to contain a 36-residue truncation from the N-terminus (StTTA- Δ 36) such that its new N-terminal residue would align with the sequence of ObiH and the other candidate TTAs.

III. Supplementary Figures



Figure S1: TTA-ADH coupled assay optimal output. The observed depletion of absorbance at 340nm for the condition TTA, ADH, and aldehyde compared to no depletion for negative controls with no enzyme, and no TTA. Assay performed in triplicate with shading representing the standard deviation.





Figure S2: TTA-ADH coupled assay background activity and reactions. (a) Background activity of the ScADH on an aromatic aldehyde of interest leading to a depletion of NADH and corresponding loss of absorbance. Assay performed as described in the main text using 1 mM aldehyde and 1.45 μ M ObiH. (b) Background activity observed from the L-threonine reacting with the TTA and releasing acetaldehyde that is then consumed by the ADH. Assay performed as described in the main text using 12.4 μ M ObiH. Assays performed in triplicate with shading representing the standard deviation.



Figure S3: Assessing alternate ADHs for background aldehyde activity. In vitro TTA-ADH coupled assay with 4 ADHs from *E. coli* using 1 as a substrate. Each has confounding activity with ADH only control, so they were not pursued further. The final ADH concentration in the assay is listed in parenthesis following the protein name. (a)EcFucO (230 μ g/mL) (b) EcAdhE (200 μ g/mL) (c) EcEutG (100 μ g/mL) (d) EcAdhP (100 μ g/mL) which had such a rapid rate that we did not screen it in the presence of ObiH. Assay performed in triplicate with shading representing the standard deviation.

Figure S4



Figure S4: Validation of the TTA-ADH assay using HPLC analysis. (a) A comparison of the rates measured using the continuous plate reader assay and a discontinuous HPLC assay to validate the rates observed on the plate reader are accurate. **3** was used as the substrate with all other conditions described in the methods of the main text and SI. In addition to the time course assay with ObiH and ADH, the assay was also performed with only ObiH to understand the impact of the ADH on the reaction rate. Plate reader rates performed and calculated in triplicate with error bars representing the standard deviation. Discontinuous HPLC assay performed in triplicate with rate calculated using the averages for each triplicate. (b) The concentration of β -OH nsAA as a function of time for the HPLC-based time course assay. Assay performed in triplicate with error bars representing standard deviation.



Figure S5: LC-MS for synthesized 2-nitro- β -OH-phenylalanine. The top two charts represent the raw spectra, and the bottom chart is the specific mass for the peak highlighted. The bottom chart shows mass spectra (m/z) extracted at the highlighted elution time.



Figure S6: ¹HNMR for chemically synthesized 2-nitro- β -OH-phenylalanine. NMR spectra to confirm the chemical synthesis of 2-nitro- β -OH-phenylalanine.



Figure S7: Coupling ADH with co-factor regeneration for improved \beta-OH-nsAA yields. As previously shown⁵, coupling the TTA to an ADH and a recycling system will improve product yields. We observed higher conversion when coupling ObiH, ADH, and an engineered phosphite dehydrogenase (PTDH)⁶ and 10 mM of **3.** Product concentrations were measured after 24 h using the reaction conditions described in the SI. Peak area is calculated as the area under the curve for the absorbance spectra output from HPLC. Experiment performed in triplicate with each replicate represented and error bars represent the standard deviation.





Figure S8: Screening photo-treated TTA in the TTA-ADH coupled assay. (a) The literature suggests that ObiH is in its most active form after being activated with light⁷. We used the TTA-ADH coupled assay to determine if there were any differences with photo-treated enzymes by using a sample directly from the dark -80 °C storage, "Pink", and another, that had been sitting on ice under ambient light, "Yellow", for 4 h. The rates measured with the TTA-ADH coupled assay were very similar between the two enzymes samples. Assay performed in triplicate with each replicate represented and the error bars represent the standard deviation. (b) The light exposure did change the color of the sample which we used as verification of photo-treatment prior to beginning the coupled assay. Since we did not observe differences in behavior, we proceeded with our assays without photo-treatment. We hypothesize that this is because of the extensive light exposure that occurs during the purification process.



Figure S9: HPLC and LC-MS confirmation for β -OH-nsAA produced from benzaldehyde (1). (a) HPLC traces at 210 nm for the with and without TTA conditions. (b) LC-MS trace.

Figure S10



Figure S10: HPLC and LC-MS confirmation for β -OH-nsAA produced from 4-nitro-benzaldehyde (2). (a) HPLC traces at 280 nm for the with and without TTA conditions. (b) LC-MS trace.



Figure S11: HPLC and LC-MS confirmation for β -OH-nsAA produced from 2-nitro-benzaldehyde (3). (a) HPLC traces at 280 nm for the with and without TTA conditions. (b) LC-MS trace.



Figure S12: HPLC and LC-MS confirmation for β -OH-nsAA produced from 4-amino-methylbenzaldehyde (4). (a) HPLC traces at 280 nm for the with and without TTA conditions. (b) LC-MS trace.





Figure S13: LC-MS confirmation for β -OH-nsAA produced from 2-amino-benzaldehyde (6). (a) LC-MS trace. It was difficult to detect 2-amino-benzaldehyde via HPLC due to its co-elution with the solvent front.



Figure S14: HPLC and LC-MS confirmation for β-OH-nsAA produced from terephthalaldehyde (7). (a) HPLC traces at 250 nm for the with and without TTA conditions. (b) LC-MS trace.



Figure S15: HPLC confirmation for β -OH-nsAA produced from 4-methoxybenzaldehyde (9). (a) HPLC traces at 210 nm for the with and without TTA conditions. Despite the robust peak formed on HPLC, we had difficulty verifying the product via LC-MS, possibly because it does not ionize well.



Figure S16: HPLC and LC-MS β -OH-nsAA produced from confirmation for 4-biphenylcarboxaldehyde (10). (a) HPLC traces at 280 nm for the with and without TTA conditions. (b) LC-MS trace.



Figure S17: HPLC and LC-MS confirmation for β-OH-nsAA produced from 2-napthaldehyde (11). (a) HPLC traces at 280nm for the with and without TTA conditions. (b) LC-MS trace.



Figure S18: LC-MS confirmation for β -OH-nsAA produced from phenylacetaldehyde (14). (a) LC-MS trace. We were unable to detect the product via HPLC due to low absorbance across all wavelengths screened.



Figure S19: LC-MS confirmation for β -OH-nsAA produced from 4-nitro-phenylacetaldehyde (15). (a) LC-MS trace. It was difficult to observe a specific product peak on HPLC because of the instability of 4-nitro-phenylacetaldehyde.

Figure S20: HPLC and LC-MS confirmation for β -OH-nsAA produced from 2-nitrophenylacetaldehyde (16). (a) HPLC traces at 280nm for the with and without TTA conditions. (b) LC-MS trace.

Figure S21: Sequence identity and similarity matrix. (a) Identity matrix from Figure 3B with % values. (b) Similarity matrix for all TTAs except DbTTA due to poor alignment⁸. Similar residues are considered the following: GAVLI, FYW, CM, ST, KRH, DENQ, P.

Figure S22: Unedited western blot from Figure 3b. Unedited image of the western blot in Figure 3b comparing the expression of TTAs with and without a SUMO-tag. The protein ladder is the Thermo ScientificTM SpectraTM Multicolor Broad Range Protein Ladder.

Figure S23

Figure S23: SUMO versus no SUMO tag for KaTTA. (a) Rates from the TTA-ADH coupled assay for KaTTA with and without the SUMO tag. (b) Structural overlay of KaTTA with (green) and without (blue) the SUMO-tag. Structures were generated using AlphaFold2 Colab⁹ notebook and aligned using PyMOL.

Figure S24

Figure S24: L-Thr is required for β -OH-nsAA production with the active TTAs. Conversion of 3 to the β -OH-nsAA only occurs in the presence of L-Thr for the active TTAs. We observed product formation for StTTA- Δ 36 indicating it is also active with significant β -OH-nsAA formation after 20 h incubation. Reaction conditions described in the SI Methods. While there appears to be some small product formation in the presence of glycine, these peaks appeared in the negative control without enzyme. We hypothesize they are from the acid-catalyzed imine formation from the unreacted aldehyde and glycine. We did not observe imine formation in the negative controls containing L-Thr and L-Ser. Assay performed in triplicate for L-Thr and Gly with all replicates represented and error bars that represent the standard deviation. Assay for L-Ser was not assayed in triplicate because there was no peak formation. The percentage above the L-Thr bars indicates the analytical percent conversion observed for that reaction.

Figure S25: de% for \beta-OH-nsAA produced from 2-nitro-benzaldehyde for all active enzymes. (a) The de% for the *threo* isomer for each of the active enzymes with reaction conditions as specified in the main text and quenched after 20 h. de% was calculated as follows (*threo - erythro*)/(*threo + erythro*). (b) HPLC traces for ObiH and PbTTA as well as the chemically synthesized standard to demonstrate how we identified the diastereomers.

Figure S26: Negative results for activity of SNTTA, and DbTTA with additional aldehyde substrates. Initial rates for a series of different aldehyde substrates using L-Thr with (a) SNTTA and (b) DbTTA. The rates are approximately equal in the "no TTA" and "TTA + ADH" cases for all aldehyde substrates tested, indicating there is no activity of SNTTA or DbTTA on the aldehyde substrate.

Figure S27: Michaelis-Menten curves for K_M and k_{cat} calculations. Initial rate versus L-Thr concentration to calculate the Michaelis-Menten parameters for each enzyme relative to L-Thr. Each reaction was performed in triplicate with each replicate displayed. The line on each graph is the result of a non-linear regression for Michaelis-Menten analysis and an asymmetric confidence interval calculation using GraphPad Prism to obtain the parameters listed in Fig. 4b. The standard TTA-ADH assay was performed using a non-saturating concentration of 1 mM phenylacetaldehyde. Each plot is the measurement for a different TTA with the concentration of initial enzyme listed: (a) ObiH – 0.174 μ M (b) PiTTA – 0.203 μ M (c) CsTTA – 0.183 μ M (d) BuTTA – 0.192 μ M (e) s-KaTTA – 0.178 μ M (f) PbTTA – 0.200 μ M.

