

SEQUENCE LISTING

<110> Chen, Janice S
Doudna, Jennifer A
Harrington, Lucas B
Ma, Enbo

<120> TYPE V CRISPR/CAS EFFECTOR PROTEINS FOR CLEAVING SSDNAS AND
DETECTING TARGET DNAS

<130> BERK-375W0

<150> US 62/590,106
<151> 2017-11-22

<150> US 62/626,593
<151> 2018-02-05

<160> 179

<170> PatentIn version 3.5

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Val Leu His Ser Ile Lys Leu Lys Asn Leu Asn Asn Tyr Ile Ser Leu
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Phe Arg Lys Lys Thr Arg Thr Glu Lys Glu Asn Lys Glu Leu Glu Asn
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Glu Gly Tyr Lys Ser Leu Phe Lys Lys Asp Ile Ile Glu Thr Ile Leu
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Pro Glu Phe Leu Asp Asp Lys Asp Glu Ile Ala Leu Val Asn Ser Phe
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Asn Gly Phe Thr Thr Ala Phe Thr Gly Phe Phe Asp Asn Arg Glu Asn
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Asn Glu Asn Leu Thr Arg Tyr Ile Ser Asn Met Asp Ile Phe Glu Lys
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Val Asp Ala Ile Phe Asp Lys His Glu Val Gln Glu Ile Lys Glu Lys
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Phe Asn Phe Val Leu Thr Gln Glu Gly Ile Asp Val Tyr Asn Ala Ile
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Ile Gly Gly Phe Val Thr Glu Ser Gly Glu Lys Ile Lys Gly Leu Asn
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Glu Tyr Ile Asn Leu Tyr Asn Gln Lys Thr Lys Gln Lys Leu Pro Lys
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Phe Lys Pro Leu Tyr Lys Gln Val Leu Ser Asp Arg Glu Ser Leu Ser
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Phe Tyr Gly Glu Gly Tyr Thr Ser Asp Glu Glu Val Leu Glu Val Phe
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Arg Asn Thr Leu Asn Lys Asn Ser Glu Ile Phe Ser Ser Ile Lys Lys
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Leu Glu Lys Leu Phe Lys Asn Phe Asp Glu Tyr Ser Ser Ala Gly Ile
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Phe Val Lys Asn Gly Pro Ala Ile Ser Thr Ile Ser Lys Asp Ile Phe
340 345 350

Gly Glu Trp Asn Val Ile Arg Asp Lys Trp Asn Ala Glu Tyr Asp Asp
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Ile His Leu Lys Lys Lys Ala Val Val Thr Glu Lys Tyr Glu Asp Asp
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Arg Arg Lys Ser Phe Lys Lys Ile Gly Ser Phe Ser Leu Glu Gln Leu
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Gln Glu Tyr Ala Asp Ala Asp Leu Ser Val Val Glu Lys Leu Lys Glu
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Glu Lys Leu Phe Asp Ala Asp Phe Val Leu Glu Lys Ser Leu Lys Lys
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Lys Tyr Ala Lys Cys Leu Gln Lys Ile Asp Lys Asp Asp Val Asn Gly
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Asn Tyr Glu Lys Ile Asn Tyr Lys Leu Leu Pro Gly Pro Asn Lys Met
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Ser Glu Asp Ile Gln Lys Ile Tyr Lys Asn Gly Thr Phe Lys Lys Gly
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Phe Ser Glu Thr Glu Lys Tyr Lys Asp Ile Ala Gly Phe Tyr Arg Glu
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Asn Pro Asp Asn Pro Lys Lys Thr Thr Thr Leu Ser Tyr Asp Val Tyr
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785 790 795 800

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Arg Val Leu Leu Lys His Asp Asp Asn Pro Tyr Val Ile Gly Ile Asp
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Asn Ile Val Glu Gln Tyr Ser Leu Asn Glu Ile Ile Asn Asn Phe Asn
850 855 860

Gly Ile Arg Ile Lys Thr Asp Tyr His Ser Leu Leu Asp Lys Lys Glu
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Gly Asn Arg Ile Arg Ile Phe Arg Asn Pro Lys Lys Asn Asn Val
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Phe Asn Lys Tyr Gly Ile Asn Tyr Gln Gln Gly Asp Ile Arg Ala
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Ala Leu Met Ser Leu Met Leu Gln Met Arg Asn Ser Ile Thr Gly
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Arg Thr Asp Val Asp Phe Leu Ile Ser Pro Val Lys Asn Ser Asp
1145 1150 1155

Gly Ile Phe Tyr Asp Ser Arg Asn Tyr Glu Ala Gln Glu Asn Ala
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Arg Lys Val Leu Trp Ala Ile Gly Gln Phe Lys Lys Ala Glu Asp
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Glu Leu Lys Pro Ile Ile Asp Arg Ile Tyr Lys Thr Tyr Ala Asp Gln
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Cys Leu Gln Leu Val Gln Leu Asp Trp Glu Asn Leu Ser Ala Ala Ile
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Asp Ser Tyr Arg Lys Glu Lys Thr Glu Glu Thr Arg Asn Ala Leu Ile
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Glu Glu Gln Ala Thr Tyr Arg Asn Ala Ile His Asp Tyr Phe Ile Gly
100 105 110

Arg Thr Asp Asn Leu Thr Asp Ala Ile Asn Lys Arg His Ala Glu Ile
115 120 125

Tyr Lys Gly Leu Phe Lys Ala Glu Leu Phe Asn Gly Lys Val Leu Lys
130 135 140

Gln Leu Gly Thr Val Thr Thr Thr Glu His Glu Asn Ala Leu Leu Arg
145 150 155 160

Ser Phe Asp Lys Phe Thr Thr Tyr Phe Ser Gly Phe Tyr Glu Asn Arg
165 170 175

Lys Asn Val Phe Ser Ala Glu Asp Ile Ser Thr Ala Ile Pro His Arg
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Ile Val Gln Asp Asn Phe Pro Lys Phe Lys Glu Asn Cys His Ile Phe
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Thr Arg Leu Ile Thr Ala Val Pro Ser Leu Arg Glu His Phe Glu Asn
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Val Lys Lys Ala Ile Gly Ile Phe Val Ser Thr Ser Ile Glu Glu Val
225 230 235 240

Phe Ser Phe Pro Phe Tyr Asn Gln Leu Leu Thr Gln Thr Gln Ile Asp
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Lys Ile Lys Gly Leu Asn Glu Val Leu Asn Leu Ala Ile Gln Lys Asn
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Asp Glu Thr Ala His Ile Ile Ala Ser Leu Pro His Arg Phe Ile Pro
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Leu Phe Lys Gln Ile Leu Ser Asp Arg Asn Thr Leu Ser Phe Ile Leu
305 310 315 320

Glu Glu Phe Lys Ser Asp Glu Glu Val Ile Gln Ser Phe Cys Lys Tyr

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Lys Thr Leu Leu Arg Asn Glu Asn Val Leu Glu Thr Ala Glu Ala Leu
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Phe Asn Glu Leu Asn Ser Ile Asp Leu Thr His Ile Phe Ile Ser His
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Lys Lys Leu Glu Thr Ile Ser Ser Ala Leu Cys Asp His Trp Asp Thr
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 385 390 395 400

Ile Thr Lys Ser Ala Lys Glu Lys Val Gln Arg Ser Leu Lys His Glu
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Asp Ile Asn Leu Gln Glu Ile Ile Ser Ala Ala Gly Lys Glu Leu Ser
 420 425 430

Glu Ala Phe Lys Gln Lys Thr Ser Glu Ile Leu Ser His Ala His Ala
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Leu Asp Trp Phe Ala Val Asp Glu Ser Asn Glu Val Asp Pro Glu Phe
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Ser Ala Arg Leu Thr Gly Ile Lys Leu Glu Met Glu Pro Ser Leu Ser
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Asp Val Asn Lys Glu Lys Asn Asn Gly Ala Ile Leu Phe Val Lys Asn
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Ala Leu Ser Phe Glu Pro Thr Glu Lys Thr Ser Glu Gly Phe Asp Lys
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Ser Thr Gln Leu Lys Ala Val Thr Ala His Phe Gln Thr His Thr Thr
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675 680 685

Lys Thr Thr Ser Ile Asp Leu Ser Ser Leu Arg Pro Ser Ser Gln Tyr
690 695 700

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Ala Glu Leu Phe Tyr Arg Pro Lys Ser Arg Met Lys Arg Met Ala His
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Arg Leu Gly Glu Lys Met Leu Asn Lys Lys Leu Lys Asp Gln Lys Thr
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Val Ile Thr Lys Glu Val Ser His Glu Ile Ile Lys Asp Arg Arg Phe
 850 855 860

Thr Ser Asp Lys Phe Phe Phe His Val Pro Ile Thr Leu Asn Tyr Gln
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Ala Ala Asn Ser Pro Ser Lys Phe Asn Gln Arg Val Asn Ala Tyr Leu
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Val Gly Thr Ile Lys Asp Leu Lys Gln Gly Tyr Leu Ser Gln Val Ile
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980 985 990

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995 1000 1005

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Val Trp Lys Thr Ile Lys Asn His Glu Ser Arg Lys His Phe Leu
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Glu Gly Phe Asp Phe Leu His Tyr Asp Val Lys Thr Gly Asp Phe
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Glu Thr Gln Phe Asp Ala Lys Gly Thr Pro Phe Ile Ala Gly Lys
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Arg Asp Leu Tyr Pro Ala Asn Glu Leu Ile Ala Leu Leu Glu Glu