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BsTTA-WP_060149112.1/1-440									- MKQ	. – – E	PTG	A F E \	/ A T \	/ L N	DI-F	
BuTTA-WP_080410754.1/1-458			- – MMT	DFAQ	AVVN	IP F	VDEQ	R K S -	- – – R	L	VEK	ISNI	FDS	SLH	SD-F	
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MjSHMT-WP_010871121.1/1-42 TmTTA-WP_188596100.1/1-43 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP 060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382 PbTTA-MBN2478762.1/1-424

MjSHMT-WP_010871121.1/1-429. TmTTA-WP_188596100.1/1-431 ObiH-AR]35753.1/1-440 PiTTA-WP_095149064.1/1-440 SsTTA-WP_018749561.1/1-440 BuTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382

MjSHMT-WP_010871121.1/1-42 TmTTA-WP_188596100.1/1-43 ObiH-ARJ35753.1/1-440 PITTA-WP 095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382 PbTTA-MBN2478762.1/1-424

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29 1	K P K L I L F G C R P K L V L L G A	S L F P F L Y L F	PHPVADAYEAA PHPIKELADAA	AQ ĒV GĀK I AHEV GAV L	AYDGAHVLGL MHDSAHVLGL	I A G K Q F Q D P L R E I A G H O F P N P L E L
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29	G C D V L 360 A G L A I A L A E A S T I V T A I E P P MW V A F K E P P MW V A F K E P P MW V A F K E P S I W V A L K E A P MY V A L S E	- I GNTHKTF 370 MLEFG-EAY MSTYG-DEY MELFG-RDY MEAFG-PAY MEAFG-HDY I EAYG-RSY VALYG-HAY	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	(KNKS 390 AQALY AEQLH ARQLH ARQLH AGHLH ARALH AHGLH	L GK E I AT E I FI 400 ER G F NV L C E - I A N G L P V V A E - I E L G L D V T G E - S E L G L N V S G E - S A R G L D V S G E - S A E G V R V S G E - S E E G V R V S G E - S	410 HK D FT E S HQ V I I E HG FT AT HQ V AM S FG FT QT HQ V H F S FG FT E T HQ V H F S FG FT E T HQ V H F S FG FT E T HQ V H V S FG FT E T HQ V H V
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29	G C D V L 360 A G L A I A L A E A S T I V T A I E P P MW V A F K E P P MW V A F K E P S I W V A L K E A P M Y V A L S E L A L S L A A L E L A L A L A A A A A L A L S L A M Y	- I GNTHKTF 370 MLEFG-EAY MSTYG-DEY MELFG-RDY MEAFG-PAY MEAFG-HDY I EAYG-RSY VALYG-RSY VALYG-HAY VEDRM-GDY FEHFG-AAY MEQHA-GDY	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	(K N K S 390 A Q A L Y A E Q L H A R Q L H A N Q L H A G A L H A H A L H A H G L H A G A L A A H R L R A H R L R	L GK E I AT E I FI 400 ER G F NV L C E - H ANG L P V V A E - I E L G L D V T G E - S E L G L N V S G E - S AR G L D V S G E - S AR G L D V S G E - S D A G F R V Y G G S / ER G F G V V G G - C D A G F R V Y G D S / ER G F G V O D A - C	410 HK D FT E S HQ V I I EHG FT AT HQ V AM S FG FT QT HQ VH F S FG FT ET HQ VH F S FG FT ET HQ VH F S FG FT ET HQ VH V S FG FT ET HQ VH V S FG FT ET HQ VH V AT G YT DT HQ VW V D R G AT A S HQ VW V D R G AT A S HQ VW V C G VI T P T HQ VW V
29	GCDVL 360 AGLAIALAE ASTIVTAIE P MWVAFKE P SMWAAFKE P SMWVAFKE P SIWVAKE AP MY I ALVE AP MY VALSE LALSLAALE LALSLAALE AALALSTAW VALAIAMVE GSLAITLEE	- I GNTHKTF 370 MLEFG-EAY MSTYG-DEY MELFG-RDY MEAFG-HDY IEAYG-PAY MSLYG-RSY VALYG-RSY VALYG-RAY FEHFG-AAY MEQHA-GDY FAECGVDY LLPHR-GDY	2 380 3 80 A K Q V I K NA K A I A A T V R S NA K A I A A Q I V S NA K T I A H Q M V R NA K A I A P Q V A R NA K A I A S Q V V R NA T A F A E Q V I K NA K A I A R Q I L A NA Q A I S R Q V L I NA R A F A T A V I A NA V Q A Q A V L A NA A A F A R Q V I A NA R E I	(K N K S 390 A Q A L Y A E Q L H A R H L H A N Q L H A G H L H A H A L H A H G L H A G A L A A H R L R A D E L A A R Q L A	L GK E I AT E I FI 400 ER G F NV L C E - I ANG L P V V A E - I E L G L DV T G E - S E L G L NV S G E - S A C G L DV S G E - S A E G V R V S G E - S A E G V R V S G E - S D A G F R V Y G D S / ER G F G V V G - C D G G L S I C A D - I D A G F D V A G E - / A R G F D V A G E - / A C G F D V A G E - / A C G F D V A G E - / A C G F D V A G E - / A C G F D V A G E - / A C G F D V A G E - /	410 HK D FT E S HQ V I I EHG FT A T HQ VAM S F G FT Q T HQ V H F S F G FT E T HQ V H F S F G FT E T HQ V H F S F G FT E T HQ V H V S F G FT E T HQ V H V A T G Y T D T HQ V W V G Q L T D T HQ V W V G Q L T D T HQ V W V G Q L T R T HQ V W V G Q L T R T HQ V W V G Q L T R T HQ V W V A F G FT D T HQ V W V A F
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29.	GCDVL 360 AGLAIALA ASTIVTAIE PPMWVAFKE PSMWAAFKE PSIWVALKE APMYIALVE APMYIALVE APMYIALVE AALALSTAW VALAIAMVE GSLAITLEE VALLIALHE VALFIALHE 1ALVVTIIE	- I GNTHKTF 370 M L E F G - E AY M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - H D Y I E AY G - P AY M S L Y G - R S Y V A L Y G - H AY V E DRM - G D Y F E H F G - A AY M E Q H A - G D Y F A E C G G V D Y L L P H R - G D Y M W Y D G - R E Y A R L T G - K A Y M Y I H G - K E Y 420	380 A K Q V I K NA K A I A A T V R S NA K A I A A Q I V S NA K T A Q I V S NA K T A Q V R NA K A I A Q V R NA K A I A Q V R NA K A I A Q V I NA R A I A R Q I L A NA Q A A R A T ND NA R R I A R Q V I NA R A I A Q V I A NA A A I A Q V I A NA A A I A Q V I A NA R I A Q V I A NA A I A Q I I K N H A I	(K N K S 390 A Q A L Y A E Q L H A R H L H A G H L H A G A L H A H G L H A H G L H A H R L R A D E L A A R Q L A A R A L H A G A L A A G A L A A G A L R A G A L R	L GK E I AT E I FI 400 ER G F NV L C E - F ANG L P V V A E - I E L G L DV T G E - S E L G L NV S G E - S A E G V R V S G E - S D A G F R V Y G D S / E R G F G V V G G - G D A G F C V Y G D S / C A C G F D V A G - I D A G F D V A G - I D A G F D V A G - I D A G F D V A G - I D A G F D V A G - I D C G F C V Y A C - I A C V P V L A R S I N E G F K I F K R - I 460 D 266	410 HK D FT E S HQ V I I E HG FT A T HQ V AM S F G FT Q T HQ V H F S F G FT E T HQ V H F S F G FT E T HQ V H F S F G FT E T HQ V H V S F G FT E T HQ V H V S F G FT E T HQ V W V S F G FT A S HQ V W V G Q L T D T HQ V W V G Q L T D T HQ V W V G Q L T D T HQ V W V G Q L T D T HQ V W V G Q L T D T HQ V W V G Q F T D T HQ V W V A F G FT D T HQ V W V T HQ V W V A F G FT D T HQ V W V T HQ
29	GCDVL 360 AGLAIALAE ASTIVTAIE PPMWVAFKE PSWWAFKE PPMWVAFKE PMWVAFKE APMYIALVE ALLSLAALE LALSLAALE AALALSTAW VALAIAAAE GSLAITLEE VALLIALHE VALFIALHE YALFIALHE YALSTALE ALSTAW GSLAITLEE VALAIALHE YALSTALE YALSTALE VALAIALE ALSTAW YALSTAW YALSTAW </td <td>- I G N T H K T F 370 M L E F G - E A Y M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - P A Y M E A F G - H D Y I E A Y G - R S Y V A L Y G - R S Y V A L Y G - H A Y V E D R M - G D Y F A E C G V D Y F A E C G V D Y M W Y D G - R E Y A R L T G - K A F M Y I H G - K E Y 430 F S A S E L A KM</td> <td>P G P Q K - G M I L) 380 A K Q V I K NA K A I A T V R S NA K A I A Q I V S NA K T A Q V R NA K A I A Q V R NA K A I A Q V I K NA K A I A Q V I A NA R I</td> <td>(K N K S 390 A Q A L Y A E Q L H A R Q L H A Q Q L H A Q A L H A Q A L H A H A L H A H A L H A H A L A A H R L A A Q E L A A Q A L A A Q</td> <td>L GK E I AT E I FI 400 ER G F N V L C E - I ANG L P V V A E - I E L G L D V T G E - S E L G L D V T G E - S A G L D V S G E - S A G L D V S G E - S A G C V V S G E - S A G C V V S G E - S D A G F R V Y G D S / E G G C V V G G - C D A G F G V V G G - C A G G C V V A G E - A D A G F D V A G E - A D A G F D V A G E - A D A G F D V A G E - A C A G G F V Y G A G A G A G A G A G A G A G A G A G</td> <td>410 HK D FT E S HQ V I I E HG FT A T HQ V AM S FG FT Q T HQ V HF S FG FT E T HQ V HF S FG FT E T HQ V HF S FG FT E T HQ V HV S FG FT E T HQ V HV A TG Y T D T HQ VWV G Q L T D T HQ VWV A FG FT D T HQ VWV G Q L T D T HQ VWV A FG FT D T HQ VWV H H H H H H H H H H H H H H H H H H</td>	- I G N T H K T F 370 M L E F G - E A Y M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - P A Y M E A F G - H D Y I E A Y G - R S Y V A L Y G - R S Y V A L Y G - H A Y V E D R M - G D Y F A E C G V D Y F A E C G V D Y M W Y D G - R E Y A R L T G - K A F M Y I H G - K E Y 430 F S A S E L A KM	P G P Q K - G M I L) 380 A K Q V I K NA K A I A T V R S NA K A I A Q I V S NA K T A Q V R NA K A I A Q V R NA K A I A Q V I K NA K A I A Q V I A NA R I	(K N K S 390 A Q A L Y A E Q L H A R Q L H A Q Q L H A Q A L H A Q A L H A H A L H A H A L H A H A L A A H R L A A Q E L A A Q A L A A Q	L GK E I AT E I FI 400 ER G F N V L C E - I ANG L P V V A E - I E L G L D V T G E - S E L G L D V T G E - S A G L D V S G E - S A G L D V S G E - S A G C V V S G E - S A G C V V S G E - S D A G F R V Y G D S / E G G C V V G G - C D A G F G V V G G - C A G G C V V A G E - A D A G F D V A G E - A D A G F D V A G E - A D A G F D V A G E - A C A G G F V Y G A G A G A G A G A G A G A G A G A G	410 HK D FT E S HQ V I I E HG FT A T HQ V AM S FG FT Q T HQ V HF S FG FT E T HQ V HF S FG FT E T HQ V HF S FG FT E T HQ V HV S FG FT E T HQ V HV A TG Y T D T HQ VWV G Q L T D T HQ VWV A FG FT D T HQ VWV G Q L T D T HQ VWV A FG FT D T HQ VWV H H H H H H H H H H H H H H H H H H
29	GC V L 360 AGLAIALAE ASTIVTAIE PPMWVAFKE PSMWAFKE PSMWVAFKE PMYVALSE ALALSLAAE ALALSLAAE AALALSTAW VALAIAAE AALALSTAW VALAIAAE VALAIAE VAL	- I G N T H K T F 370 M L E F G - E A Y M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - H D Y I E A Y G - P A Y M S L Y G - R S Y V A L Y G - H A Y V E D R M - G D Y F E H F G - A A Y M E Q H A - G D Y F A E C G G V D Y L L P H R - G D Y M W Y D G - R E Y A R L T G - K A F M Y I H G - K E Y 430 F S A S E L A K M - G G G P I A K A - A L D L C V N S	P G P Q K - G M I L Y 380 A K Q V I K N A K A I A A T V R S N A K A I A A T V R S N A K A I A A Q I V S N A K T I A H Q M V R N A K A I A Q V V R N A K A I A Q Q V V R N A T A I A R Q I L A N A Q A I A R Q I L A N A Q A I A R Q V I A N A R I A R Q V I A N A R I A Q Q V L A N A A A I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A Q Q V I A N A R I A A Q V I A N A R I A Q A V I A N A R I A Q A V I A N A R I A A V I A N A A I A N A A I A N A A I A N A A I A A A I A A A I A A A A	(K N K S 390 A Q A L Y A E Q L H A R Q L H A G H L H A G A L H A G A L H A H G L H A H G L H A H A L H A H R L R A H R L R A D E L A A R Q L A A G A L R A G	L GK E I AT E I FI 400 E R G F N V L C E - F A N G L P V V A E - I E L G L D V T G E - S E L G L D V T G E - S A E G V R V S G E - S A E G V R V S G E - S D A G F R V Y G D S / E R G F G V V G G - A C G G L S I C A D - I D A G P G V Q D A - G A C G P V V A E - I A C V P V L A R S I N E G F K I F K R - I 460 R G G R S G I R L - V K P S G I R L - V K P S G I R M - K P G V G I R M	410 HK D FT E S HQ V I I EHG FT A T HQ V AM S FG FT Q T HQ V H F S FG FT E T HQ V H F S FG FT E T HQ V H F S FG FT E T HQ V HV S FG FT E T HQ V HV S FG FT E T HQ V WV C FG FT A N HV S FG FT D T HQ VWV C FG FT C T R L G MK F C VQ E M T R M G M K E
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29	GC UV L 360 AG L A I A L A E A ST I VT A I E P PMWVA FK E P SMWAA FK E P SMWVA FK E P SMWVA FK E P SMWVA FK E P SMV A L S AL SLAAL AL A L SLAAL GS L A I T L E VA L I A L H A C A L S T AW A C A L S T AW Y C D U Q C - A A V G D L Q C - A S V G T P E A - S	- I G N T H K T F 370 M L E F G - E A Y M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - P A Y M E A F G - H A Y V A L Y G - R S Y V A L Y G - R S Y V A L Y G - R A Y M E A F G - D A Y M E A F G - A A Y M E A C A Y A R L T G - K E Y 430 F S A S E L A K M - G G G P I A K A - A L D L C M N T - A L L T C R D Y	P G P Q K - G M I L Y 380 A K Q V I K N A K A I A T V R S N A K A I A A T V R S N A K A I A Q I V S N A K T I A Q V V R N A K A I A Q V V R N A K A I A Q V V R N A K A I A Q V V R N A K A I A Q V I K N A K A I A Q V I K N A K A I A Q V I A N A Q I A Q A V L A N A Q I A Q A V L A N A A Q I A Q A V L A N A A R I A Q V I A N A R I A Q O V I A N	<pre></pre>	L GK E I AT E I FI 400 ER G F NV L C E - I AN G L P V V A E - I E L G L D V T G E - S E L G L NV S G E - S A C G L D V S G E - S A C G L D V S G E - S A C G L D V S G E - S A C G V V S G E - S A C G V V S G E - S A C G F V V G G E - S D A G F C V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S A C G F G V V G G E - S A C G F G V V G G E - S A C G F G V V G G E - S A C G F G V V G G E - S A C G F G V V G G E - S A C G F G V Y G S G E - S A C G F G V G G E - S A C G G F G G G G G E - S A C G G G G G G G G G G E - S A C G G G G G G G G G G G G G G G G G G	410 HK D FT E S HQ V I I EHG FT AT HQ VAM S FG FT Q T HQ VH F S FG FT E T HQ VH F S FG FT E T HQ VH F S FG FT E T HQ VH V S FG FT E T HQ VH V S FG FT E T HQ VH V S FG FT E T HQ VW V C Q T D T HQ VW V S FG FT A NHM F V O Q G T A S HQ VW V C Q C T R T HQ VW V C Q Q M T R G M K E C V Q AM T R G M K E C V Q AM T R G M V E