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Ile Arg Ser Val Leu Gln Met Arg Asn Ser Asn Ala Ala Thr Gly
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Glu Asp Tyr Ile Asn Ser Pro Val Arg Asp Leu Asn Gly Val Cys
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Ala Asn Gly Ala Tyr His Ile Ala Leu Lys Gly Gln Leu Leu Leu
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Ile Leu Ser Ser Val Cys Ile Ser Glu Asp Leu Leu Gln Asn Tyr Ser
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Asp Val Tyr Phe Lys Leu Lys Lys Ser Asp Asp Asp Asn Leu Gln Lys
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Asp Phe Lys Ser Ala Lys Asp Thr Ile Lys Lys Gln Ile Ser Glu Tyr
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Ile Lys Asp Ser Glu Lys Phe Lys Asn Leu Phe Asn Gln Asn Leu Ile
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Asp Ala Lys Lys Gly Gln Glu Ser Asp Leu Ile Leu Trp Leu Lys Gln
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Ser Lys Asp Asn Gly Ile Glu Leu Phe Lys Ala Asn Ser Asp Ile Thr
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Asp Ile Asp Glu Ala Leu Glu Ile Ile Lys Ser Phe Lys Gly Trp Thr
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Thr Tyr Phe Lys Gly Phe His Glu Asn Arg Lys Asn Val Tyr Ser Ser
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Pro Lys Phe Leu Glu Asn Lys Ala Lys Tyr Glu Ser Leu Lys Asp Lys
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Val Phe Ser Leu Asp Glu Val Phe Glu Ile Ala Asn Phe Asn Asn Tyr
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Leu Asn Gln Ser Gly Ile Thr Lys Phe Asn Thr Ile Ile Gly Gly Lys
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Asn Leu Tyr Ser Gln Gln Ile Asn Asp Lys Thr Leu Lys Lys Tyr Lys
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Gln Ser Phe Tyr Glu Gln Ile Ala Ala Phe Lys Thr Val Glu Glu Lys
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Ser Ile Lys Glu Thr Leu Ser Leu Leu Phe Asp Asp Leu Lys Ala Gln
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Lys Leu Asp Leu Ser Lys Ile Tyr Phe Lys Asn Asp Lys Ser Leu Thr
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Asp Asn Leu Ala Gln Ile Ser Ile Lys Tyr Gln Asn Gln Gly Lys Lys
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Ile Ser Gln Ser Glu Asp Lys Ala Asn Ile Leu Asp Lys Asp Glu His
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Trp Asp Lys Asn Lys Glu Pro Asp Asn Thr Ala Ile Leu Phe Ile Lys
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Asp Asp Lys Tyr Tyr Leu Gly Val Met Asn Lys Lys Asn Asn Lys Ile
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Phe Asp Asp Lys Ala Ile Lys Glu Asn Lys Gly Glu Gly Tyr Lys Lys
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Ile Val Tyr Lys Leu Leu Pro Gly Ala Asn Lys Met Leu Pro Lys Val
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Phe Phe Ser Ala Lys Ser Ile Lys Phe Tyr Asn Pro Ser Glu Asp Ile
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Leu Arg Ile Arg Asn His Ser Thr His Thr Lys Asn Gly Ser Pro Gln
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Pro Asn Leu His Thr Leu Tyr Trp Lys Ala Leu Phe Asp Glu Arg Asn
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Ile Leu Ser Ile Asp Arg Gly Glu Arg His Leu Ala Tyr Tyr Thr Leu
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Val Asp Gly Lys Gly Asn Ile Ile Lys Gln Asp Thr Phe Asn Ile Ile
930 935 940

Gly Asn Asp Arg Met Lys Thr Asn Tyr His Asp Lys Leu Ala Ala Ile
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Glu Lys Asp Arg Asp Ser Ala Arg Lys Asp Trp Lys Lys Ile Asn Asn
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Ile Lys Glu Met Lys Glu Gly Tyr Leu Ser Gln Val Val His Glu Ile
980 985 990

Ala Lys Leu Val Ile Glu Tyr Asn Ala Ile Val Val Phe Glu Asp Leu
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Asp Tyr Glu Lys Leu Lys Lys Val Ile Asp Glu Tyr His Glu Asp Phe
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Ile Ala Asn Ile Leu Ser Ser Phe Ser Phe Ser Glu Glu Ile Leu Gln
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Ser Tyr Ile Gln Asn Leu Ser Glu Ser Glu Ala Arg Ala Lys Ile Glu
85 90 95

Lys Thr Met Arg Asp Thr Leu Ala Lys Ala Phe Ser Glu Asp Glu Arg
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Tyr Lys Ser Ile Phe Lys Lys Glu Leu Val Lys Lys Asp Ile Pro Val
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Trp Cys Pro Ala Tyr Lys Ser Leu Cys Lys Lys Phe Asp Asn Phe Thr
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Thr Ser Leu Val Pro Phe His Glu Asn Arg Lys Asn Leu Tyr Thr Ser
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Asn Glu Ile Thr Ala Ser Ile Pro Tyr Arg Ile Val His Val Asn Leu
165 170 175

Pro Lys Phe Ile Gln Asn Ile Glu Ala Leu Cys Glu Leu Gln Lys Lys
180 185 190

Met Gly Ala Asp Leu Tyr Leu Glu Met Met Glu Asn Leu Arg Asn Val
195 200 205

Trp Pro Ser Phe Val Lys Thr Pro Asp Asp Leu Cys Asn Leu Lys Thr
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Tyr Asn His Leu Met Val Gln Ser Ser Ile Ser Glu Tyr Asn Arg Phe
225 230 235 240

Val Gly Gly Tyr Ser Thr Glu Asp Gly Thr Lys His Gln Gly Ile Asn
245 250 255

Glu Trp Ile Asn Ile Tyr Arg Gln Arg Asn Lys Glu Met Arg Leu Pro
260 265 270

Gly Leu Val Phe Leu His Lys Gln Ile Leu Ala Lys Val Asp Ser Ser
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Ser Phe Ile Ser Asp Thr Leu Glu Asn Asp Asp Gln Val Phe Cys Val
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Leu Arg Gln Phe Arg Lys Leu Phe Trp Asn Thr Val Ser Ser Lys Glu
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Asp Asp Ala Ala Ser Leu Lys Asp Leu Phe Cys Gly Leu Ser Gly Tyr
325 330 335