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29	GC V L 360 AGLAIALAE ASTIVTAIE PPMWVAFKE PSWWAFKE PSWWAFKE PSWVAFKE PSWVAFKE PSWVAFKE PMYVALSE LALSLAAE AALALSTAW VALAIAMVE GSLAITLEE VALAIAHE VALAIAE VALAIAE AQU VALAIAE AQU ASSPDIE AVGDLQC- AVGDLQQ- SVGTPEA- VVGSERK- VTGSAAD- RLPLEES-	- I GNT HKT F 370 M L E F G - E A Y M S T Y G - D E Y M E L F G - R D Y M E A F G - P A Y M E A F G - P A Y M E A F G - H A Y M E A F G - A A Y M E A F G C G V D Y L P H R - G D Y M Y D G - R E Y A R L T G - K E Y 430 F S A S E L A K M - A L D L C M N T - A L L T C R D Y - A L R L S L G E - A Y A L S N R	P G P Q K - G M I L Y 380 A K Q V I K N A K A I A T V R S N A K A I A A T V R S N A K A I A Q I V S N A K T I A Q V S N A K A I A Q V V R N A K A I A Q V V R N A K A I A Q V V R N A K A I A Q V I K N A K A I A Q I L A N A Q A I A R A T N D N A R R I A Q V I A N A Y A A Q V I A N A Y A A Q V I A N A Y A A Q V I A N A R I A Q O V I A N A C I A Q O I I K N N H A I A Q O V I A N A C I A Q O I I K N N H A I A Q O V I A N A C I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H A I A Q O I I K N N H	<pre></pre>	L GK E I AT E I FI 400 ER G F NV L C E - I AN G L P V V A E - I E L G L D V T G E - S E L G L D V S G E - S A G L D V S G E - S A G L D V S G E - S A G L D V S G E - S A G C V V S G E - S D A G F C V V S G E - S D A G F C V V S G E - S D A G F G V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S D A G F G V V G G E - S A G G F C G G G G G E - S A G G F C G G G G G E - S A G G F C G G G G G E - S A G G G G G G G G G E - S A G G G G G G G G G G G G G G G G G G G	410 HK D FT E S HQ V I I EHG FT AT HQ VAM S FG FT Q T HQ VH F S FG FT E T HQ VH F S FG FT E T HQ VH F S FG FT E T HQ VH V S FG FT E T HQ VH V S FG FT E T HQ VH V S FG FT E T HQ VW V G Q L T D T HQ VW V O RG A T A S HQ VW V G Q L T D T HQ VW V S FG FT D T HQ VW V S FG FT E T HQ VH V A FG FT D T HQ VW V C Q Q T T R T HQ VW V C Q Q T T R T HQ VW V C Q Q T T R T HQ VW V C Q Q T R T HQ VW V C Q Q A T R G K E C V Q AM T R R G M K E C V Q AM T R R G I K E C V Q AM T R R G I K E C V Q AM T R R G I K E C V Q AM T R R G I K E C V Q AM T R R G I K E C V Q AM T R R G R E C V Q AM T R C Q R E C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y F F C A C R C C V C X C Y C Y C Y C Y C Y C Y C Y C Y C Y
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OHH ADJ FK T E AK MAQ IK E LQA FLANS DUYLAS TO DE ELLAAVIGUN DHT-AWD0514011211/1-40 DIF RAY ACLINGUYFRAT E AK MAQ IK E LQA FLANS DUYLAS TO DE ELLAAVIGUN BATTA-WD0501401121/1-40 DIF RAY ACLINGUYFRAT E RAY ACLANS DUYLAS TO DE ELLAAVIGUN BATTA-WD0501401121/1-40 DIF RAY ACLINGUYFRAT E RAY ACLANS DUYLAS TO DE ELLAAVIGUN BATTA-WD0501401121/1-40 DIF RAY ACLINK T FLODYFRAT E RAY ACLANS DUYLAS TO DE ELLAAVIGUN STTA-WD0501401121/1-41 DIF RAY ACLINK T KE LLAR C A TAK RA TA E CAD LLQHHELDD LANS E DE YNDS PAARA ELLGE KI STTA-WD0501474417142 PORTE STATUS E RAY ACLINK T C THANS DAVINGUN STTA-WD050147445171423 DE TAY LUK KIVL REAL E RAY ACLINK T C THANS DAVINGUN STTA-WD050147445171423 DE TAY LUK KIVL REAL E RAY ACLINK T C THANS DAVINGUN STTA-WD05014744517 DE TAY ACLINK T E RAY ACLINK T C THANS DAVINGUN E RAY ACLINK T C THANS DAVINGUN STTA-WD050147111211/1-424 DE TAY ACLINK ALL RE T FLUKAK C REAL AND ROW C RAY ALL REAL C C THANS DAVINGUN E RAY ACLINK T C THANS DAVINGUN STTA-WD05014711211/1-429 DE TAY ACLINK ALL REAL C C THANS DAVINGUN E RAY ACLINK RAY ACL	TmTTA-WP_188596100.1/1-431	G E <mark>M</mark> A A V <mark>A</mark> E I	. I <mark>A</mark> K V V I K G V -	E P S K V K P E V V	E	· R <mark>Y G F D</mark> L S T L (5 L N C P C <mark>L</mark> P L L -
PI IA 2005 J1906H J1 - 440 DD F K VOLL IA DUT F K K I - D KAC G AS AN ALL LUD T AF LAT S F DG CUM TA K IA S F DG CUM TA	ObiH-ARJ35753.1/1-440	KDFEVVARE	FIADLYFKKT-	EPAKVAQQIK	EFLQAFPLAPL	AYSFDNYLDI	ELLAAVYQGA
Lan 2, 2017,	Pil IA-WP_095149064.1/1-440	DDFRRVAGI		EPARVASKVK	ELLGDFPLAPL	AYSFDQQIDI	
BUTLA WU 2004107541/1-475 STTA-WP 200775/11/-477 STTA-WP 200775/11/-477 UpK-B005887.11-427 QA IE EL IA CAL YT AE REAL - C PK THE I - 8 C RF CA P FY D F LAC DC P CAL LEA DITA-B024525.11-431 QA IE EL ICAL YT AE REAL - C PK THE I - 8 C RF CA P FY D F LAC DC P CE VS KA RTA-CH118352.11-431 QA IE EL ICAL YT AE REAL - C PK THE I - 8 C RF CA P FY D F LAC DC P CE VS KA NOTTA-WP 20323445.11/-429 DOM TY AE LL & RU L REC - 0 S R S WA AD VA DL AR S F P CV - AF AD R F AL AC L F HAC DC P CE VS KA KATTA-WP 20333434.11/-429 DDM TY AE LL & RU L REC - 0 S R S WA AD VA DL AR S F PC V - AF AD R F AL AC L F HAC DC P CE VS KA KATTA-WP 20333434.11/-429 DDM TY AE LL & RU L REC - 0 S R S WA AD VA DL AR S F PC V - AF AD R F AL AC F F NU A VA TEAL-WP 2013527.11-631 DDM TY AE LL & RU L REC - 0 S R S WA AD VA DL AR S F C V - AF AD R F AL AC F F NU A VA TEAL-WP 2013527.11-631 DDM TY AE LL & RU L REC - 0 S R S WA AD VA DL AR S F C V - AF AD R F AL AC F F NU A VA TEAL-WP 2013527.11-637 S C E M C U A VU L R K F L F L I LD R K N - N I S K I K IE F NNK R K I - E N S U D E I Y E K L F N I S K I K IE F NNK R K I - E N S U D E I Y E K L F N I S K I K IE F NNK R K I - E N S U D E I Y E K L F N I S K I K IE F NNK R K I - E N S U D E I Y E K L F N I S K I K IE F NNK R K I - E N S U D E I Y E K L F N I S K I K IE F NNK R K I - E N S U D E I Y E K L F	CSTTA-WP_018749561.1/1-440	DDFEQVARI					
STTA-WP 1012/97/5 1/1-424 MATEL DE VALVER VALUY KEVLER A - EXAMPLE VALVER VLER A - EXAMPLE OF HPT LOG LAY SETO YVD SP AAR ALL GEV MUKAD245329.1/1-424 A ALE LA GALVET AR ER AL - G P RT VID IF EKLY KE AGL STTA-MPD 23373.144.11-43 P EM A LE GL LH GY AVD R I - A YV A FOG LA R TG LT P DE RH GL EG FLR ACD P QE SY YAA RATTA-CHIL1859.101-431 P EM A LE GL LH GY AVD R I - A YV A FOG LA R TG LT P DE RH GL EG FLR ACD P QE SY YAA RATTA-WPD 23373.144.11-43 D D LD LA A D LV A AV LL R GL E FE R LR R R VA EL V GR R TV - R Y GD Y A SA ACP P AR ERY P A PTTA-MBR024757G.1/1-434 DD LD LA A D LV A AV LL R GL E FE R LR R R VA EL V GR R R TV - R Y GD Y A SA ACP P AR ERY P A PTTA-WBR024757G.1/1-434 DD LD LK FF KE I I LD R K N I SSK I KE FNNK R SI - ES SL I Y E KL F PTTA-WBR024757G.1/1-434 NTTA-WP 0183753.1/1-440 Q R	BUTTA-WP_0804107541/1-440	HGMAEVARE		SPTAIRNEIA	S F I F S Y P I N T I		
Link-Bag05887.1/1-434 NOTA-WP_052337445.1/1-425 NOTA-WP_052337445.1/1-425 NOTA-WP_052337445.1/1-425 NOTA-WP_052337445.1/1-425 NOTA-WP_052337445.1/1-425 NOTA-WP_052337445.1/1-425 NOTA-WP_052137445.1/1-425 NOTA-WP_052137445.1/1-427 NOTA-WP_05213064.1/1.420 NOTA-WP_05213	StTTA-WP 101279775.1/1-477	POMREVARI		EPAAVRAEVAI		AYSFDSYVDS	SPAAARLLGEV
SNITA-AD24323.1/1-434 PAMET L EIF & LVRACEA-T K-AVD L FQV L PHEMCEP NETCLPQ EACLE HGCNOTAU KARANA NOTTA-WP, 052373445.1/1-430 DENT V L LVLAVA VA VA CARANA L R CLL HE CALVA VA VA CARANA FTase-WP, 014151017.1/1-634 DD LD TA AN LE LA CLL HE CALVA CARANA RAVA ADA CARANA RAVA ADA CARANA FTase-WP, 014351017.1/1-634 DD LD LA AD LVA AV LLE RQ - EFER INFR VA ELV CARR TV - RYT CG TY OC CALVA ADA CLA ADA LLE RQ - EFER INFR VA ELV CARR TV - RYT CG TY OC CALVA FTASE-WP, 01435703.1/1-434 DD LD LA K FK E I ILD RK NI S SK IK EFNNK EN SI - EK SLDE I Y EK LE F NITTA-WP, 01837101.1/1.424 S50 \$60 \$70 \$90 MISHMT-WP, 01837101.1/1.424 R R R R R NITTA-WP, 01837101.1/1.424 R R R R R SITTA-WP, 0183703.1/1-440 R R R R R SITTA-WP, 01805887.1/1-424 N R	LipK-BAJ05887.1/1-424	QAIEELAGA	LVTARERAL-	G P R T V H	EI-RGRFGA	PFYTDPEKL	(
NOTTA-WP_052373445.11-425 PE MA E L & CL HQ VA VDE R - A T AV WA POME A L & TG LT LP EDR HG LE FG LR AC DP QE VS VA- RATTA-WP_03335431.11-430 DDM TT VA E LL AR LL RG E - QS RS VA AD VA AD L CAR S PC V - A F AD R P L AV A- Trae-WP_013107.11-431 DD LD E A AD U A AV LE RG - DS RS VA AD VA AD L CAR S PC V - A F AD R P L AV A- TRAE-WP_0137502.11-424 VD TTA-MB8509263.11-322 TOTTA-WP_0137502.11-424 ND VTA-WP_103596100.11-431 OR AD VA AV LE RG - DS S S S S S S S S S S S S S S S S S	SNTTA-ADZ45329.1/1-434	P A M E T L <mark>A</mark> E I	F <mark>A</mark> L <u>V</u> R A G E A –	TK AVDLFQ	V <mark>L</mark> – P H E M G E – –	- P <mark>Y</mark> F <mark>F</mark> T G L P Q I	E A G L F H G
RaTTA-CHI1859.1/1-431 PEMAELAGLLHGVAVDRI-AVAEAGERVAAM-RQAARP - AKORPAVAS FTAB-WP 014151017.1/1-434 DD DATT VELLAR LL LRCC QS RS VAAV RD LAR SFGC - A FADR PAVA	NoTTA-WP_052373448.1/1-425	DGMTVLTW	/ L T Q <mark>L</mark> L V H N A –	A T A V <mark>V A</mark> P Q M E J	A <mark>L</mark> R T G L T L P E E	DR H G L E G F L R A	ACDPQEVSVA-
Kall A-WP 0333441.1/1-399 DDM TVA ELLA KLLK KLE V2 SKAA DV KLAKS KPC V - A KOP VA FLAVA	RaTTA-GIH11859.1/1-431	PEMAELAGI	LHGVAVDRI-	AVAEAGERVA	AM – RQAARP – -	AYCFSEDVVA	ASKLRELTGA-
Flate-WP_01415101/.11-834 DD_DEPADD_UVAAVUEERU-SERUKEPAAVAECVURKETV-SETURATEVACUURKETV-SETURATEVACUURKETV-SETURATEVACUURKETV-SETURATEVACUURKETVACUURUKETVACUURKETVACUURKETVACUURUKETVACUURUKETVACUURUKETVACUURUKETVACUURUKETVACUURUKETVACUURUKETVACUURUKETVUURUKETVUURUURUURUURUURUURUURUURUURUURUURUURUUR	KaTTA-WP_033354341.1/1-399	DDMTTVAEL	LARLLLRGE-	QSRSVAADVRI	DLARSFPGV	AFADRPAPLA	
DDTA-MBUX273762.1/1.424 540 550 560 570 580 590 MSHMT-WP.010871121.1/1-429- TMTTA-WP.038139061.1/1-440 QR PTTA-WP.04951.1/1-440 QR PTTA-WP.04951.1/1-440 QR STTA-WP.060149112.1/1-440 RA STTA-WP.060149112.1/1-440 RA STTA-WP.06023.1/1-423 - STTA-WP.01237975.1/1-477 FR STTA-WP.01237975.1/1-474 PT AP ACHP AR PRWI CV R.LT PLP E P V T E A EC ACAQ R L G R L ACA F P NQ I D S' G NV S F T S I D G DTTA-WP.060149112.1/1-431 PT AP ACHP AR PRWI CV R.LT PLP E P V T E A EC ACAQ R L G R L ACA F P NQ I D S' G NV S F T S I D G DTTA-WP.060149112.1/1-431 PT AP ACHP AR PRWI CV R LT PLP E P V T E A EC ACAQ R L G R L ACA F P NQ I D S' G NV S F T S I D G DTTA-WP.06017121.1/1-434 PT AP ACHP AR PRWI CV R LT PLP E P V T E A EC ACAQ R L G R L ACA F P NQ I D S' G NV S F T S I D G DTTA-WP.060189112.1/1-434 DTTA-WP.0601871121.1/1-434 DTTA-WP.060383.1/1-432 - FT B C AVB C A G NV D V R L C ND F AM D C F S E I R AL G AA C AC F P NQ I D S' G NV S I R S - CA PDTTA-MBUX2787C2.1/1-424 600 610 620 630 640 650 MSHMT-WP.010871121.1/1-429 - TTA-WP.01843505.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.01873753.1/1-440 STTA-WP.0187353.1/1-440 STTA-WP.0187353.1/1-440 STTA-WP.0187353.1/1-440 STTA-WP.0187353.1/1-440 STTA-WP.01873757.1/1-473 LIF AVB CO STTA-WF.0187353.1/1-440 STTA-WP.017353.1/1-440 STTA-WP.017353.1/1-440 STTA-WP.017353.1/1-440 STTA-WP.017353.1/1-44	FTase-WP_014151017.1/1-634						4 G P P A K E K Y A P / I D I