Asp Pro Glu Ala Ile Tyr Val Ser Asp Ala His Leu Ala Thr Ile Ser
340 345 350

Lys Asn Ile Phe Asp Arg Trp Asn Tyr Ile Ser Asp Ala Ile Arg Arg
355 360 365

Lys Thr Glu Val Leu Met Pro Arg Lys Lys Glu Ser Val Glu Arg Tyr
370 375 380

Ala Glu Lys Ile Ser Lys Gln Ile Lys Lys Arg Gln Ser Tyr Ser Leu
385 390 395 400

Ala Glu Leu Asp Asp Leu Leu Ala His Tyr Ser Glu Glu Ser Leu Pro
405 410 415

Ala Gly Phe Ser Leu Leu Ser Tyr Phe Thr Ser Leu Gly Gly Gln Lys

420

425

430

Tyr Leu Val Ser Asp Gly Glu Val Ile Leu Tyr Glu Glu Gly Ser Asn
 435 440 445

Ile Trp Asp Glu Val Leu Ile Ala Phe Arg Asp Leu Gln Val Ile Leu
 450 455 460

Asp Lys Asp Phe Thr Glu Lys Lys Leu Gly Lys Asp Glu Glu Ala Val
 465 470 475 480

Ser Val Ile Lys Lys Ala Leu Asp Ser Ala Leu Arg Leu Arg Lys Phe
 485 490 495

Phe Asp Leu Leu Ser Gly Thr Gly Ala Glu Ile Arg Arg Asp Ser Ser
 500 505 510

Phe Tyr Ala Leu Tyr Thr Asp Arg Met Asp Lys Leu Lys Gly Leu Leu
 515 520 525

Lys Met Tyr Asp Lys Val Arg Asn Tyr Leu Thr Lys Lys Pro Tyr Ser
 530 535 540

Ile Glu Lys Phe Lys Leu His Phe Asp Asn Pro Ser Leu Leu Ser Gly
 545 550 555 560

Trp Asp Lys Asn Lys Glu Leu Asn Asn Leu Ser Val Ile Phe Arg Gln
 565 570 575

Asn Gly Tyr Tyr Tyr Leu Gly Ile Met Thr Pro Lys Gly Lys Asn Leu
 580 585 590

Phe Lys Thr Leu Pro Lys Leu Gly Ala Glu Glu Met Phe Tyr Glu Lys
 595 600 605

Met Glu Tyr Lys Gln Ile Ala Glu Pro Met Leu Met Leu Pro Lys Val
 610 615 620

Phe Phe Pro Lys Lys Thr Lys Pro Ala Phe Ala Pro Asp Gln Ser Val
 625 630 635 640

Val Asp Ile Tyr Asn Lys Lys Thr Phe Lys Thr Gly Gln Lys Gly Phe
645 650 655

Asn Lys Lys Asp Leu Tyr Arg Leu Ile Asp Phe Tyr Lys Glu Ala Leu
660 665 670

Thr Val His Glu Trp Lys Leu Phe Asn Phe Ser Phe Ser Pro Thr Glu
675 680 685

Gln Tyr Arg Asn Ile Gly Glu Phe Phe Asp Glu Val Arg Glu Gln Ala
690 695 700

Tyr Lys Val Ser Met Val Asn Val Pro Ala Ser Tyr Ile Asp Glu Ala
705 710 715 720

Val Glu Asn Gly Lys Leu Tyr Leu Phe Gln Ile Tyr Asn Lys Asp Phe
725 730 735

Ser Pro Tyr Ser Lys Gly Ile Pro Asn Leu His Thr Leu Tyr Trp Lys
740 745 750

Ala Leu Phe Ser Glu Gln Asn Gln Ser Arg Val Tyr Lys Leu Cys Gly
755 760 765

Gly Gly Glu Leu Phe Tyr Arg Lys Ala Ser Leu His Met Gln Asp Thr
770 775 780

Thr Val His Pro Lys Gly Ile Ser Ile His Lys Lys Asn Leu Asn Lys
785 790 795 800

Lys Gly Glu Thr Ser Leu Phe Asn Tyr Asp Leu Val Lys Asp Lys Arg
805 810 815

Phe Thr Glu Asp Lys Phe Phe Phe His Val Pro Ile Ser Ile Asn Tyr
820 825 830

Lys Asn Lys Lys Ile Thr Asn Val Asn Gln Met Val Arg Asp Tyr Ile
835 840 845

Ala Gln Asn Asp Asp Leu Gln Ile Ile Gly Ile Asp Arg Gly Glu Arg

850

855

860

Asn Leu Leu Tyr Ile Ser Arg Ile Asp Thr Arg Gly Asn Leu Leu Glu
 865 870 875 880

Gln Phe Ser Leu Asn Val Ile Glu Ser Asp Lys Gly Asp Leu Arg Thr
 885 890 895

Asp Tyr Gln Lys Ile Leu Gly Asp Arg Glu Gln Glu Arg Leu Arg Arg
 900 905 910

Arg Gln Glu Trp Lys Ser Ile Glu Ser Ile Lys Asp Leu Lys Asp Gly
 915 920 925

Tyr Met Ser Gln Val Val His Lys Ile Cys Asn Met Val Val Glu His
 930 935 940

Lys Ala Ile Val Val Leu Glu Asn Leu Asn Leu Ser Phe Met Lys Gly
 945 950 955 960

Arg Lys Lys Val Glu Lys Ser Val Tyr Glu Lys Phe Glu Arg Met Leu
 965 970 975

Val Asp Lys Leu Asn Tyr Leu Val Val Asp Lys Lys Asn Leu Ser Asn
 980 985 990

Glu Pro Gly Gly Leu Tyr Ala Ala Tyr Gln Leu Thr Asn Pro Leu Phe
 995 1000 1005

Ser Phe Glu Glu Leu His Arg Tyr Pro Gln Ser Gly Ile Leu Phe
 1010 1015 1020

Phe Val Asp Pro Trp Asn Thr Ser Leu Thr Asp Pro Ser Thr Gly
 1025 1030 1035

Phe Val Asn Leu Leu Gly Arg Ile Asn Tyr Thr Asn Val Gly Asp
 1040 1045 1050

Ala Arg Lys Phe Phe Asp Arg Phe Asn Ala Ile Arg Tyr Asp Gly
 1055 1060 1065

Lys Gly Asn Ile Leu Phe Asp Leu Asp Leu Ser Arg Phe Asp Val
1070 1075 1080

Arg Val Glu Thr Gln Arg Lys Leu Trp Thr Leu Thr Thr Phe Gly
1085 1090 1095

Ser Arg Ile Ala Lys Ser Lys Lys Ser Gly Lys Trp Met Val Glu
1100 1105 1110

Arg Ile Glu Asn Leu Ser Leu Cys Phe Leu Glu Leu Phe Glu Gln
1115 1120 1125

Phe Asn Ile Gly Tyr Arg Val Glu Lys Asp Leu Lys Lys Ala Ile
1130 1135 1140

Leu Ser Gln Asp Arg Lys Glu Phe Tyr Val Arg Leu Ile Tyr Leu
1145 1150 1155

Phe Asn Leu Met Met Gln Ile Arg Asn Ser Asp Gly Glu Glu Asp
1160 1165 1170

Tyr Ile Leu Ser Pro Ala Leu Asn Glu Lys Asn Leu Gln Phe Asp
1175 1180 1185

Ser Arg Leu Ile Glu Ala Lys Asp Leu Pro Val Asp Ala Asp Ala
1190 1195 1200

Asn Gly Ala Tyr Asn Val Ala Arg Lys Gly Leu Met Val Val Gln
1205 1210 1215

Arg Ile Lys Arg Gly Asp His Glu Ser Ile His Arg Ile Gly Arg
1220 1225 1230

Ala Gln Trp Leu Arg Tyr Val Gln Glu Gly Ile Val Glu
1235 1240 1245

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<213> Moraxella bovoculi

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Met Leu Phe Gln Asp Phe Thr His Leu Tyr Pro Leu Ser Lys Thr Val
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Arg Phe Glu Leu Lys Pro Ile Asp Arg Thr Leu Glu His Ile His Ala
20 25 30