540 550 560 570 580 590 MISHMT-WP.010871121.1/1-429 INTTA-WP.18550100.1/1-431 QR INTTA-WP.18550100.1/1-431 QR INTA-WP.05149064.1/1-440 QR INTA-WP.05149064.1/1-440 QR INTA-WP.05149064.1/1-440 QR INTA-WP.05149064.1/1-440 QR INTA-WP.05174956.1/1-440 RR INTA-WP.05174956.1/1-440 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05237348.1/1-425 INTA-WP.05273744.1/1-431 INTA-WP.05273744.1/1-431 INTA-WP.057474956.1/1-424 INTA-WP.057474956.1/1-424 INTA-WP.057474956.1/1-424 INTA-WP.057474956.1/1-424 INTA-WP.05747956.1/1-424 INTA-WP.0574956.1/1-424 INTA-WP.0574956.1/1-424<	PhTTA-MB/3009203.1/1-302		FKFIIIDRK-				(F
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MJSMT-WP_01087112.11/1-429 TMTA-WP_035595100.1/1-431 CSTTA-WP_00314054.1/1-440 BUTTA-WP_0352951.1/1-440 BUTTA-WP_035291.1/1-431 SCA CV DE LAAWLY R KATTA-WP_035291.1/1-434 SCA CV DE LAAWLY R KATTA-WP_03535434.1/1-239 PT AP A CHP AR P RW I GV R. LT P LP EP VT EA ECA GAQ R LGR LA GA F P NQT D ST GN V S F T ST D C D DTA-MB560233.1/1-32 PT AP A CHP AR P RW I GV R. LT P LP EP VT EA ECA GAQ R LGR LA GA F P NQT D ST GN V S F T ST D C D DTA-MB560233.1/1-434 SCA GV DE LAAWLY R KATTA-WP_03535434.1/1-249 TMTA-WP_035149661.1/1-440 BTTA-WP_005149061.1/1-440 BTTA-WP_005149061.1/1-440 BTTA-WP_005149061.1/1-440 BTTA-WP_00531341.1/1-249 TMTA-WP_00531341.1/1-249 FT Ase WP_01451017.1/1-631 R LF VT C SCT Y I K D L AP GD F V ELT GA - E GWT L H CR GD CP P S A EAY L HH LL R ER V GAR V V C PTTA-WP_005123.1/1-429 TMTA-WP_00531341.1/1-249 FT Ase WP_01451017.1/1-631 STTA-WP_10872775.1/1-477 UpK-B400687.1/1-424 STTA-WP_005123.1/1-424 STTA-WP_005123.1/1-425 R T W V C SC S C Y I K H LA D C GD F V ELT GA - E GWT L H CR GD CP P S A EAY L HH LL R ER V GAR V V V PTTA-WP_005121.1/1-429 TMTA-WP_00531341.1/1-431 STTA-WP_10873121.1/1-429 TMTA-WP_00531341.1/1-431 STTA-WP_005373448.1/1-432 STTA-WP_00		540	550	560	570	580	590
TmTTA-WP_188596100.1/1-431 PTTA-WP_005149106.1/1-440 QR CTTA-WP_005149106.1/1-440 R BSTTA-WP_005149106.1/1-440 R STTA-WP_0032733448.1/1-425 STTA-WP_0127975.1/1-477 FR Upt-B405875.1/1-424 STTA-WP_0127975.1/1-473 STA-MP_0127975.1/1-473 FTase-WP_01415107.1/1-634 FTASE-WP_0145107.1/1-634 FTTA-WP_005317.1/32 FTASE-WP_0145107.1/1-634 FTTA-WP_0145107.1/1-634 FTTA-WP_0145 FTTA-WP_0145107.1/1-634 FTTA-WP_0145 FTTA-W	MjSHMT-WP_010871121.1/1-429)					
Obit-ARJ35753.1/1-440 QR CSTTA-WP_005149064.1/1-440 R STTA-WP_00514912.1/1-440 R BUTTA-WP_00514912.1/1-440 R BUTTA-WP_00512775.1/1-474 N STTA-WP_012775.1/1-474 N NOTTA-WP_025273448.1/1-425 SAGCV DE LA AWL Y R KATTA-WP_0153575.1/1-474 SGACV DE LA AWL Y R KATTA-WP_015375.1/1-474 SGACV DE LA AWL Y R KATTA-WP_03334341.1/1-39 PT AP A GHP AR P RWI CVR LTP LP EP VT EA ECACAQR LCR LAGA FP HQI D S SGN V SF T ST DC DDHTA-MBS059283.1/1-382 PE I AP S AK GRW VD Y R HL GN D F ANDDT EF S E I R AL GAA AG AF P NOT D ST GN V S LR S - GA PbTTA-MBS059283.1/1-424 600 610 620 630 640 650 MJSHMT-WP_01087122.1/1-424 STTA-WP_018596100.1/1-440 STTA-WP_018596100.1/1-440 STTA-WP_0187495611.1/1-440 STTA-WP_0187495611.1/1-440 STTA-WP_0187495611.1/1-440 STTA-WP_0187495611.1/1-440 STTA-WP_01874956101.1/1-440 STTA-WP_01874956101.1/1-440 STTA-WP_01874956101.1/1-440 STTA-WP_01874956101.1/1-440 STTA-WP_01874956101.1/1-440 STTA-WP_01874975.1/1-424 STTA-WP_01874975.1/1-424 STTA-WP_018749762.1/1-424 STTA-WP_018749762.1/1-424 STTA-WP_018749762.1/1-424 STTA-WP_01874121.1/1-429 STTA-WP_0187495610.1/1-410 <td>TmTTA-WP_188596100.1/1-431</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	TmTTA-WP_188596100.1/1-431						
PI ITA-WP_005149064,1/1-440 LR BSTTA-WP_006149112,1/1-430 LR STTA-WP_005149112,1/1-438 LA STTA-WP_00527373448,1/1-425 RATTA-CHI1859,1/1-431 STTA-WP_005383,1/1-425 RATTA-CHI1859,1/1-431 STTA-WP_005383,1/1-432 PE I AAP S AK CR WW DY R LT P LP EP Y T E AE C A C A Q R L G R LA C A F P HQ I D S S G N V S F T S T D C DOTTA-WB 500283,1/1-432 PE I AAP S AK CR WW DY R L C N D F AM DD T E F S E I R A L G A A C A F P HQ I D S S G N V S F T S T D C DOTTA-WB 500283,1/1-432 PE I AAP S AK CR WW DY R H L C N D F AM DD T E F S E I R A L G A A C A F P HQ I D S S G N V S I R S - C A PbTTA-WB 005283,1/1-432 PE I AAP S AK CR WW DY R H L G N D F AM DD T E F S E I R A L G A A C A F P HQ I D S S G N V S I R S - C A PbTTA-WB 00571121.1/1-429 TM TA-WP_00571121.1/1-429 STTA-WP_005149064,1/1-440 BSTTA-WP_005149162,1/1-440 BSTTA-WP_005149162,1/1-440 BSTTA-WP_005233,1/1-434 STTA-WP_00533,1/1-434 STTA-WP_00533,1/1-434 STTA-WP_0053,1/1-434 STTA-WP_0053,1/1-434 STTA-WP_0053,1/1-434 STTA-WP_0053,1/1-434 STTA-WP_0053,1/1-434 STTA-WP_0053,1/1-440 BSTTA-WP_0053,1/1-434 STTA-WP_00	ObiH-ARJ35753.1/1-440	Q R					
LSHTA-WP_060149112.1/1-440 MR BUTTA-WP_060149112.1/1-440 MR BUTTA-WP_08014974.1/1-438 IA STTA-WP_01027975.1/1-441 NOTTA-WP_052373484.1/1-439 KATTA-WP_01355434.1/1-434 PT AP A GHP AR P RWI G VR LTP LP EP VT EA ECAGAQ R LGR LAGA FP HQ I D S S GNV S FT S T D G D bTTA-MWP_0535434.1/1-432 PT I A AP S AK GRWV DY R H LGN D F AN DD F F S E I R A LGAA AG A FP HQ I D S S GNV S FT S T D G D bTTA-MB5609283.1/1-422 C 00 610 620 630 640 650 MISHMT-WP_01087112.1/1-429 TMTTA-WP_01087112.1/1-429 TMTTA-WP_01087112.1/1-429 TMTTA-WP_01087112.1/1-431 OHH-A8135753.1/1-440 BUTTA-WP_01087112.1/1-431 OHH-A8135753.1/1-440 BUTTA-WP_01087112.1/1-431 OHH-A8135753.1/1-440 BUTTA-WP_01087112.1/1-431 OHH-A8135753.1/1-440 BUTTA-WP_01087112.1/1-438 STTA-WP_01087112.1/1-438 STTA-WP_01087112.1/1-438 STTA-WP_0108711912.1/1-440 BUTTA-WP_0108711912.1/1-440 BUTTA-WP_0108711912.1/1-440 BUTTA-WP_01087112.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_0108749561.1/1-440 BUTTA-WP_	PITTA-WP_095149064.1/1-440	QR					
BUTTA-WP_0080410754.1/1-435 StTTA-WP_10279775.1/1-477 FR StTTA-WP_103354341.1/1-435 SATA-WP_103354341.1/1-435 SATA-WP_103354341.1/1-435 FT AS-WP_104512017.1/1-634 PT AP ACHP AR P RW I GVR LT P LP EP V TE A ECACAQR LCR LACA FP PHQ I D S GNV S FT ST D C DTTA-MBS09283.1/1-832 PE I AA P S AK GRW D V R H LCAN FAM DD T EF S EI R AL CAAACA FP PHQ I D S S GNV S FT ST D C 600 610 620 630 640 650 MISHMT-WP_00871121.1/1-429 TMTTA-WP_1088596100.1/1-431 ODH-AR35753.1/1-440 BTTA-WP_108749561.1/1-440 BTTA-WP_108749561.1/1-440 BTTA-WP_101871121.1/1-458 STTA-WP_101871121.1/1-458 STTA-WP_1018749561.1/1-440 BTTA-WP_101871121.1/1-458 STTA-WP_101871112.1/1-458 STTA-WP_101871112.1/1-458 STTA-WP_101871112.1/1-458 STTA-WP_101871112.1/1-458 STTA-WP_101871112.1/1-458	CSTTA-WP_018749561.1/1-440						
SITTA-W0 101279775.1/1-477 FR LIpK-B405887.1/1-424 SNTA-AD245323.1/1-434 NOTTA-W0 SGACVDELAAWLYR KATTA-W0 SGACVDELAAWLYR KATTA-W0 SGACVDELAAWLYR KATTA-W0 SGACVDELAAWLYR KATTA-W0 PTAPACHPARPRWIGVRLTPLPEPVTEAECAGAQRLGRLAAAACAFPNQTDSTGNVSFTSTDC DbTTA-MBS009283.1/1-382 PEIAAPSAKGRWVDYRHLGNDFAMDDTEFSEIRALGAAACAFPNQTDSTGNVSLRS-GA PbTTA-MBS809100.1/1-432 PEIAAPSAKGRWVDYRHLGNDFAMDDTEFSEIRALGAAACAFPNQTDSTGNVSLRS-GA PbTTA-MBS859100.1/1-422 600 610 620 630 640 650 MJSHNT-WP_010871121.1/1-429 600 610 620 630 640 650 MJTA-WD 010871121.1/1-429 FITA-W0 018719064.1/1-440 551 <	Butta-WP_0804107541/1-458						
Lipk-B405887.1/1-424 NoTTA-WP_052373448.1/1-435 RaTTA-CH11859.1/1-431 STTA-WP_054273448.1/1-430 PTTA-MB1509283.1/1-342 PTTA-ABP SAK GRWV DY R H LCND F AND DT E F S E IR A LCAA AC AF P NQT D S S G N V S F T S T D G 600 610 620 630 640 650 MJSHMT-WP_01087112.1.1/1-429 TMTTA-WP_10879112.1.1/1-429 TMTTA-WP_0187950.1/1-440 STTA-WP_0187950.1/1-440 STTA-WP_0187950.1/1-440 STTA-WP_0197353.3/1.1-440 STTA-WP_0197353.3/1.1-440 STTA-WP_0197353.3/1.1-440 STTA-WP_0197353.3/1.1-440 STTA-WP_0197353.3/1.1-431 NOTTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-432 STTA-WP_0197353.3/1.1-432 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_0197353.3/1.1-431 STTA-WP_00197312.1.1/1-438 STTA-WP_00197312.1.1/1-438 STTA-WP_00197312.1.1/1-438 STTA-WP_00197312.1.1/1-434 STTA-WP_00197312.1.1/1-434 STTA-WP_00197312.1.1/1-434 STTA-WP_00197312.1.1/1-434 STTA-WP_00197312.1.1/1-434 STTA-WP_00197312.1.1/1-434 STTA-WP_00007312.1.1/1-434 STTA-WP_0007312.1.1/1-434 STTA-WP_0007312.1.1/1-434 STTA-WP_0007312.1.1/	StTTA-WP 101279775.1/1-477	FR					
SNTTA-AD245329.1/1-434 NOTTA-WP_052373448.1/1-435 RaTTA-CH11859.1/1-431 P TAP AG HP AR P RW I G V R L T P L P E P V T E A E C A G A Q R L G R L A G A F P HQ I D S S G N V S F T S T D G P T A P A G HP A R P RW I G V R L T P L P E P V T E A E C A G A Q R L G R L A G A F P HQ I D S S G N V S F T S T D G DD TTA-MBS09283.1/1-32 P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S AK G RW V D Y R H L G N D F A MD D T E F S E I R A L G A A A G A F P NQ T D S T G N V S L R S - G A P E I A A P S 3 S 3 3 4 1.1 - 429 P E I A A P S 3 S 3 4 1 .1 - 440 SITTA-WP_0 1087 1120 .1 - 441 SITTA-WP_0 1087 135 134 .1 - 1440 NTA-NDC 9 S 237 3 4 48 .1 /1 - 439 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 439 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 3 3 5 4 3 4 .1 /1 - 399 F T as - D Q 2 1 0 M S A H A D C Q V V E L T G A - E G WT L H C R G C C P S A E A Y L H H L R E V G A R Y V V D T T - MB S D G 2 2 .1 /1 - 424 S T A - D Q 2 3 3 5 4 3 4 .1 /1 - 399 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A - D Q 2 3 7 3 4 48 .1 /1 - 429 S T A -	LipK-BAJ05887.1/1-424						
NoTTA-WP_052373448.1/1-425 KATTA-WP_03353341.1/1-399 - PE I A A P S A K G R W V D Y R H L G N D F AM D D T E F S E I R A L G A A A G A F P HQ I D S S G N V S F T S T D G DD TTA-MBS609283.1/1-382 - PE I A A P S A K G R W V D Y R H L G N D F AM D D T E F S E I R A L G A A A G A F P HQ I D S S G N V S F T S T D G DD TTA-MBS609283.1/1-382 - PE I A A P S A K G R W V D Y R H L G N D F AM D D T E F S E I R A L G A A A G A F P HQ I D S S G N V S F T S T D G DD TTA-MBS609283.1/1-424 - PE I A A P S A K G R W V D Y R H L G N D F AM D D T E F S E I R A L G A A A G A F P HQ I D S S G N V S F T S T D G DD TTA-MBS733.1/1-440 - PTTA-WP_10871121.1/1-429 - TTA-WP_10871121.1/1-440 - STTA-WP_00514901G A, 1/1-440 - STTA-WP_00410754.1/1-440 - STTA-WP_00410754.1/1-440 - STTA-WP_00410754.1/1-440 - STTA-WP_00410754.1/1-443 NOTTA-WP_00335434.1/1-458 - STTA-WP_01013101.1/1-634 - R L F V G S G Y I K D L A P G D F V E L T G A - E G WT L H C R G C C P P S A E A Y L H H L L R E R V G A R Y V D D TTA-MBS609283.1/1-322 - R V F V S S S G S Y I K H L A D G Q V E L D A V D P S C E L I D Y H G A L P S S E S L M H F L V Y Q N V P A G A V V P D T A - MBS609283.1/1-324 	SNTTA-ADZ45329.1/1-434						
RaTTA-CIH 11859.1/1-431 - S G A G V D E LAAW L Y R	NoTTA-WP_052373448.1/1-425						
KAITA-WP.033354341.1/1-339 PTAPAGHPARPRWIGVRLTPLPEPVTEAECAGAQRLGRLAGAFPHQTDSSGNVSFTSTDC Ffase-WP.018151017.1/1-634 PEIAAPSAKGRWVDVRHLGNDFAMDDTEFSEIRALGAAAGFPNQTDSTGNVSLRS-GA PbTTA-MBR2478762.1/1-424 600 610 620 630 640 650 MJSHMT-WP.010871121.1/1-429 TMTA-WP.010871121.1/1-429 TMTA-WP.0108749561.1/1-440 BSTTA-WP.018749561.1/1-440 BSTTA-WP.008140154.1/1-440 BSTTA-WP.008140154.1/1-440 BSTTA-WP.008140154.1/1-448 STTA-WP.008140154.1/1-448 STTA-WP.008140154.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.018749561.1/1-448 STTA-WP.01871121.1/1-458 STTA-WP.01871121.1/1-458 STTA-WP.010871121.1/1-458 STTA-WP.010871121.1/1-454 STTA-WP.010871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.00871121.1/1-428 STTA-WP.001748561.1/1-440 STTA-WP.00871121.1/1-428 STTA-WP.00174871.1/1-428 STTA-WP.00174871.1/1-428 STTA-WP.00174871.1/1-428 STTA-WP.001748745.1/1-424 STTA-WP.002773448.1/1-425 STTA-WP.001748745.1/1-424 STTA-WP.002773448.1/1-426 STTA-WP.002773448.1/1-425 STTA-WP.002773448.1/1-426 STTA-WP.002773448.1/1-426 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.002773448.1/1-428 STTA-WP.0027773448.1/1-428 STTA-WP.0027773448.1/1-428 STTA-WP.002773448.	RaTTA-GIH11859.1/1-431	SGAGVDE	E L A A W L Y R – – –				
F1 A5C MP AK P KW TO KK L P L P E Y TE A E GAA QK L GAA A GA F P QT D S GN S J F S L D G DDTTA-MB509283.1/1-832 P E I A A P S AK G KW VD Y R HL CN D F AM DD T E F S E I R A L GAA A G A P P QT D S GN S L R S - G A MJSHMT-WP_010871121.1/1-424 600 610 620 630 640 650 MJSHMT-WP_010871121.1/1-429	KaTTA-WP_033354341.1/1-399						
DDTTA-MBD2478762.1/1-424 600 610 620 630 640 650 MJSHMT-WP_01871121.1/1-429 7 <t< td=""><td>$P_{135} = WP_{014151017.1/1-034}$</td><td></td><td></td><td></td><td></td><td></td><td>5 G N V S F I S I D G 5 G N V S I P S - C A</td></t<>	$P_{135} = WP_{014151017.1/1-034}$						5 G N V S F I S I D G 5 G N V S I P S - C A
600 610 620 630 640 650 MJSHMT-WP_010871121.1/1-429	PhTTA-MB/3009203.1/1-302						
MJSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 BTTA-WP_005149064.1/1-440 SSTTA-WP_0061491121.1/1-440 BuTTA-WP_080410754.1/1-458 SSTTA-WP_0061491121.1/1-458 SSTTA-WP_0061491121.1/1-458 SSTTA-WP_0051373448.1/1-458 SSTTA-WP_0052373448.1/1-454 SNTTA-AD245329.1/1-431 SNTTA-WP_053354341.1/1-399 FTase-WP_014151017.1/1-634 R L F V T C S C T Y I K D L AP C D F V E L T C A - E C WT L H C R C D C P P S A E A Y L H H L L R E R V C A R Y V V D D TTA-WP_188596100.1/1-431 SNTTA-WP_010871121.1/1-634 R L F V T C S C T Y I K D L AP C D F V E L T C A - E C WT L H C R C D C P P S A E A Y L H H L L R E R V C A R Y V V D D TTA-MBIS609283.1/1-82 R V F V S S S C S Y I K H L A D C Q V V E L D A V D P S C E L I D Y H G A L P S S E S L M H F L V Y Q N V P A G A V V PD TTA-MBIS609283.1/1-424 							
MJSHMT-WP_0188596100.1/1-431 ThTTA-WP_05149064.1/1-440 CSTTA-WP_06149112.1/1-440 BSTTA-WP_06149112.1/1-440 BSTTA-WP_060149112.1/1-447 LipK-BAJ05887.1/1-424 NOTTA-WP_052373448.1/1-425 RATTA-CH11859.1/1-434 PTTA-MBI509283.1/1-332 RV FV S S G S Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P S A E AY L H H L L R E R V G A R V V V D bTTA-MBI509283.1/1-382 RV F V S S G S Y I K H L A D G V V E L D A V D P S G E L I D Y H G A L P S S E S L M H F L V Q N V P A G A V V D TTA-MBI509283.1/1-424 660 670 680 690 700 710 MJSHMT-WP_01087112.1/1-644 BTTA-WP_08112.1/1-440 STTA-WP_08112.1/1-440 STTA-WP_08112.1/1-440 STTA-WP_08164.1/1-440 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_08173573.1/1-441 STTA-WP_0		600	610	620	630	640	650
Init I, AW _ 103 > 103 + 1, 1 - 440 PITTA - WP_095 149064.1/1 - 440 STTA - WP_0804 10754.1/1 - 458 SUTTA - WP_0804 10754.1/1 - 458 SUTTA - WP_052373448.1/1 - 424 SNTTA - ADZ 453 29.1/1 - 434 No TTA - WP_05335434.1/1 - 399 Frase - WP_014151017.1/1 - 634 R L F V T G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P P S A E AY L H H L L R E R V G A R Y V V ND TA - MBIS609283.1/1 - 389 Frase - WP_014151017.1/1 - 634 R L F V T G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P P S A E AY L H H L L R E R V G A R Y V V ND TTA - MBIS609283.1/1 - 389 Frase - WP_01451017.1/1 - 634 R L F V T G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P P S A E AY L H H L L R E R V G A R Y V V ND TTA - MBIS609283.1/1 - 382 R T A - WP_01871121.1/1 - 429 Tm TTA - WP_01835753.1/1 - 440 PTTA - WP_018749561.1/1 - 440 STTA - WP_060149112.1/1 - 440 SUTA - WP_0603437448.	MICLINE WD 010071121 1/1 42	600 •	610	620 •	630	640	650
DTTA-WP_005149061.1/1-440 STTA-WP_0018749561.1/1-440 BUTTA-WP_0010879561.1/1-458 STTA-WP_001279775.1/1-477 LipK-B405887.1/1-424 SNTTA-ADZ45329.1/1-431 KaTTA-WP_03354341.1/1-399 FTase-WP_012151017.1/1-634 MJSHMT-WP_0127975.1/1-477 LipK-B405887.1/1-421 660 670 680 690 700 710 MJSHMT-WP_018749561.1/1-440 STTA-WP_188596100.1/1-431 Obit-ARJ35753.1/1-440 BTTA-WP_18859610.1/1-440 STTA-WP_01874121.1/1-440 STTA-WP_01874961.1/1-440 STTA-WP_01874954.1/1-440 STTA-WP_014151017.1/1-634 BTTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_014151017.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_014151017.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_014151017.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_014151017.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_014151017.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_01415007.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-431 STTA-WP_01415007.1/1-634 STTA-WP_0141500928.1/1-431 STTA-WP_0141500928.1/1-434 STTA-WP_0141500928.1/1-434 STTA-WP_0141500928.1/1-434 STTA-WP_0141500928.1/1-434 STTA-WP_0141500928.1/1-434 STTA-WP_0141500928.1/1	MjSHMT-WP_010871121.1/1-429	600 9	610 • • • • • • • • • • • •	620 	630 	640 	650
CSTTA-WP_018749561.1/1-440 BSTTA-WP_060149112.1/1-440 BSTTA-WP_080410754.1/1-458 StTTA-WP_052373448.1/1-425 RaTTA-GH11859.1/1-431 KTTA-WP_0335543.1/1-382 PT ase-WP_014151017.1/1-634 RLFVTCSCTYIKDLAPCDFVELTGA - ECWTLHCRCDGPP SAEAYLHHLLRERVGARYVV VDTTA-MBN2478762.1/1-424 660 670 680 690 700 710 MJSHMT-WP_010871121.1/1-429 mTTA-WP_188596100.1/1-431 STTA-WP_05119064.1/1-440 STTA-WP_05149064.1/1-440 STTA-WP_080410754.1/1-440 STTA-WP_080410754.1/1-440 STTA-WP_080410754.1/1-440 STTA-WP_080410754.1/1-440 STTA-WP_087149064.1/1-440 STTA-WP_087149175.1/1-637 STTA-WP_08737448.1/1-425 STTA-WP_08737448.1/1-425 STTA-WP_08733341.1/1-399 FT ase-WP_014151017.1/1-634 HNHC LP GR - A LET SGALV I PP K EY GS VA LA EA VA DA CQ D SQ VMY V R HG LV FWA H SY D EC DD TA-MB15009283.1/1-382 HT H VLLT NQ EA AD F D VA VI AP Q EY AS I A LA RAVA A EA SK R SI VI Y Q K HG LV FWG TD TA AD C DD TTA-MB2478762.1/1-424	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH_ARI357531/1-440	600 9		620 	630 	640 • • • • • • • • • • • • • • • • • • •	650
BSTTA-WP_060149112.1/1-440 BUTTA-WP_080410754.1/1-458 STTA-WP_101279775.1/1-477 LipK-BAJO5887.1/1-424 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTTAse-WP_014151017.1/1-634 R L F V T G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P S A E AY L H H L L R E R V G A R V V V D bTTA-MBI5609283.1/1-382 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L MH F L V Y Q N V P A G A V V D bTTA-MBI5609283.1/1-382 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L MH F L V Y Q N V P A G A V V D bTTA-MBI5609283.1/1-424 660 670 680 690 700 710 MJSHMT-WP_01871121.1/1-449 	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP 095149064.1/1-440	600 9	610 	620 	630 	640 	650
BuTTA-WP_080410754.1/1-458 StTTA-WP_011279775.1/1-477 LipK-BaJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 KaTTA-WP_052373448.1/1-425 RaTTA-GH11859.1/1-431 Mither WP_014151017.1/1-634 Mither WP_014151017.1/1-634 Mither WP_014278762.1/1-424 Mither WP_014278762.1/1-424 Mither WP_014278762.1/1-424 Mither WP_0142787651.1/1-429 Mither WP_0142787651.1/1-440 Bitta-WP_0142787651.1/1-440 Mither WP_014278761.1/1-440 Bitta-WP_0147775.1/1-474 Mither WP_01427775.1/1-477 LipK-BaJ05887.1/1-424 Mither WP_01427373448.1/1-425 Sitta-WP_0147775.1/1-477 LipK-BaJ05887.1/1-424 Mither WP_01427775.1/1-477 LipK-BaJ05887.1/1-424 Mither WP_01451017.1/1-634 Hither WP_01451017.1/	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440	600 	610 	620 • • • • • • • • • • • • • • • • • • •	630 	640	650
SKTTA-WP_101279775.1/1-477 Lipk-BAJO5887.1/1-424 SNTTA-ADZ45329.1/1-434 KATTA-WP_033354341.1/1-425 RaTTA-GIH11859.1/1-431 KATTA-WP_03355431.1/1-399 FTase-WP_014151017.1/1-634 R L F V T G S G T Y I K D L A P G D F V E L T G A - E G WT L H C R G D G P S A E A Y L H H L L R E R V G A R Y V V DbTTA-MBI5609283.1/1-822 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L M H F L V Q N V P A G A V V DbTTA-MBI5609283.1/1-822 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L M H F L V Q N V P A G A V V DbTTA-MBI5609283.1/1-824 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L M H F L V Q N V P A G A V V D TTA-MBN2478762.1/1-424 FTTA-WP_010871121.1/1-429 FTTA-WP_010871121.1/1-429 STTA-WP_080410754.1/1-431 STTA-WP_080410754.1/1-440 STTA-WP_0080410754.1/1-440 STTA-WP_001754.1/1-440 STTA-WP_001754.1/1-445 STTA-VP_001754.1/1-447 STTA-WP_001754.1/1-447 STTA-GIH11859.1/1-431 NoTTA-WP_03354348.1/1-425 RaTTA-GIH11859.1/1-431 H H H C I P G R - A L E T S G A L V I P P K E Y G S V A L A E A V A D A C Q D S Q VM Y R H G L V F W A H S Y D E C D b TTA-MB2478762.1/1-424 H T H Y L L T NQ E A A D F D V A V I A P Q E Y A S I A L A R A V A E A S K R S R I V I Q K H G L V F W G T A AD C	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440	600 		620 ••••••••••••••••••••••••••••••••••••	630	640	650
Lipk-BAJOS 887.1/1-424 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_010871121.1/1-634 MOTA-WP_010871121.1/1-429 MJSHMT-WP_010871121.1/1-429 MJSHMT-WP_010871121.1/1-429 MJSHMT-WP_010871121.1/1-429 MTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PITTA-WP_051849661.1/1-440 STTA-WP_060149112.1/1-440 STTA-WP_060149112.1/1-440 STTA-WP_08087.1/1-458 STTA-WP_010874175.1/1-477 Lipk-BAJOS 887.1/1-424 STTA-WP_033354341.1/1-425 RaTTA-WP_033354341.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-439 FTase-WP_014511017.1/1-634 HT HC LP GR - A LET S GA LV I P P K EY G S V A LA RA VA DA CQ D S Q VM V R R HG LV FWAH S Y D E C Db TTA-MB54747862.1/1-424 HT HY LLT NQ EA AD F D VA V I AP Q EY AS I LA RA VA EA S K R S R I VY I Q K HG LV FWAH S Y D E C Db TTA-M8747862.1/1-424	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458			620	630	640	650
SN 1TA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-CIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_011451017.1/1-634 NoTTA-WP_0387.1/1-424 SN TTA-WP_0387.1/1-424 SN TTA-WP_0387.1/1-424 SN TTA-WP_033354341.1/1-458 STTA-WP_044512017.1/1-634 HNHC IP GR - A L ET S G A LV IP P K EY G S V A L A E A V A D A C Q D S Q VM Y V R R H G LV F W A H S Y D E C D bTTA-MBX2478762.1/1-424	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_01279775.1/1-477			620	630		650
No TrA-WIL_033354341.1/1-399 FTase=WP_014151017.1/1-634 R L F V T G S G T Y I K D L A P G D F V E L T G A E GWT L H C R G D G P P S A E A Y L H H L L R E R V G A R Y V Y DbTTA-MB15609283.1/1-382 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A L P S S E S L M H F L V Y Q N V P A G A V V PbTA-MBN2478762.1/1-424 660 670 680 690 700 710 MJSHMT-WP_010871121.1/1-429 660 670 680 690 700 710 MJSHMT-WP_0188596100.1/1-431	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424			620	630		650
KatTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 R L F VT G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P P S A E AY L H H L L R E V G A R Y V V DbTTA-MBIS609283.1/1-382 R V F V S S S G S Y I K H L AD G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L M H F L V Y Q N V P A G A V V PbTTA-MBN2478762.1/1-424 660 670 680 690 700 710 MJSHMT-WP_010871121.1/1-424	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NDTTA-WP_052724481/1/1425			620	630		650
FTase-WP_014151017.1/1-634 R L F VT G S G T Y I K D L AP G D F V E L T G A - E GWT L H C R G D G P S A E A Y L H H L L R E R V G A R Y V V DbTTA-MBI5 609283.1/1-382 R V F V S S S G S Y I K H L A D G Q V V E L D A V D P S G E L I D Y H G A A L P S S E S L MH F L V Y Q N V P A G A V V PbTTA-MBN2478762.1/1-424 660 670 680 690 700 710 MJSHMT-WP_010871121.1/1-429	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_060149112.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-CH11859 1/1-431			620	630		650
DbTTA-MBI5609283.1/1-382 R V F V S S S G S Y I K H L A D GQ V V E L D A V D P S G E L I D Y H G A A L P S S E S L MH F L V Y Q N V P A G A V V PbTTA-MBN2478762.1/1-424 660 670 680 690 700 710 MjSHMT-WP_010871121.1/1-429	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP 033354341.1/1-399				630		650