Lys Asn Phe Leu Ser Gln Asp Glu Thr Met Ala Asp Met His Gln Lys
35 40 45

Val Lys Val Ile Leu Asp Asp Tyr His Arg Asp Phe Ile Ala Asp Met
50 55 60

Met Gly Glu Val Lys Leu Thr Lys Leu Ala Glu Phe Tyr Asp Val Tyr
65 70 75 80

Leu Lys Phe Arg Lys Asn Pro Lys Asp Asp Glu Leu Gln Lys Gln Leu
85 90 95

Lys Asp Leu Gln Ala Val Leu Arg Lys Glu Ile Val Lys Pro Ile Gly
100 105 110

Asn Gly Gly Lys Tyr Lys Ala Gly Tyr Asp Arg Leu Phe Gly Ala Lys
115 120 125

Leu Phe Lys Asp Gly Lys Glu Leu Gly Asp Leu Ala Lys Phe Val Ile
130 135 140

Ala Gln Glu Gly Glu Ser Ser Pro Lys Leu Ala His Leu Ala His Phe
145 150 155 160

Glu Lys Phe Ser Thr Tyr Phe Thr Gly Phe His Asp Asn Arg Lys Asn
165 170 175

Met Tyr Ser Asp Glu Asp Lys His Thr Ala Ile Ala Tyr Arg Leu Ile
180 185 190

His Glu Asn Leu Pro Arg Phe Ile Asp Asn Leu Gln Ile Leu Thr Thr
195 200 205

Ile Lys Gln Lys His Ser Ala Leu Tyr Asp Gln Ile Ile Asn Glu Leu
210 215 220

Thr Ala Ser Gly Leu Asp Val Ser Leu Ala Ser His Leu Asp Gly Tyr
225 230 235 240

His Lys Leu Leu Thr Gln Glu Gly Ile Thr Ala Tyr Asn Thr Leu Leu
245 250 255

Gly Gly Ile Ser Gly Glu Ala Gly Ser Pro Lys Ile Gln Gly Ile Asn
260 265 270

Glu Leu Ile Asn Ser His His Asn Gln His Cys His Lys Ser Glu Arg
275 280 285

Ile Ala Lys Leu Arg Pro Leu His Lys Gln Ile Leu Ser Asp Gly Met
290 295 300

Ser Val Ser Phe Leu Pro Ser Lys Phe Ala Asp Asp Ser Glu Met Cys
305 310 315 320

Gln Ala Val Asn Glu Phe Tyr Arg His Tyr Ala Asp Val Phe Ala Lys
325 330 335

Val Gln Ser Leu Phe Asp Gly Phe Asp Asp His Gln Lys Asp Gly Ile
340 345 350

Tyr Val Glu His Lys Asn Leu Asn Glu Leu Ser Lys Gln Ala Phe Gly
355 360 365

Asp Phe Ala Leu Leu Gly Arg Val Leu Asp Gly Tyr Tyr Val Asp Val
370 375 380

Val Asn Pro Glu Phe Asn Glu Arg Phe Ala Lys Ala Lys Thr Asp Asn
385 390 395 400

Ala Lys Ala Lys Leu Thr Lys Glu Lys Asp Lys Phe Ile Lys Gly Val
405 410 415

His Ser Leu Ala Ser Leu Glu Gln Ala Ile Glu His Tyr Thr Ala Arg
420 425 430

His Asp Asp Glu Ser Val Gln Ala Gly Lys Leu Gly Gln Tyr Phe Lys
435 440 445

His Gly Leu Ala Gly Val Asp Asn Pro Ile Gln Lys Ile His Asn Asn
450 455 460

His Ser Thr Ile Lys Gly Phe Leu Glu Arg Glu Arg Pro Ala Gly Glu
465 470 475 480

Arg Ala Leu Pro Lys Ile Lys Ser Gly Lys Asn Pro Glu Met Thr Gln
485 490 495

Leu Arg Gln Leu Lys Glu Leu Leu Asp Asn Ala Leu Asn Val Ala His
500 505 510

Phe Ala Lys Leu Leu Thr Thr Lys Thr Thr Leu Asp Asn Gln Asp Gly
515 520 525

Asn Phe Tyr Gly Glu Phe Gly Val Leu Tyr Asp Glu Leu Ala Lys Ile
530 535 540

Pro Thr Leu Tyr Asn Lys Val Arg Asp Tyr Leu Ser Gln Lys Pro Phe
545 550 555 560

Ser Thr Glu Lys Tyr Lys Leu Asn Phe Gly Asn Pro Thr Leu Leu Asn
565 570 575

Gly Trp Asp Leu Asn Lys Glu Lys Asp Asn Phe Gly Val Ile Leu Gln
580 585 590

Lys Asp Gly Cys Tyr Tyr Leu Ala Leu Leu Asp Lys Ala His Lys Lys
595 600 605

Val Phe Asp Asn Ala Pro Asn Thr Gly Lys Ser Ile Tyr Gln Lys Met
610 615 620

Ile Tyr Lys Tyr Leu Glu Val Arg Lys Gln Phe Pro Lys Val Phe Phe
625 630 635 640

Ser Lys Glu Ala Ile Ala Ile Asn Tyr His Pro Ser Lys Glu Leu Val
645 650 655

Glu Ile Lys Asp Lys Gly Arg Gln Arg Ser Asp Asp Glu Arg Leu Lys
660 665 670

Leu Tyr Arg Phe Ile Leu Glu Cys Leu Lys Ile His Pro Lys Tyr Asp
675 680 685

Lys Lys Phe Glu Gly Ala Ile Gly Asp Ile Gln Leu Phe Lys Lys Asp
690 695 700

Lys Lys Gly Arg Glu Val Pro Ile Ser Glu Lys Asp Leu Phe Asp Lys
705 710 715 720

Ile Asn Gly Ile Phe Ser Ser Lys Pro Lys Leu Glu Met Glu Asp Phe
725 730 735

Phe Ile Gly Glu Phe Lys Arg Tyr Asn Pro Ser Gln Asp Leu Val Asp
740 745 750

Gln Tyr Asn Ile Tyr Lys Lys Ile Asp Ser Asn Asp Asn Arg Lys Lys
755 760 765

Glu Asn Phe Tyr Asn Asn His Pro Lys Phe Lys Lys Asp Leu Val Arg
770 775 780

Tyr Tyr Tyr Glu Ser Met Cys Lys His Glu Glu Trp Glu Glu Ser Phe
785 790 795 800

Glu Phe Ser Lys Lys Leu Gln Asp Ile Gly Cys Tyr Val Asp Val Asn
805 810 815

Glu Leu Phe Thr Glu Ile Glu Thr Arg Arg Leu Asn Tyr Lys Ile Ser
820 825 830

Phe Cys Asn Ile Asn Ala Asp Tyr Ile Asp Glu Leu Val Glu Gln Gly
835 840 845

Gln Leu Tyr Leu Phe Gln Ile Tyr Asn Lys Asp Phe Ser Pro Lys Ala
850 855 860

His Gly Lys Pro Asn Leu His Thr Leu Tyr Phe Lys Ala Leu Phe Ser
865 870 875 880

Glu Asp Asn Leu Ala Asp Pro Ile Tyr Lys Leu Asn Gly Glu Ala Gln
885 890 895

Ile Phe Tyr Arg Lys Ala Ser Leu Asp Met Asn Glu Thr Thr Ile His
900 905 910

Arg Ala Gly Glu Val Leu Glu Asn Lys Asn Pro Asp Asn Pro Lys Lys
915 920 925

Arg Gln Phe Val Tyr Asp Ile Ile Lys Asp Lys Arg Tyr Thr Gln Asp
930 935 940

Lys Phe Met Leu His Val Pro Ile Thr Met Asn Phe Gly Val Gln Gly
945 950 955 960

Met Thr Ile Lys Glu Phe Asn Lys Lys Val Asn Gln Ser Ile Gln Gln
965 970 975

Tyr Asp Glu Val Asn Val Ile Gly Ile Asp Arg Gly Glu Arg His Leu
980 985 990

Leu Tyr Leu Thr Val Ile Asn Ser Lys Gly Glu Ile Leu Glu Gln Cys
995 1000 1005

Ser Leu Asn Asp Ile Thr Thr Ala Ser Ala Asn Gly Thr Gln Met
1010 1015 1020

Thr Thr Pro Tyr His Lys Ile Leu Asp Lys Arg Glu Ile Glu Arg
1025 1030 1035

Leu Asn Ala Arg Val Gly Trp Gly Glu Ile Glu Thr Ile Lys Glu
1040 1045 1050

Leu Lys Ser Gly Tyr Leu Ser His Val Val His Gln Ile Ser Gln
1055 1060 1065

Leu 1070	Met	Leu	Lys	Tyr	Asn	Ala 1075	Ile	Val	Val	Leu	Glu 1080	Asp	Leu	Asn
Phe 1085	Gly	Phe	Lys	Arg	Gly	Arg 1090	Phe	Lys	Val	Glu	Lys 1095	Gln	Ile	Tyr
Gln 1100	Asn	Phe	Glu	Asn	Ala	Leu 1105	Ile	Lys	Lys	Leu	Asn 1110	His	Leu	Val
Leu 1115	Lys	Asp	Lys	Ala	Asp	Asp 1120	Glu	Ile	Gly	Ser	Tyr 1125	Lys	Asn	Ala
Leu 1130	Gln	Leu	Thr	Asn	Asn	Phe 1135	Thr	Asp	Leu	Lys	Ser 1140	Ile	Gly	Lys
Gln 1145	Thr	Gly	Phe	Leu	Phe	Tyr 1150	Val	Pro	Ala	Trp	Asn 1155	Thr	Ser	Lys
Ile 1160	Asp	Pro	Glu	Thr	Gly	Phe 1165	Val	Asp	Leu	Leu	Lys 1170	Pro	Arg	Tyr
Glu 1175	Asn	Ile	Ala	Gln	Ser	Gln 1180	Ala	Phe	Phe	Gly	Lys 1185	Phe	Asp	Lys
Ile 1190	Cys	Tyr	Asn	Ala	Asp	Lys 1195	Asp	Tyr	Phe	Glu	Phe 1200	His	Ile	Asp
Tyr 1205	Ala	Lys	Phe	Thr	Asp	Lys 1210	Ala	Lys	Asn	Ser	Arg 1215	Gln	Ile	Trp
Thr 1220	Ile	Cys	Ser	His	Gly	Asp 1225	Lys	Arg	Tyr	Val	Tyr 1230	Asp	Lys	Thr
Ala 1235	Asn	Gln	Asn	Lys	Gly	Ala 1240	Ala	Lys	Gly	Ile	Asn 1245	Val	Asn	Asp
Glu 1250	Leu	Lys	Ser	Leu	Phe	Ala 1255	Arg	His	His	Ile	Asn 1260	Glu	Lys	Gln
Pro 1265	Asn	Leu	Val	Met	Asp	Ile 1270	Cys	Gln	Asn	Asn	Asp 1275	Lys	Glu	Phe

His Lys Ser Leu Met Tyr Leu Leu Lys Thr Leu Leu Ala Leu Arg
1280 1285 1290

Tyr Ser Asn Ala Ser Ser Asp Glu Asp Phe Ile Leu Ser Pro Val
1295 1300 1305

Ala Asn Asp Glu Gly Val Phe Phe Asn Ser Ala Leu Ala Asp Asp
1310 1315 1320

Thr Gln Pro Gln Asn Ala Asp Ala Asn Gly Ala Tyr His Ile Ala
1325 1330 1335

Leu Lys Gly Leu Trp Leu Leu Asn Glu Leu Lys Asn Ser Asp Asp
1340 1345 1350

Leu Asn Lys Val Lys Leu Ala Ile Asp Asn Gln Thr Trp Leu Asn
1355 1360 1365

Phe Ala Gln Asn Arg
1370

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Met Gly Ile His Gly Val Pro Ala Ala Leu Phe Gln Asp Phe Thr His
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Leu Tyr Pro Leu Ser Lys Thr Val Arg Phe Glu Leu Lys Pro Ile Gly
20 25 30

Arg Thr Leu Glu His Ile His Ala Lys Asn Phe Leu Ser Gln Asp Glu
35 40 45

Thr Met Ala Asp Met Tyr Gln Lys Val Lys Val Ile Leu Asp Asp Tyr
50 55 60

His Arg Asp Phe Ile Ala Asp Met Met Gly Glu Val Lys Leu Thr Lys

80

95

110

125

140

160

175

190

205

220

240

255

270

285

Pro Leu His Lys Gln Ile Leu Ser Asp Gly Met Gly Val Ser Phe Leu
290 295 300

Pro Ser Lys Phe Ala Asp Asp Ser Glu Met Cys Gln Ala Val Asn Glu
305 310 315 320

Phe Tyr Arg His Tyr Thr Asp Val Phe Ala Lys Val Gln Ser Leu Phe
325 330 335

Asp Gly Phe Asp Asp His Gln Lys Asp Gly Ile Tyr Val Glu His Lys
340 345 350

Asn Leu Asn Glu Leu Ser Lys Gln Ala Phe Gly Asp Phe Ala Leu Leu
355 360 365

Gly Arg Val Leu Asp Gly Tyr Tyr Val Asp Val Val Asn Pro Glu Phe
370 375 380

Asn Glu Arg Phe Ala Lys Ala Lys Thr Asp Asn Ala Lys Ala Lys Leu
385 390 395 400

Thr Lys Glu Lys Asp Lys Phe Ile Lys Gly Val His Ser Leu Ala Ser
405 410 415

Leu Glu Gln Ala Ile Glu His His Thr Ala Arg His Asp Asp Glu Ser
420 425 430

Val Gln Ala Gly Lys Leu Gly Gln Tyr Phe Lys His Gly Leu Ala Gly
435 440 445

Val Asp Asn Pro Ile Gln Lys Ile His Asn Asn His Ser Thr Ile Lys
450 455 460

Gly Phe Leu Glu Arg Glu Arg Pro Ala Gly Glu Arg Ala Leu Pro Lys
465 470 475 480

Ile Lys Ser Gly Lys Asn Pro Glu Met Thr Gln Leu Arg Gln Leu Lys
485 490 495

Glu Leu Leu Asp Asn Ala Leu Asn Val Ala His Phe Ala Lys Leu Leu

500

505

510

Thr Thr Lys Thr Thr Leu Asp Asn Gln Asp Gly Asn Phe Tyr Gly Glu
 515 520 525

Phe Gly Val Leu Tyr Asp Glu Leu Ala Lys Ile Pro Thr Leu Tyr Asn
 530 535 540

Lys Val Arg Asp Tyr Leu Ser Gln Lys Pro Phe Ser Thr Glu Lys Tyr
 545 550 555 560

Lys Leu Asn Phe Gly Asn Pro Thr Leu Leu Asn Gly Trp Asp Leu Asn
 565 570 575

Lys Glu Lys Asp Asn Phe Gly Val Ile Leu Gln Lys Asp Gly Cys Tyr
 580 585 590

Tyr Leu Ala Leu Leu Asp Lys Ala His Lys Lys Val Phe Asp Asn Ala
 595 600 605

Pro Asn Thr Gly Lys Asn Val Tyr Gln Lys Met Val Tyr Lys Leu Leu
 610 615 620

Pro Gly Pro Asn Lys Met Leu Pro Lys Val Phe Phe Ala Lys Ser Asn
 625 630 635 640

Leu Asp Tyr Tyr Asn Pro Ser Ala Glu Leu Leu Asp Lys Tyr Ala Lys
 645 650 655

Gly Thr His Lys Lys Gly Asp Asn Phe Asn Leu Lys Asp Cys His Ala
 660 665 670

Leu Ile Asp Phe Phe Lys Ala Gly Ile Asn Lys His Pro Glu Trp Gln
 675 680 685

His Phe Gly Phe Lys Phe Ser Pro Thr Ser Ser Tyr Arg Asp Leu Ser
 690 695 700

Asp Phe Tyr Arg Glu Val Glu Pro Gln Gly Tyr Gln Val Lys Phe Val
 705 710 715 720

Asp Ile Asn Ala Asp Tyr Ile Asp Glu Leu Val Glu Gln Gly Lys Leu
725 730 735

Tyr Leu Phe Gln Ile Tyr Asn Lys Asp Phe Ser Pro Lys Ala His Gly
740 745 750

Lys Pro Asn Leu His Thr Leu Tyr Phe Lys Ala Leu Phe Ser Glu Asp
755 760 765

Asn Leu Ala Asp Pro Ile Tyr Lys Leu Asn Gly Glu Ala Gln Ile Phe
770 775 780

Tyr Arg Lys Ala Ser Leu Asp Met Asn Glu Thr Thr Ile His Arg Ala
785 790 795 800

Gly Glu Val Leu Glu Asn Lys Asn Pro Asp Asn Pro Lys Lys Arg Gln
805 810 815

Phe Val Tyr Asp Ile Ile Lys Asp Lys Arg Tyr Thr Gln Asp Lys Phe
820 825 830

Met Leu His Val Pro Ile Thr Met Asn Phe Gly Val Gln Gly Met Thr
835 840 845

Ile Lys Glu Phe Asn Lys Lys Val Asn Gln Ser Ile Gln Gln Tyr Asp
850 855 860

Glu Val Asn Val Ile Gly Ile Asp Arg Gly Glu Arg His Leu Leu Tyr
865 870 875 880

Leu Thr Val Ile Asn Ser Lys Gly Glu Ile Leu Glu Gln Arg Ser Leu
885 890 895

Asn Asp Ile Thr Thr Ala Ser Ala Asn Gly Thr Gln Val Thr Thr Pro
900 905 910

Tyr His Lys Ile Leu Asp Lys Arg Glu Ile Glu Arg Leu Asn Ala Arg
915 920 925

Val Gly Trp Gly Glu Ile Glu Thr Ile Lys Glu Leu Lys Ser Gly Tyr

930

935

940

Leu Ser His Val Val His Gln Ile Asn Gln Leu Met Leu Lys Tyr Asn
 945 950 955 960

Ala Ile Val Val Leu Glu Asp Leu Asn Phe Gly Phe Lys Arg Gly Arg
 965 970 975

Phe Lys Val Glu Lys Gln Ile Tyr Gln Asn Phe Glu Asn Ala Leu Ile
 980 985 990

Lys Lys Leu Asn His Leu Val Leu Lys Asp Lys Ala Asp Asp Glu Ile
 995 1000 1005

Gly Ser Tyr Lys Asn Ala Leu Gln Leu Thr Asn Asn Phe Thr Asp
 1010 1015 1020

Leu Lys Ser Ile Gly Lys Gln Thr Gly Phe Leu Phe Tyr Val Pro
 1025 1030 1035

Ala Trp Asn Thr Ser Lys Ile Asp Pro Glu Thr Gly Phe Val Asp
 1040 1045 1050

Leu Leu Lys Pro Arg Tyr Glu Asn Ile Ala Gln Ser Gln Ala Phe
 1055 1060 1065

Phe Gly Lys Phe Asp Lys Ile Cys Tyr Asn Thr Asp Lys Gly Tyr
 1070 1075 1080

Phe Glu Phe His Ile Asp Tyr Ala Lys Phe Thr Asp Lys Ala Lys
 1085 1090 1095

Asn Ser Arg Gln Lys Trp Ala Ile Cys Ser His Gly Asp Lys Arg
 1100 1105 1110

Tyr Val Tyr Asp Lys Thr Ala Asn Gln Asn Lys Gly Ala Ala Lys
 1115 1120 1125

Gly Ile Asn Val Asn Asp Glu Leu Lys Ser Leu Phe Ala Arg Tyr
 1130 1135 1140

His Ile Asn Asp Lys Gln Pro Asn Leu Val Met Asp Ile Cys Gln
1145 1150 1155

Asn Asn Asp Lys Glu Phe His Lys Ser Leu Met Cys Leu Leu Lys
1160 1165 1170

Thr Leu Leu Ala Leu Arg Tyr Ser Asn Ala Ser Ser Asp Glu Asp
1175 1180 1185

Phe Ile Leu Ser Pro Val Ala Asn Asp Glu Gly Val Phe Phe Asn
1190 1195 1200

Ser Ala Leu Ala Asp Asp Thr Gln Pro Gln Asn Ala Asp Ala Asn
1205 1210 1215

Gly Ala Tyr His Ile Ala Leu Lys Gly Leu Trp Leu Leu Asn Glu
1220 1225 1230

Leu Lys Asn Ser Asp Asp Leu Asn Lys Val Lys Leu Ala Ile Asp
1235 1240 1245

Asn Gln Thr Trp Leu Asn Phe Ala Gln Asn Arg
1250 1255

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<213> Moraxella bovoculi

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Met Gly Ile His Gly Val Pro Ala Ala Leu Phe Gln Asp Phe Thr His
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Leu Tyr Pro Leu Ser Lys Thr Val Arg Phe Glu Leu Lys Pro Ile Gly
20 25 30