PbTTA-MBN2478762.1/1-424 660 670 680 690 700 710 MjSHMT-WP_010871121.1/1-429 700 710 Tm TTA-WP_188596100.1/1-431 700 710 ObiH-ARJ35753.1/1-440 700 710 CSTTA-WP_095149064.1/1-440 700 700 CSTTA-WP_018749561.1/1-440 700 700 BsTTA-WP_060149112.1/1-440 700 700 BuTTA-WP_080410754.1/1-458 700 700 StTTA-WP_0101279775.1/1-477 700 700 Lipk-BAJ05887.1/1-424 700 700 SNTTA-ADZ45329.1/1-434 700 700 NoTTA-WP_052373448.1/1-425 700 700 RaTTA-GIH11859.1/1-431 700 700 KaTTA-WP_033354341.1/1-399 700 700 FTase-WP_014151017.1/1-634 1000000000000000000000000000000000000	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_03354341.1/1-399 FTase-WP_014151017.1/1-634	600 	610	620	630 	640 	650
660 670 680 690 700 710 MjSHMT-WP_010871121.1/1-429 - </td <td>MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_03354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382</td> <td>600 </td> <td>610 </td> <td>620 </td> <td>630 630 630 630 630 630 630 630</td> <td>640 640 640 640 640 640 640 640</td> <td>650 </td>	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_03354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382	600 	610 	620 	630 630 630 630 630 630 630 630	640 640 640 640 640 640 640 640	650
MJSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PITTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BSTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNHC I P G R - A L ET S G A L V I P P K EY G S V A L A E A V A D A C Q D S Q VMY V R H G L V F W A H S Y D E C DbTTA-MBI260283.1/1-382 HT H Y L L T NQ E A A D F D V A V I A P Q EY A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T T A DC	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_03354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382 PbTTA-MBN2478762.1/1-424	600 	610 	620 	630 • • • • • • • • • • • • • • • • • • •	640 640 640 640 640 640 640 640	650
TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PITTA-WP_095149064.1/1-440 STTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 STTA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 No TTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_014151017.1/1-634 HNHC I P GR - A L ET S GA L V I P P K EY G S V A L A E A V A D A CQ D S Q VMY V R R HG L V F W A H S Y D E C DbTTA-MB15609283.1/1-382 HT H Y L L T NQ E A A D F D V A V I A P Q EY A S I A L AR A V A E A S K R S R I V Y I Q K HG L V F W G T T A DC	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-CIH11859.1/1-431 KaTTA-WP_03335434.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MBI5609283.1/1-382 PbTTA-MBN2478762.1/1-424	600 	610	620 620 620 620 620 620 620 620	630 	640 640 640 640 640 640 640 640	650
ObiH-ARJ35753.1/1-440	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-CIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-425	600 	610 	620 620 620 620 620 620 620 620	630 	640 640 640 640 640 640 640 640	650
PITTA-WP_052373448.1/1-440 KaTTA-WP_052373448.1/1-458 RaTTA-WP_052373448.1/1-458 RaTTA-WP_052373448.1/1-424 No TTA-MP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_014151017.1/1-634 HNHC I P GR - A L ET S GA L V I P P K EY G S V A L A E A V A D A CQ D S Q VMY V R H G L V F W A H S Y D E C Db TTA-MB15609283.1/1-382 HT H Y L L T NQ E A A D F D V A V I A P Q E Y A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T T A DC	MjSHMT-WP_010871121.1/1-420 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-CIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-425 TmTTA-WP_188596100.1/1-431	600 	610	620 620 620 620 620 620 620 620	630 • • • • • • • • • • • • • • • • • • •	640 640 640 640 640 640 640 640	650
Cs1TA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNHC I P GR - A L ET S GA L V I P P K EY G S V A L A E A V A D A CQ D S Q VMY V R H G L V F W A H S Y D E C DbTTA-MBN2478762.1/1-424	MjSHMT-WP_010871121.1/1-420 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_0101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-423 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440	600 	610 Y I K D L A P G D F Y I K H L A D G Q V 670	620 620 620 620 620 620 620 620	630 • • • • • • • • • • • • • • • • • • •	640 640 640 640 640 640 640 640	650
Bit TA-WP_080149112.1/1-440 ButTA-WP_080410754.1/1-458 StTTA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 No TTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNNC IP GR - A L ET S GA L V IP P K EY G S VA LA E A VA DA CQD S Q VMY VR R HG L V FWAH S Y D E C DbTTA-MB15609283.1/1-382 HT H Y L L T NQ E A A D F D VA V I A P Q EY A S I A L AR A VA E A S K R S R I V Y I Q K HG L V FWGT DT A DC	MjSHMT-WP_010871121.1/1-420 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_001279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-423 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_05149064.1/1-440	600 R L F VT G S G T R L F VT G S G T R V F V S S S G S 660	610 Y I KDLAPGDF Y I KDLAPGDF Y I KHLADGQV 670	620 620 620 620 620 620 620 620	630 • • • • • • • • • • • • •	640 9 9 9 9 9 9 9 9 9 9 9 9 9	650
ShiftA-WP_101279775.1/1-477 Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNNC IP GR - A L ET S GA L V IP P K EY G S VA L A E A V A DA CQD S Q VMY V R R HG L V FWAH S Y D E C DbTTA-MBI260283.1/1-382 HT H Y L L T NQ E A A D F D V A V I A P Q EY A S I A L A R A V A E A S K R S R I V Y I Q K HG L V FWGT D T A DC	MjSHMT-WP_010871121.1/1-421 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_0101279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_01871121.1/1-423 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CsTTA-WP_018749561.1/1-440	600 	610 Y I K D L A P G D F Y I K H L A D G Q V 670	620 	630 WT L H C R G D G P P L I D Y H G A A L P 690	640	650
Lipk-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 No TTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNHC I P G R - A L ET S G A L V I P P K EY G S V A L A E A V A D A C Q D S Q V M Y V R H G L V F W A H S Y D E C Db TTA-MBN2478762.1/1-424 HT H Y L L T N Q E A A D F D V A V I A P Q E Y A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T D T A D C	MjSHMT-WP_010871121.1/1-421 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_001279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_01871121.1/1-424 MjSHMT-WP_0881490.1/1-440 PiTTA-WP_085149064.1/1-440 SsTTA-WP_088140754.1/1-440	600 	610 Y I K D L A P G D F Y I K H L A D G Q V 670	620 	630 WT L H C R G D G P P L I D Y H G A A L P 690	640 SAEAYLHHLI SSESLMHFLX 700	650
SNTTA-ADZ45329.1/1-434 No TTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNHC I P G R - A L ET S G A L V I P P K EY G S V A L A E A V A D A CQD S Q VMY V R H G L V F W A H S Y D E C DbTTA-MBI5609283.1/1-382 HT H Y L L T NQ E A A D F D V A V I A P Q EY A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T T A D C	MjSHMT-WP_010871121.1/1-421 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_010279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-382 PbTTA-MB2478762.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_085149064.1/1-440 PiTTA-WP_085149064.1/1-440 BsTTA-WP_08410754.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458	600 	610 Y I KD LAP GD F Y I KH LAD GQ V 670	620 	630 WT L H C R G D G P P E L I D Y H G A A L P 690	640 5 A E A Y L H H L I 5 S E S L M H F L V 700	650
No TTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 HNHC I P G R - A L E T S G A L V I P P K E Y G S V A L A E A V A D A C Q D S Q V M Y R R H G L V F W A H S Y D E C DbTTA-MB15609283.1/1-382 HT H Y L L T N Q E A A D F D V A V I A P Q E Y A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T D T A D C	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_010279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-AD245329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-382 PbTTA-MB2478762.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_085149064.1/1-440 PiTTA-WP_085149064.1/1-440 BsTTA-WP_08410754.1/1-458 StTTA-WP_080410754.1/1-458	600 	610 Y I KD LAP GD F Y I KH LAD GQ V 670	620 	630 MT L H C R G D G P P E L I D Y H G A A L P 690	640	650
RaTTA-GIH11859.1/1-431	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_052373448.1/1-425 RaTTA-OZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_085496100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_08549064.1/1-440 CSTTA-WP_08149761.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_080410755.1/1-447 LipK-BAJ05887.1/1-424	600 	610 Y I K D L A P G D F Y I K H L A D G Q V 670 670	620 VELTGAEGV VELTGAEGV VELDAVDPSG	630 MTLHCRGDGPP ELIDYHGAALP 690	640	650
KAIIIA-WP_U33354341.1/1–399 FTase=WP_014151017.1/1–634 HNHC I P G R – A L E T S G A L V I P P K E Y G S V A L A E A V A D A C Q D S Q V M Y V R H G L V F W A H S Y D E C Db TTA-MBI5609283.1/1–382 HT H Y L L T N Q E A A D F D V A V I A P Q E Y A S I A L A R A V A E A S K R S R I V Y I Q K H G L V F W G T D T A D C Pb TTA-MBN2478762.1/1–424	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BsTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-382 PbTTA-MB15609283.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_018749561.1/1-440 PiTTA-WP_085149064.1/1-440 RSTTA-WP_080410754.1/1-4458 StTTA-WP_080410755.1/1-447 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-MP_052373448.1/1-425	600 	610 Y I K D L A P G D F Y I K H L A D G Q V 670 670	620 	630 MTLHCRGDGPP ELIDYHGAALP 690	640	650
DbTTA-MBI2609283.1/1-382 HT HYLLT NQ EAAD F DVAVIAPQEYASIALAEAVADACQD SQ VMI V KKHGLV FWGT DT ADC PbTTA-MBI2609283.1/1-382 HT HYLLT NQ EAAD F DVAVIAPQEYASIALAR AVA EA SKR SR I VYIQK HGLV FWGT DT ADC	MjSHMT-WP_010871121.1/1-429 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_0018749561.1/1-440 BSTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_010279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NOTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_08549610.1/1-440 PiTTA-WP_188596100.1/1-441 ObiH-ARJ35753.1/1-440 PiTTA-WP_085149064.1/1-440 BsTTA-WP_080140754.1/1-458 StTTA-WP_080410754.1/1-458 StTTA-WP_0052373448.1/1-425 RaTTA-ADZ45329.1/1-434 NOTTA-WP_052373448.1/1-425	600 	610 Y I K D L AP G D F Y I K H L AD G Q V 670	620 	630 MTLHCRGDGPP ELIDYHGAALP 690	640	650
PbTTA-MBN2478762.1/1-424	MjSHMT-WP_010871121.1/1-421 TmTTA-WP_188596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_095149064.1/1-440 CSTTA-WP_018749561.1/1-440 BuTTA-WP_060149112.1/1-440 BuTTA-WP_080410754.1/1-458 StTTA-WP_010279775.1/1-477 LipK-BAJ05887.1/1-424 SNTTA-ADZ45329.1/1-434 NoTTA-WP_052373448.1/1-425 RaTTA-GIH11859.1/1-431 KaTTA-WP_033354341.1/1-399 FTase-WP_014151017.1/1-634 DbTTA-MB15609283.1/1-382 PbTTA-MBN2478762.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_010871121.1/1-424 MjSHMT-WP_08596100.1/1-431 ObiH-ARJ35753.1/1-440 PiTTA-WP_18596100.1/1-440 CSTTA-WP_080410754.1/1-440 STTA-WP_080410754.1/1-448 StTTA-WP_060149112.1/1-440 StTTA-WP_080410754.1/1-458 StTTA-WP_01279775.1/1-477 LipK-BAJ05887.1/1-424 NOTTA-M245329.1/1-434 NOTTA-WP_052373448.1/1-425 RaTTA-WP_033354341.1/1-399	600 	610 Y I K D L AP G D F Y I K D L AP G D F Y I K H L AD G Q V 670	620 VELTGAEGV VELTGAEGV VELDAVDPSG 680 680	630 WT L H C R G D G P P E L I D Y H G A A L P 690	640 9 9 9 9 9 9 9 9 9 9 9 9 9	650
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	720	730	740
MjSHMT-WP_010871121.1/1-429	,		
TmTTA-WP_188596100.1/1-431			
ObiH-ARJ35753.1/1-440			
PiTTA-WP_095149064.1/1-440			
CsTTA-WP_018749561.1/1-440			
BsTTA-WP_060149112.1/1-440			
BuTTA-WP_080410754.1/1-458			
StTTA-WP_101279775.1/1-477			
LipK-BAJ05887.1/1-424			
SNTTA-ADZ45329.1/1-434			
NoTTA-WP_052373448.1/1-425			
RaTTA-GIH11859.1/1-431			
KaTTA-WP_033354341.1/1-399			
FTase-WP_014151017.1/1-634	LALIEDVRRI	T G	
DbTTA-MBI5609283.1/1-382	LSQVHNFIHN	RPNRRAAEAV	YAS
PbTTA-MBN2478762.1/1-424			