Lys Thr Leu Glu His Ile His Ala Lys Asn Phe Leu Asn Gln Asp Glu
35 40 45

Thr Met Ala Asp Met Tyr Gln Lys Val Lys Ala Ile Leu Asp Asp Tyr
50 55 60

His Arg Asp Phe Ile Ala Asp Met Met Gly Glu Val Lys Leu Thr Lys
65 70 75 80

Leu Ala Glu Phe Tyr Asp Val Tyr Leu Lys Phe Arg Lys Asn Pro Lys
85 90 95

Asp Asp Gly Leu Gln Lys Gln Leu Lys Asp Leu Gln Ala Val Leu Arg
100 105 110

Lys Glu Ile Val Lys Pro Ile Gly Asn Gly Gly Lys Tyr Lys Ala Gly
115 120 125

Tyr Asp Arg Leu Phe Gly Ala Lys Leu Phe Lys Asp Gly Lys Glu Leu
130 135 140

Gly Asp Leu Ala Lys Phe Val Ile Ala Gln Glu Gly Glu Ser Ser Pro
145 150 155 160

Lys Leu Ala His Leu Ala His Phe Glu Lys Phe Ser Thr Tyr Phe Thr
165 170 175

Gly Phe His Asp Asn Arg Lys Asn Met Tyr Ser Asp Glu Asp Lys His
180 185 190

Thr Ala Ile Ala Tyr Arg Leu Ile His Glu Asn Leu Pro Arg Phe Ile
195 200 205

Asp Asn Leu Gln Ile Leu Ala Thr Ile Lys Gln Lys His Ser Ala Leu
210 215 220

Tyr Asp Gln Ile Ile Asn Glu Leu Thr Ala Ser Gly Leu Asp Val Ser
225 230 235 240

Leu Ala Ser His Leu Asp Gly Tyr His Lys Leu Leu Thr Gln Glu Gly
245 250 255

Ile Thr Ala Tyr Asn Thr Leu Leu Gly Gly Ile Ser Gly Glu Ala Gly
260 265 270

Ser Arg Lys Ile Gln Gly Ile Asn Glu Leu Ile Asn Ser His His Asn
275 280 285

Gln His Cys His Lys Ser Glu Arg Ile Ala Lys Leu Arg Pro Leu His
290 295 300

Lys Gln Ile Leu Ser Asp Gly Met Gly Val Ser Phe Leu Pro Ser Lys
305 310 315 320

Phe Ala Asp Asp Ser Glu Val Cys Gln Ala Val Asn Glu Phe Tyr Arg
325 330 335

His Tyr Ala Asp Val Phe Ala Lys Val Gln Ser Leu Phe Asp Gly Phe
340 345 350

Asp Asp Tyr Gln Lys Asp Gly Ile Tyr Val Glu Tyr Lys Asn Leu Asn
355 360 365

Glu Leu Ser Lys Gln Ala Phe Gly Asp Phe Ala Leu Leu Gly Arg Val
370 375 380

Leu Asp Gly Tyr Tyr Val Asp Val Val Asn Pro Glu Phe Asn Glu Arg
385 390 395 400

Phe Ala Lys Ala Lys Thr Asp Asn Ala Lys Ala Lys Leu Thr Lys Glu
405 410 415

Lys Asp Lys Phe Ile Lys Gly Val His Ser Leu Ala Ser Leu Glu Gln
420 425 430

Ala Ile Glu His Tyr Thr Ala Arg His Asp Asp Glu Ser Val Gln Ala
435 440 445

Gly Lys Leu Gly Gln Tyr Phe Lys His Gly Leu Ala Gly Val Asp Asn
450 455 460

Pro Ile Gln Lys Ile His Asn Asn His Ser Thr Ile Lys Gly Phe Leu
465 470 475 480

Glu Arg Glu Arg Pro Ala Gly Glu Arg Ala Leu Pro Lys Ile Lys Ser
485 490 495

Asp Lys Ser Pro Glu Ile Arg Gln Leu Lys Glu Leu Leu Asp Asn Ala
500 505 510

Leu Asn Val Ala His Phe Ala Lys Leu Leu Thr Thr Lys Thr Thr Leu
515 520 525

His Asn Gln Asp Gly Asn Phe Tyr Gly Glu Phe Gly Ala Leu Tyr Asp
530 535 540

Glu Leu Ala Lys Ile Ala Thr Leu Tyr Asn Lys Val Arg Asp Tyr Leu
545 550 555 560

Ser Gln Lys Pro Phe Ser Thr Glu Lys Tyr Lys Leu Asn Phe Gly Asn
565 570 575

Pro Thr Leu Leu Asn Gly Trp Asp Leu Asn Lys Glu Lys Asp Asn Phe
580 585 590

Gly Val Ile Leu Gln Lys Asp Gly Cys Tyr Tyr Leu Ala Leu Leu Asp
595 600 605

Lys Ala His Lys Lys Val Phe Asp Asn Ala Pro Asn Thr Gly Lys Ser
610 615 620

Val Tyr Gln Lys Met Ile Tyr Lys Leu Leu Pro Gly Pro Asn Lys Met
625 630 635 640

Leu Pro Lys Val Phe Phe Ala Lys Ser Asn Leu Asp Tyr Tyr Asn Pro
645 650 655

Ser Ala Glu Leu Leu Asp Lys Tyr Ala Gln Gly Thr His Lys Lys Gly
660 665 670

Asp Asn Phe Asn Leu Lys Asp Cys His Ala Leu Ile Asp Phe Phe Lys
675 680 685

Ala Gly Ile Asn Lys His Pro Glu Trp Gln His Phe Gly Phe Lys Phe
690 695 700

Ser Pro Thr Ser Ser Tyr Gln Asp Leu Ser Asp Phe Tyr Arg Glu Val
705 710 715 720

Glu Pro Gln Gly Tyr Gln Val Lys Phe Val Asp Ile Asn Ala Asp Tyr
725 730 735

Ile Asn Glu Leu Val Glu Gln Gly Gln Leu Tyr Leu Phe Gln Ile Tyr
740 745 750

Asn Lys Asp Phe Ser Pro Lys Ala His Gly Lys Pro Asn Leu His Thr
755 760 765

Leu Tyr Phe Lys Ala Leu Phe Ser Glu Asp Asn Leu Val Asn Pro Ile
770 775 780

Tyr Lys Leu Asn Gly Glu Ala Glu Ile Phe Tyr Arg Lys Ala Ser Leu
785 790 795 800

Asp Met Asn Glu Thr Thr Ile His Arg Ala Gly Glu Val Leu Glu Asn
805 810 815

Lys Asn Pro Asp Asn Pro Lys Lys Arg Gln Phe Val Tyr Asp Ile Ile
820 825 830

Lys Asp Lys Arg Tyr Thr Gln Asp Lys Phe Met Leu His Val Pro Ile
835 840 845

Thr Met Asn Phe Gly Val Gln Gly Met Thr Ile Lys Glu Phe Asn Lys
850 855 860

Lys Val Asn Gln Ser Ile Gln Gln Tyr Asp Glu Val Asn Val Ile Gly
865 870 875 880

Ile Asp Arg Gly Glu Arg His Leu Leu Tyr Leu Thr Val Ile Asn Ser
885 890 895

Lys Gly Glu Ile Leu Glu Gln Arg Ser Leu Asn Asp Ile Thr Thr Ala
900 905 910

Ser Ala Asn Gly Thr Gln Met Thr Thr Pro Tyr His Lys Ile Leu Asp
915 920 925

Lys Arg Glu Ile Glu Arg Leu Asn Ala Arg Val Gly Trp Gly Glu Ile
930 935 940

Glu Thr Ile Lys Glu Leu Lys Ser Gly Tyr Leu Ser His Val Val His
945 950 955 960

Gln Ile Ser Gln Leu Met Leu Lys Tyr Asn Ala Ile Val Val Leu Glu
965 970 975

Asp Leu Asn Phe Gly Phe Lys Arg Gly Arg Phe Lys Val Glu Lys Gln
980 985 990

Ile Tyr Gln Asn Phe Glu Asn Ala Leu Ile Lys Lys Leu Asn His Leu
995 1000 1005

Val Leu Lys Asp Lys Ala Asp Asp Glu Ile Gly Ser Tyr Lys Asn
1010 1015 1020

Ala Leu Gln Leu Thr Asn Asn Phe Thr Asp Leu Lys Ser Ile Gly
1025 1030 1035

Lys Gln Thr Gly Phe Leu Phe Tyr Val Pro Ala Trp Asn Thr Ser
1040 1045 1050

Lys Ile Asp Pro Glu Thr Gly Phe Val Asp Leu Leu Lys Pro Arg
1055 1060 1065

Tyr Glu Asn Ile Ala Gln Ser Gln Ala Phe Phe Gly Lys Phe Asp
1070 1075 1080

Lys Ile Cys Tyr Asn Ala Asp Arg Gly Tyr Phe Glu Phe His Ile
1085 1090 1095

Asp Tyr Ala Lys Phe Asn Asp Lys Ala Lys Asn Ser Arg Gln Ile
1100 1105 1110

Trp Lys Ile Cys Ser His Gly Asp Lys Arg Tyr Val Tyr Asp Lys
1115 1120 1125

Thr Ala Asn Gln Asn Lys Gly Ala Thr Ile Gly Val Asn Val Asn
1130 1135 1140

Asp Glu Leu Lys Ser Leu Phe Thr Arg Tyr His Ile Asn Asp Lys
1145 1150 1155

Gln Pro Asn Leu Val Met Asp Ile Cys Gln Asn Asn Asp Lys Glu
1160 1165 1170

Phe His Lys Ser Leu Met Tyr Leu Leu Lys Thr Leu Leu Ala Leu
1175 1180 1185

Arg Tyr Ser Asn Ala Ser Ser Asp Glu Asp Phe Ile Leu Ser Pro
1190 1195 1200

Val Ala Asn Asp Glu Gly Val Phe Phe Asn Ser Ala Leu Ala Asp
1205 1210 1215

Asp Thr Gln Pro Gln Asn Ala Asp Ala Asn Gly Ala Tyr His Ile
1220 1225 1230

Ala Leu Lys Gly Leu Trp Leu Leu Asn Glu Leu Lys Asn Ser Asp
1235 1240 1245

Asp Leu Asn Lys Val Lys Leu Ala Ile Asp Asn Gln Thr Trp Leu
1250 1255 1260

Asn Phe Ala Gln Asn Arg
1265

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<213> Thiomicrospira sp.XS5

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Met Gly Ile His Gly Val Pro Ala Ala Thr Lys Thr Phe Asp Ser Glu
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Phe Phe Asn Leu Tyr Ser Leu Gln Lys Thr Val Arg Phe Glu Leu Lys
20 25 30