Figure S28: Multiple Sequence Alignment. Clustal Omega alignment of representative PLP-dependent enzymes (LipK, FTase, and MjSHMT) and all TTAs in this study colored by % identity. Visualized and aligned using JalView. The residues reported to be important for catalysis and stabilization are highlighted with a black box and the labeled ObiH residue is labeled at the top of the black box.

	ObiH	Y55	E107	H131	D204	K234	R366
	ObiH	93% Y	93% E	93% H	96% D	89% K	93% R
ng	LipK	100% Y	88% M	100% H	100% D	100% K	97% R
uste aini	FTase	94% Y	88% M	88% H	94% D	88% K	100% R
or CI	KaTTA	100% Y	100% M	100% H	100% D	100% K	100% R
ö	PbTTA	100% Y	40% T	100% H	100% D	100% K	100% R
	SHMT	100% Y	90% N	100% H	100% D	100% K	100% R

Figure S29: Conservation of catalytic and stabilizing residues by cluster. Alignment and identity calculated using JalView via the Clustal Omega alignment web service.

Figure S30: Loop length analysis. The average length for loop 1 (ObiH: Tyr55-Pro71) and loop 2 (ObiH: Glu355-His363) for several clusters. For ObiH, PbTTA, and KaTTA, analysis contains the lengths for every protein in the cluster. For SHMT and LipK, the values are for 25 randomly selected proteins within those clusters. The lengths were defined relative to alignment with ObiH.