Pro Val Gly Glu Thr Ala Ser Phe Val Glu Asp Phe Lys Asn Glu Gly
35 40 45

Leu Lys Arg Val Val Ser Glu Asp Glu Arg Arg Ala Val Asp Tyr Gln
50 55 60

Lys Val Lys Glu Ile Ile Asp Asp Tyr His Arg Asp Phe Ile Glu Glu
65 70 75 80

Ser Leu Asn Tyr Phe Pro Glu Gln Val Ser Lys Asp Ala Leu Glu Gln
85 90 95

Ala Phe His Leu Tyr Gln Lys Leu Lys Ala Ala Lys Val Glu Glu Arg
100 105 110

Glu Lys Ala Leu Lys Glu Trp Glu Ala Leu Gln Lys Lys Leu Arg Glu
115 120 125

Lys Val Val Lys Cys Phe Ser Asp Ser Asn Lys Ala Arg Phe Ser Arg
130 135 140

Ile Asp Lys Lys Glu Leu Ile Lys Glu Asp Leu Ile Asn Trp Leu Val
145 150 155 160

Ala Gln Asn Arg Glu Asp Asp Ile Pro Thr Val Glu Thr Phe Asn Asn
165 170 175

Phe Thr Thr Tyr Phe Thr Gly Phe His Glu Asn Arg Lys Asn Ile Tyr
180 185 190

Ser Lys Asp Asp His Ala Thr Ala Ile Ser Phe Arg Leu Ile His Glu
195 200 205

Asn Leu Pro Lys Phe Phe Asp Asn Val Ile Ser Phe Asn Lys Leu Lys
210 215 220

Glu Gly Phe Pro Glu Leu Lys Phe Asp Lys Val Lys Glu Asp Leu Glu
225 230 235 240

Val Asp Tyr Asp Leu Lys His Ala Phe Glu Ile Glu Tyr Phe Val Asn

245

250

255

Phe Val Thr Gln Ala Gly Ile Asp Gln Tyr Asn Tyr Leu Leu Gly Gly
 260 265 270

Lys Thr Leu Glu Asp Gly Thr Lys Lys Gln Gly Met Asn Glu Gln Ile
 275 280 285

Asn Leu Phe Lys Gln Gln Gln Thr Arg Asp Lys Ala Arg Gln Ile Pro
 290 295 300

Lys Leu Ile Pro Leu Phe Lys Gln Ile Leu Ser Glu Arg Thr Glu Ser
 305 310 315 320

Gln Ser Phe Ile Pro Lys Gln Phe Glu Ser Asp Gln Glu Leu Phe Asp
 325 330 335

Ser Leu Gln Lys Leu His Asn Asn Cys Gln Asp Lys Phe Thr Val Leu
 340 345 350

Gln Gln Ala Ile Leu Gly Leu Ala Glu Ala Asp Leu Lys Lys Val Phe
 355 360 365

Ile Lys Thr Ser Asp Leu Asn Ala Leu Ser Asn Thr Ile Phe Gly Asn
 370 375 380

Tyr Ser Val Phe Ser Asp Ala Leu Asn Leu Tyr Lys Glu Ser Leu Lys
 385 390 395 400

Thr Lys Lys Ala Gln Glu Ala Phe Glu Lys Leu Pro Ala His Ser Ile
 405 410 415

His Asp Leu Ile Gln Tyr Leu Glu Gln Phe Asn Ser Ser Leu Asp Ala
 420 425 430

Glu Lys Gln Gln Ser Thr Asp Thr Val Leu Asn Tyr Phe Ile Lys Thr
 435 440 445

Asp Glu Leu Tyr Ser Arg Phe Ile Lys Ser Thr Ser Glu Ala Phe Thr
 450 455 460

Gln Val Gln Pro Leu Phe Glu Leu Glu Ala Leu Ser Ser Lys Arg Arg
465 470 475 480

Pro Pro Glu Ser Glu Asp Glu Gly Ala Lys Gly Gln Glu Gly Phe Glu
485 490 495

Gln Ile Lys Arg Ile Lys Ala Tyr Leu Asp Thr Leu Met Glu Ala Val
500 505 510

His Phe Ala Lys Pro Leu Tyr Leu Val Lys Gly Arg Lys Met Ile Glu
515 520 525

Gly Leu Asp Lys Asp Gln Ser Phe Tyr Glu Ala Phe Glu Met Ala Tyr
530 535 540

Gln Glu Leu Glu Ser Leu Ile Ile Pro Ile Tyr Asn Lys Ala Arg Ser
545 550 555 560

Tyr Leu Ser Arg Lys Pro Phe Lys Ala Asp Lys Phe Lys Ile Asn Phe
565 570 575

Asp Asn Asn Thr Leu Leu Ser Gly Trp Asp Ala Asn Lys Glu Thr Ala
580 585 590

Asn Ala Ser Ile Leu Phe Lys Lys Asp Gly Leu Tyr Tyr Leu Gly Ile
595 600 605

Met Pro Lys Gly Lys Thr Phe Leu Phe Asp Tyr Phe Val Ser Ser Glu
610 615 620

Asp Ser Glu Lys Leu Lys Gln Arg Arg Gln Lys Thr Ala Glu Glu Ala
625 630 635 640

Leu Ala Gln Asp Gly Glu Ser Tyr Phe Glu Lys Ile Arg Tyr Lys Leu
645 650 655

Leu Pro Gly Ala Ser Lys Met Leu Pro Lys Val Phe Phe Ser Asn Lys
660 665 670

Asn Ile Gly Phe Tyr Asn Pro Ser Asp Asp Ile Leu Arg Ile Arg Asn

675

680

685

Thr Ala Ser His Thr Lys Asn Gly Thr Pro Gln Lys Gly His Ser Lys
 690 695 700

Val Glu Phe Asn Leu Asn Asp Cys His Lys Met Ile Asp Phe Phe Lys
 705 710 715 720

Ser Ser Ile Gln Lys His Pro Glu Trp Gly Ser Phe Gly Phe Thr Phe
 725 730 735

Ser Asp Thr Ser Asp Phe Glu Asp Met Ser Ala Phe Tyr Arg Glu Val
 740 745 750

Glu Asn Gln Gly Tyr Val Ile Ser Phe Asp Lys Ile Lys Glu Thr Tyr
 755 760 765

Ile Gln Ser Gln Val Glu Gln Gly Asn Leu Tyr Leu Phe Gln Ile Tyr
 770 775 780

Asn Lys Asp Phe Ser Pro Tyr Ser Lys Gly Lys Pro Asn Leu His Thr
 785 790 795 800

Leu Tyr Trp Lys Ala Leu Phe Glu Glu Ala Asn Leu Asn Asn Val Val
 805 810 815

Ala Lys Leu Asn Gly Glu Ala Glu Ile Phe Phe Arg Arg His Ser Ile
 820 825 830

Lys Ala Ser Asp Lys Val Val His Pro Ala Asn Gln Ala Ile Asp Asn
 835 840 845

Lys Asn Pro His Thr Glu Lys Thr Gln Ser Thr Phe Glu Tyr Asp Leu
 850 855 860

Val Lys Asp Lys Arg Tyr Thr Gln Asp Lys Phe Phe Phe His Val Pro
 865 870 875 880

Ile Ser Leu Asn Phe Lys Ala Gln Gly Val Ser Lys Phe Asn Asp Lys
 885 890 895

Val Asn Gly Phe Leu Lys Gly Asn Pro Asp Val Asn Ile Ile Gly Ile
900 905 910

Asp Arg Gly Glu Arg His Leu Leu Tyr Phe Thr Val Val Asn Gln Lys
915 920 925

Gly Glu Ile Leu Val Gln Glu Ser Leu Asn Thr Leu Met Ser Asp Lys
930 935 940

Gly His Val Asn Asp Tyr Gln Gln Lys Leu Asp Lys Lys Glu Gln Glu
945 950 955 960

Arg Asp Ala Ala Arg Lys Ser Trp Thr Thr Val Glu Asn Ile Lys Glu
965 970 975

Leu Lys Glu Gly Tyr Leu Ser His Val Val His Lys Leu Ala His Leu
980 985 990

Ile Ile Lys Tyr Asn Ala Ile Val Cys Leu Glu Asp Leu Asn Phe Gly
995 1000 1005

Phe Lys Arg Gly Arg Phe Lys Val Glu Lys Gln Val Tyr Gln Lys
1010 1015 1020

Phe Glu Lys Ala Leu Ile Asp Lys Leu Asn Tyr Leu Val Phe Lys
1025 1030 1035

Glu Lys Glu Leu Gly Glu Val Gly His Tyr Leu Thr Ala Tyr Gln
1040 1045 1050

Leu Thr Ala Pro Phe Glu Ser Phe Lys Lys Leu Gly Lys Gln Ser
1055 1060 1065

Gly Ile Leu Phe Tyr Val Pro Ala Asp Tyr Thr Ser Lys Ile Asp
1070 1075 1080

Pro Thr Thr Gly Phe Val Asn Phe Leu Asp Leu Arg Tyr Gln Ser
1085 1090 1095

Val Glu Lys Ala Lys Gln Leu Leu Ser Asp Phe Asn Ala Ile Arg

1100						1105						1110			
Phe	Asn	Ser	Val	Gln	Asn	Tyr	Phe	Glu	Phe	Glu	Ile	Asp	Tyr	Lys	
1115						1120					1125				
Lys	Leu	Thr	Pro	Lys	Arg	Lys	Val	Gly	Thr	Gln	Ser	Lys	Trp	Val	
1130						1135					1140				
Ile	Cys	Thr	Tyr	Gly	Asp	Val	Arg	Tyr	Gln	Asn	Arg	Arg	Asn	Gln	
1145						1150					1155				
Lys	Gly	His	Trp	Glu	Thr	Glu	Glu	Val	Asn	Val	Thr	Glu	Lys	Leu	
1160						1165					1170				
Lys	Ala	Leu	Phe	Ala	Ser	Asp	Ser	Lys	Thr	Thr	Thr	Val	Ile	Asp	
1175						1180					1185				
Tyr	Ala	Asn	Asp	Asp	Asn	Leu	Ile	Asp	Val	Ile	Leu	Glu	Gln	Asp	
1190						1195					1200				
Lys	Ala	Ser	Phe	Phe	Lys	Glu	Leu	Leu	Trp	Leu	Leu	Lys	Leu	Thr	
1205						1210					1215				
Met	Thr	Leu	Arg	His	Ser	Lys	Ile	Lys	Ser	Glu	Asp	Asp	Phe	Ile	
1220						1225					1230				
Leu	Ser	Pro	Val	Lys	Asn	Glu	Gln	Gly	Glu	Phe	Tyr	Asp	Ser	Arg	
1235						1240					1245				
Lys	Ala	Gly	Glu	Val	Trp	Pro	Lys	Asp	Ala	Asp	Ala	Asn	Gly	Ala	
1250						1255					1260				
Tyr	His	Ile	Ala	Leu	Lys	Gly	Leu	Trp	Asn	Leu	Gln	Gln	Ile	Asn	
1265						1270					1275				
Gln	Trp	Glu	Lys	Gly	Lys	Thr	Leu	Asn	Leu	Ala	Ile	Lys	Asn	Gln	
1280						1285					1290				
Asp	Trp	Phe	Ser	Phe	Ile	Gln	Glu	Lys	Pro	Tyr	Gln	Glu			
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<400> 9

Met Gly Ile His Gly Val Pro Ala Ala Tyr Tyr Gln Asn Leu Thr Lys
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Lys Tyr Pro Val Ser Lys Thr Ile Arg Asn Glu Leu Ile Pro Ile Gly
20 25 30

Lys Thr Leu Glu Asn Ile Arg Lys Asn Asn Ile Leu Glu Ser Asp Val
35 40 45

Lys Arg Lys Gln Asp Tyr Glu His Val Lys Gly Ile Met Asp Glu Tyr
50 55 60

His Lys Gln Leu Ile Asn Glu Ala Leu Asp Asn Tyr Met Leu Pro Ser
65 70 75 80

Leu Asn Gln Ala Ala Glu Ile Tyr Leu Lys Lys His Val Asp Val Glu
85 90 95

Asp Arg Glu Glu Phe Lys Lys Thr Gln Asp Leu Leu Arg Arg Glu Val
100 105 110

Thr Gly Arg Leu Lys Glu His Glu Asn Tyr Thr Lys Ile Gly Lys Lys
115 120 125

Asp Ile Leu Asp Leu Leu Glu Lys Leu Pro Ser Ile Ser Glu Glu Asp
130 135 140

Tyr Asn Ala Leu Glu Ser Phe Arg Asn Phe Tyr Thr Tyr Phe Thr Ser
145 150 155 160

Tyr Asn Lys Val Arg Glu Asn Leu Tyr Ser Asp Glu Glu Lys Ser Ser
165 170 175

Thr Val Ala Tyr Arg Leu Ile Asn Glu Asn Leu Pro Lys Phe Leu Asp
180 185 190

Asn Ile Lys Ser Tyr Ala Phe Val Lys Ala Ala Gly Val Leu Ala Asp
195 200 205

Cys Ile Glu Glu Glu Glu Gln Asp Ala Leu Phe Met Val Glu Thr Phe
210 215 220

Asn Met Thr Leu Thr Gln Glu Gly Ile Asp Met Tyr Asn Tyr Gln Ile
225 230 235 240

Gly Lys Val Asn Ser Ala Ile Asn Leu Tyr Asn Gln Lys Asn His Lys
245 250 255

Val Glu Glu Phe Lys Lys Ile Pro Lys Met Lys Val Leu Tyr Lys Gln
260 265 270

Ile Leu Ser Asp Arg Glu Glu Val Phe Ile Gly Glu Phe Lys Asp Asp
275 280 285

Glu Thr Leu Leu Ser Ser Ile Gly Ala Tyr Gly Asn Val Leu Met Thr
290 295 300

Tyr Leu Lys Ser Glu Lys Ile Asn Ile Phe Phe Asp Ala Leu Arg Glu
305 310 315 320

Ser Glu Gly Lys Asn Val Tyr Val Lys Asn Asp Leu Ser Lys Thr Thr
325 330 335

Met Ser Asn Ile Val Phe Gly Ser Trp Ser Ala Phe Asp Glu Leu Leu
340 345 350

Asn Gln Glu Tyr Asp Leu Ala Asn Glu Asn Lys Lys Lys Asp Asp Lys
355 360 365

Tyr Phe Glu Lys Arg Gln Lys Glu Leu Lys Lys Asn Lys Ser Tyr Thr
370 375 380

Leu Glu Gln Met Ser Asn Leu Ser Lys Glu Asp Ile Ser Pro Ile Glu
385 390 395 400

Asn Tyr Ile Glu Arg Ile Ser Glu Asp Ile Glu Lys Ile Cys Ile Tyr
405 410 415

Asn Gly Glu Phe Glu Lys Ile Val Val Asn Glu His Asp Ser Ser Arg
420 425 430

Lys Leu Ser Lys Asn Ile Lys Ala Val Lys Val Ile Lys Asp Tyr Leu
435 440 445

Asp Ser Ile Lys Glu Leu Glu His Asp Ile Lys Leu Ile Asn Gly Ser
450 455 460

Gly Gln Glu Leu Glu Lys Asn Leu Val Val Tyr Val Gly Gln Glu Glu
465 470 475 480

Ala Leu Glu Gln Leu Arg Pro Val Asp Ser Leu Tyr Asn Leu Thr Arg
485 490 495

Asn Tyr Leu Thr Lys Lys Pro Phe Ser Thr Glu Lys Val Lys Leu Asn
500 505 510

Phe Asn Lys Ser Thr Leu Leu Asn Gly Trp Asp Lys Asn Lys Glu Thr
515 520 525

Asp Asn Leu Gly Ile Leu Phe Phe Lys Asp Gly Lys Tyr Tyr Leu Gly
530 535 540

Ile Met Asn Thr Thr Ala Asn Lys Ala Phe Val Asn Pro Pro Ala Ala
545 550 555 560

Lys Thr Glu Asn Val Phe Lys Lys Val Asp Tyr Lys Leu Leu Pro Gly
565 570 575

Ser Asn Lys Met Leu Pro Lys Val Phe Phe Ala Lys Ser Asn Ile Gly
580 585 590

Tyr Tyr Asn Pro Ser Thr Glu Leu Tyr Ser Asn Tyr Lys Lys Gly Thr
595 600 605

His Lys Lys Gly Pro Ser Phe Ser Ile Asp Asp Cys His Asn Leu Ile
610 615 620

Asp Phe Phe Lys Glu Ser Ile Lys Lys His Glu Asp Trp Ser Lys Phe
625 630 635 640

Gly Phe Glu Phe Ser Asp Thr Ala Asp Tyr Arg Asp Ile Ser Glu Phe
645 650 655

Tyr Arg Glu Val Glu Lys Gln Gly Tyr Lys Leu Thr Phe Thr Asp Ile
660 665 670

Asp Glu Ser Tyr Ile Asn Asp Leu Ile Glu Lys Asn Glu Leu Tyr Leu
675 680 685

Phe Gln Ile Tyr Asn Lys Asp Phe Ser Glu Tyr Ser Lys Gly Lys Leu
690 695 700

Asn Leu His Thr Leu Tyr Phe Met Met Leu Phe Asp Gln Arg Asn Leu
705 710 715 720

Asp Asn Val Val Tyr Lys Leu Asn Gly Glu Ala Glu Val Phe Tyr Arg
725 730 735

Pro Ala Ser Ile Ala Glu Asn Glu Leu Val Ile His Lys Ala Gly Glu
740 745 750

Gly Ile Lys Asn Lys Asn Pro Asn Arg Ala Lys Val Lys Glu Thr Ser
755 760 765

Thr Phe Ser Tyr Asp Ile Val Lys Asp Lys Arg Tyr Ser Lys Tyr Lys
770 775 780

Phe Thr Leu His Ile Pro Ile Thr Met Asn Phe Gly Val Asp Glu Val
785 790 795 800

Arg Arg Phe Asn Asp Val Ile Asn Asn Ala Leu Arg Thr Asp Asp Asn
805 810 815

Val Asn Val Ile Gly Ile Asp Arg Gly Glu Arg Asn Leu Leu Tyr Val
820 825 830

Val Val Ile Asn Ser Glu Gly Lys Ile Leu Glu Gln Ile Ser Leu Asn
835 840 845

Ser Ile Ile Asn Lys Glu Tyr Asp Ile Glu Thr Asn Tyr His Ala Leu
850 855 860

Leu Asp Glu Arg Glu Asp Asp Arg Asn Lys Ala Arg Lys Asp Trp Asn
865 870 875 880

Thr Ile Glu Asn Ile Lys Glu Leu Lys Thr Gly Tyr Leu Ser Gln Val
885 890 895

Val Asn Val Val Ala Lys Leu Val Leu Lys Tyr Asn Ala Ile Ile Cys
900 905 910

Leu Glu Asp Leu Asn Phe Gly Phe Lys Arg Gly Arg Gln Lys Val Glu
915 920 925

Lys Gln Val Tyr Gln Lys Phe Glu Lys Met Leu Ile Glu Lys Leu Asn
930 935 940

Tyr Leu Val Ile Asp Lys Ser Arg Glu Gln Val Ser Pro Glu Lys Met
945 950 955 960

Gly Gly Ala Leu Asn Ala Leu Gln Leu Thr Ser Lys Phe Lys Ser Phe
965 970 975

Ala Glu Leu Gly Lys Gln Ser Gly Ile Ile Tyr Tyr Val Pro Ala Tyr
980 985 990

Leu Thr Ser Lys Ile Asp Pro Thr Thr Gly Phe Val Asn Leu Phe Tyr
995 1000 1005

Ile Lys Tyr Glu Asn Ile Glu Lys Ala Lys Gln Phe Phe Asp Gly
1010 1015 1020

Phe Asp Phe Ile Arg Phe Asn Lys Lys Asp Asp Met Phe Glu Phe
1025 1030 1035

Ser Phe Asp Tyr Lys Ser Phe Thr Gln Lys Ala Cys Gly Ile Arg
1040 1045 1050

Ser Lys Trp Ile Val Tyr Thr Asn Gly Glu Arg Ile Ile Lys Tyr
1055 1060 1065

Pro Asn Pro Glu Lys Asn Asn Leu Phe Asp Glu Lys Val Ile Asn
1070 1075 1080

Val Thr Asp Glu Ile Lys Gly Leu Phe Lys Gln Tyr Arg Ile Pro
1085 1090 1095

Tyr Glu Asn Gly Glu Asp Ile Lys Glu Ile Ile Ile Ser Lys Ala
1100 1105 1110

Glu Ala Asp Phe Tyr Lys Arg Leu Phe Arg Leu Leu His Gln Thr
1115 1120 1125

Leu Gln Met Arg Asn Ser Thr Ser Asp Gly Thr Arg Asp Tyr Ile
1130 1135 1140

Ile Ser Pro Val Lys Asn Asp Arg Gly Glu Phe Phe Cys Ser Glu
1145 1150 1155

Phe Ser Glu Gly Thr Met Pro Lys Asp Ala Asp Ala Asn Gly Ala
1160 1165 1170

Tyr Asn Ile Ala Arg Lys Gly Leu Trp Val Leu Glu Gln Ile Arg
1175 1180 1185

Gln Lys Asp Glu Gly Glu Lys Val Asn Leu Ser Met Thr Asn Ala
1190 1195 1200

Glu Trp Leu Lys Tyr Ala Gln Leu His Leu Leu
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<223> Synthetic sequence