Figure S31: Demonstration of the aldehyde stabilizing effects of the *E. coli* RARE strain for relevant candidate substrates using HPLC. (a) HPLC trace from the production of β -OH-nsAA from 3 with an observed alcohol peak with a retention time at 11 minutes. The samples were collected after 20 h. We observe a smaller alcohol peak in RARE demonstrating some stabilization of the aldehyde group. (b) HPLC trace from the production of 4-azido-benzaldehyde from 4-azido benzoic acid in RARE indicating formation of both an aldehyde peak and a predicted alcohol by-product. MavCAR and 4-azido-benzoic acid is from an in vitro reaction as described in Fig. 6a and serves as a standard for the aldehyde since we were unable to purchase an aldehyde standard.

Figure S32: HPLC confirmation for β -OH-nsAA production from 4-azido-benzaldehyde. HPLC traces for acid, aldehyde and β -OH-nsAA product from an in vitro CAR-TTA reaction.

Figure S33: Phylogenetic tree for all published TTAs. Clusters are identified by color: blue is ObiH; red is PbTTA; green is SHMTs; orange is KaTTA; gray is the FTase; teal is NoTTA; black is LipK.^{10–23} The phylogenetic tree was generated using the One-click method from phylogeny.fr²⁴ with the sequences identified in Table S3 and the accession numbers listed in the tree. The bolded TTAs were characterized in this study.

IV. Supplementary References

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