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Glu Ile Arg Ala Gly Leu Trp Lys Leu His Lys Glu Val Asn Ala Gly
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Val Arg Tyr Tyr Thr Glu Trp Leu Ser Leu Leu Arg Gln Glu Asn Leu
35 40 45

Tyr Arg Arg Ser Pro Asn Gly Asp Gly Glu Gln Glu Cys Asp Lys Thr
50 55 60

Ala Glu Glu Cys Lys Ala Glu Leu Leu Glu Arg Leu Arg Ala Arg Gln
65 70 75 80

Val Glu Asn Gly His Arg Gly Pro Ala Gly Ser Asp Asp Glu Leu Leu
85 90 95

Gln Leu Ala Arg Gln Leu Tyr Glu Leu Leu Val Pro Gln Ala Ile Gly
100 105 110

Ala Lys Gly Asp Ala Gln Gln Ile Ala Arg Lys Phe Leu Ser Pro Leu
115 120 125

Ala Asp Lys Asp Ala Val Gly Gly Leu Gly Ile Ala Lys Ala Gly Asn
130 135 140

Lys Pro Arg Trp Val Arg Met Arg Glu Ala Gly Glu Pro Gly Trp Glu
145 150 155 160

Glu Glu Lys Glu Lys Ala Glu Thr Arg Lys Ser Ala Asp Arg Thr Ala
165 170 175

Asp Val Leu Arg Ala Leu Ala Asp Phe Gly Leu Lys Pro Leu Met Arg
180 185 190

Val Tyr Thr Asp Ser Glu Met Ser Ser Val Glu Trp Lys Pro Leu Arg
195 200 205

Lys Gly Gln Ala Val Arg Thr Trp Asp Arg Asp Met Phe Gln Gln Ala
210 215 220

Ile Glu Arg Met Met Ser Trp Glu Ser Trp Asn Gln Arg Val Gly Gln
225 230 235 240

Glu Tyr Ala Lys Leu Val Glu Gln Lys Asn Arg Phe Glu Gln Lys Asn
245 250 255

Phe Val Gly Gln Glu His Leu Val His Leu Val Asn Gln Leu Gln Gln
260 265 270

Asp Met Lys Glu Ala Ser Pro Gly Leu Glu Ser Lys Glu Gln Thr Ala
275 280 285

His Tyr Val Thr Gly Arg Ala Leu Arg Gly Ser Asp Lys Val Phe Glu
290 295 300

Lys Trp Gly Lys Leu Ala Pro Asp Ala Pro Phe Asp Leu Tyr Asp Ala
305 310 315 320

Glu Ile Lys Asn Val Gln Arg Arg Asn Thr Arg Arg Phe Gly Ser His
325 330 335

Asp Leu Phe Ala Lys Leu Ala Glu Pro Glu Tyr Gln Ala Leu Trp Arg
340 345 350

Glu Asp Ala Ser Phe Leu Thr Arg Tyr Ala Val Tyr Asn Ser Ile Leu
355 360 365

Arg Lys Leu Asn His Ala Lys Met Phe Ala Thr Phe Thr Leu Pro Asp
370 375 380

Ala Thr Ala His Pro Ile Trp Thr Arg Phe Asp Lys Leu Gly Gly Asn
385 390 395 400

Leu His Gln Tyr Thr Phe Leu Phe Asn Glu Phe Gly Glu Arg Arg His
405 410 415

Ala Ile Arg Phe His Lys Leu Leu Lys Val Glu Asn Gly Val Ala Arg
420 425 430

Glu Val Asp Asp Val Thr Val Pro Ile Ser Met Ser Glu Gln Leu Asp
435 440 445

Asn Leu Leu Pro Arg Asp Pro Asn Glu Pro Ile Ala Leu Tyr Phe Arg
450 455 460

Asp Tyr Gly Ala Glu Gln His Phe Thr Gly Glu Phe Gly Gly Ala Lys
465 470 475 480

Ile Gln Cys Arg Arg Asp Gln Leu Ala His Met His Arg Arg Arg Gly
485 490 495

Ala Arg Asp Val Tyr Leu Asn Val Ser Val Arg Val Gln Ser Gln Ser
500 505 510

Glu Ala Arg Gly Glu Arg Arg Pro Pro Tyr Ala Ala Val Phe Arg Leu
515 520 525

Val Gly Asp Asn His Arg Ala Phe Val His Phe Asp Lys Leu Ser Asp
530 535 540

Tyr Leu Ala Glu His Pro Asp Asp Gly Lys Leu Gly Ser Glu Gly Leu
545 550 555 560

Leu Ser Gly Leu Arg Val Met Ser Val Asp Leu Gly Leu Arg Thr Ser
565 570 575

Ala Ser Ile Ser Val Phe Arg Val Ala Arg Lys Asp Glu Leu Lys Pro
580 585 590

Asn Ser Lys Gly Arg Val Pro Phe Phe Phe Pro Ile Lys Gly Asn Asp
595 600 605

Asn Leu Val Ala Val His Glu Arg Ser Gln Leu Leu Lys Leu Pro Gly
610 615 620

Glu Thr Glu Ser Lys Asp Leu Arg Ala Ile Arg Glu Glu Arg Gln Arg
625 630 635 640

Thr Leu Arg Gln Leu Arg Thr Gln Leu Ala Tyr Leu Arg Leu Leu Val
645 650 655

Arg Cys Gly Ser Glu Asp Val Gly Arg Arg Glu Arg Ser Trp Ala Lys
660 665 670

Leu Ile Glu Gln Pro Val Asp Ala Ala Asn His Met Thr Pro Asp Trp
675 680 685

Arg Glu Ala Phe Glu Asn Glu Leu Gln Lys Leu Lys Ser Leu His Gly
690 695 700

Ile Cys Ser Asp Lys Glu Trp Met Asp Ala Val Tyr Glu Ser Val Arg
705 710 715 720

Arg Val Trp Arg His Met Gly Lys Gln Val Arg Asp Trp Arg Lys Asp
725 730 735

Val Arg Ser Gly Glu Arg Pro Lys Ile Arg Gly Tyr Ala Lys Asp Val
740 745 750

Val Gly Gly Asn Ser Ile Glu Gln Ile Glu Tyr Leu Glu Arg Gln Tyr
755 760 765

Lys Phe Leu Lys Ser Trp Ser Phe Phe Gly Lys Val Ser Gly Gln Val
770 775 780

Ile Arg Ala Glu Lys Gly Ser Arg Phe Ala Ile Thr Leu Arg Glu His
785 790 795 800

Ile Asp His Ala Lys Glu Asp Arg Leu Lys Lys Leu Ala Asp Arg Ile
805 810 815

Ile Met Glu Ala Leu Gly Tyr Val Tyr Ala Leu Asp Glu Arg Gly Lys
820 825 830

Gly Lys Trp Val Ala Lys Tyr Pro Pro Cys Gln Leu Ile Leu Leu Glu
835 840 845

Glu Leu Ser Glu Tyr Gln Phe Asn Asn Asp Arg Pro Pro Ser Glu Asn
850 855 860

Asn Gln Leu Met Gln Trp Ser His Arg Gly Val Phe Gln Glu Leu Ile
865 870 875 880

Asn Gln Ala Gln Val His Asp Leu Leu Val Gly Thr Met Tyr Ala Ala
885 890 895

Phe Ser Ser Arg Phe Asp Ala Arg Thr Gly Ala Pro Gly Ile Arg Cys
900 905 910

Arg Arg Val Pro Ala Arg Cys Thr Gln Glu His Asn Pro Glu Pro Phe
915 920 925

Pro Trp Trp Leu Asn Lys Phe Val Val Glu His Thr Leu Asp Ala Cys
930 935 940

Pro Leu Arg Ala Asp Asp Leu Ile Pro Thr Gly Glu Gly Glu Ile Phe
945 950 955 960

Val Ser Pro Phe Ser Ala Glu Glu Gly Asp Phe His Gln Ile His Ala
965 970 975

Asp Leu Asn Ala Ala Gln Asn Leu Gln Gln Arg Leu Trp Ser Asp Phe
980 985 990

Asp Ile Ser Gln Ile Arg Leu Arg Cys Asp Trp Gly Glu Val Asp Gly
995 1000 1005

Glu Leu Val Leu Ile Pro Arg Leu Thr Gly Lys Arg Thr Ala Asp
1010 1015 1020

Ser Tyr Ser Asn Lys Val Phe Tyr Thr Asn Thr Gly Val Thr Tyr
1025 1030 1035

Tyr Glu Arg Glu Arg Gly Lys Lys Arg Arg Lys Val Phe Ala Gln
1040 1045 1050

Glu Lys Leu Ser Glu Glu Glu Ala Glu Leu Leu Val Glu Ala Asp
1055 1060 1065

Glu Ala Arg Glu Lys Ser Val Val Leu Met Arg Asp Pro Ser Gly
1070 1075 1080

Ile Ile Asn Arg Gly Asn Trp Thr Arg Gln Lys Glu Phe Trp Ser
1085 1090 1095

Met Val Asn Gln Arg Ile Glu Gly Tyr Leu Val Lys Gln Ile Arg
1100 1105 1110

Ser Arg Val Pro Leu Gln Asp Ser Ala Cys Glu Asn Thr Gly Asp
1115 1120 1125

Ile

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<212> RNA
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Lys Arg Pro Ala Ala Thr Lys Lys Ala Gly Gln Ala Lys Lys Lys Lys

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Pro Ala Ala Lys Arg Val Lys Leu Asp

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Arg Ser Ser Gly Pro Tyr Gly Gly Gly Gly Gln Tyr Phe Ala Lys Pro
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Arg Asn Gln Gly Gly Tyr
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Arg Met Arg Ile Glx Phe Lys Asn Lys Gly Lys Asp Thr Ala Glu Leu
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Arg Arg Arg Arg Val Glu Val Ser Val Glu Leu Arg Lys Ala Lys Lys
20 25 30

Asp Glu Gln Ile Leu Lys Arg Arg Asn Val
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Val Ser Arg Lys Arg Pro Arg Pro
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Pro Pro Lys Lys Ala Arg Glu Asp
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Pro Gln Pro Lys Lys Lys Pro Leu
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Ser Ala Leu Ile Lys Lys Lys Lys Lys Met Ala Pro
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Asp Arg Leu Arg Arg
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Pro Lys Gln Lys Lys Arg Lys
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Lys Ser Lys Lys
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Lys

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Lys

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