

SEQUENCE LISTING

<110> SUMITOMO CHEMICAL CO., LTD.

<120> Oxidase, polynucleotide encoding the same and use thereof

<130> S33396W001

<150> JP2014-143021

<151> 2014-7-11

<160> 45

<170> PatentIn version 3.5

<210> 1

<211> 391

<212> PRT

<213> Achromobacter denitrificans

<400> 1

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Ala	Arg	Arg	Ile	Met	Pro	Arg	Cys	Val	Glu	Gly	Tyr	Val	Cys	Gly	Gly
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Thr	Glu	Asp	Gly	Ala	Ser	Leu	Ala	Glu	Ser	Val	Arg	Ala	Leu	Gly	Asp
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Val	Gly	Phe	Arg	Pro	Arg	Gly	Leu	Arg	Val	Val	Asp	Gln	Arg	Asn	Ser
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Lys	Val	Glu	Leu	Tyr	Gly	Gln	Thr	Tyr	Ala	Met	Pro	Val	Gly	Phe	Ala
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Pro	Thr	Gly	Phe	Ser	Ala	Ile	Val	Met	His	Glu	Cys	Asp	Leu	Ala	Leu
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Ala	Gln	Ala	Ala	Gln	His	Ala	Glu	Ile	Pro	Phe	Ile	Ile	Ser	Gly	Ala
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Ser Ser Val Pro Leu Glu Arg Leu Gln Gln Ala Thr Gly Lys Arg Cys
 115 120 125

Trp Tyr Gln Ala Tyr Leu Pro Gly Asn Thr Glu Arg Ile Gly Arg Leu
 130 135 140

Leu Gly Arg Leu Arg Gln Ala Glu Ile Pro Val Leu Val Val Thr Ile
 145 150 155 160

Asp Thr Cys Val Gly Ala Asn Arg Glu Asn Leu Gln Arg Leu Ala Phe
 165 170 175

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

His Pro Arg Trp Ser Leu Asn Val Phe Met Arg Thr Leu Leu Gly Ser
 195 200 205

Gly Val Pro Arg Phe Ser Asn Leu Cys Glu Glu Ile Gly Pro Pro Ile
 210 215 220

Thr Gln Asp Pro Pro Asn Gly Phe Arg Gly Glu Arg Asp Lys Leu Ser
 225 230 235 240

Trp Glu His Ile Arg Trp Ile Arg Glu Asn Trp Pro Gly Lys Leu Val
 245 250 255

Leu Lys Gly Val Met His Pro Asp Asp Ala Arg Gln Ala Cys Val Ala
 260 265 270

Gly Ala Asp Gly Val Ile Val Ser Asn His Gly Gly Arg Gln Leu Asp
 275 280 285

Gly Cys Ile Ser Pro Leu Gln Ala Leu Pro Glu Ile Val Ala Ala Val
 290 295 300

Pro Pro Gly Phe Pro Val Met Val Asp Gly Gly Phe Arg Arg Gly Ser
305 310 315 320

Asp Val Leu Lys Ala Val Ala Leu Gly Ala Arg Met Val Phe Thr Gly
325 330 335

Arg Pro Gln Leu Phe Gly Ala Ala Val Gly Gly Gln Ala Gly Ile Arg
340 345 350

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

Leu Gly Cys Ser Ser Leu Ala Asp Val Thr Pro Asp Leu Ile Ala Pro
370 375 380

Ile Arg Pro Ala Ser Pro Ala
385 390

<210> 2
<211> 1173
<212> DNA
<213> *Achromobacter denitrificans*

<400> 2
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atcggcaggc tgttgggceg cctgcgccag gccgagatcc cggctgtggt ggtcaccatc 48
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gacacctgcg taggcgcgaa ccgcgagaac ctgcagcgcc tggccttcac cgtgcctttc 54
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aagatgagcg ccagcgtggt actcgacggc ctgcggcatc cgcgctggag cctgaacgtc 60
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atgcattccg acgacgcg cgaggcctgc gtggccggcg ccgacggcgt catcgtctcc 84
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aaccacggcg gccgccagct ggacggctgc atttcgccgc tgcaggcgct gcccgagatc 90
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gaaatctcga ccgacctggc gctgctgggc tgcagcagcc tggccgacgt cagcccgat 114
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ctgatecgcg cgatacggcc ggccagcccg gca 117
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<210> 3

<211> 386

<212> PRT

<213> *Achromobacter denitrificans*

<400> 3

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20 25 30

Glu Asp Cys Leu Thr Leu Gln Ala Asn Arg Glu Ala Phe Arg Ser Val
35 40 45

Gln Phe Arg Pro Arg Gly Leu Val Gly Val Ala Gln Arg Thr Gln Ala
50 55 60

Val Glu Leu Trp Gly Arg Gln Tyr Arg His Pro Phe Gly Ile Ala Pro
65 70 75 80

Met Gly Met Thr Ala Met Cys Arg His Arg Cys Glu Trp Asp Leu Ala
85 90 95

Lys Ala Ala Ser Glu Ala Lys Ile Pro Phe Val Leu Ser Gly Leu Ser
100 105 110

Thr Leu Ala Met Glu Thr Val Arg Gln Ala Asp Ala Asp Phe Trp Tyr
115 120 125

Gln Gly Tyr Ile Pro Gly Asp Lys Asp Val Ile Glu Pro Leu Leu Arg
130 135 140

Arg Leu Arg Ala Asn Glu Val Asp Val Leu Val Val Thr Ile Asp Thr
145 150 155 160

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

Pro Phe Lys Phe Ser Gly Gly Leu Leu Trp Asp Gly Leu Arg His Pro
 180 185 190

Arg Trp Ser Ala Asn Val Phe Leu Arg Thr Leu Leu Ser Asp Arg Gln
 195 200 205

Val Pro Arg Phe Cys Asn Val Val Ala Asp Thr Arg Gly Tyr Arg Ile
 210 215 220

Thr Glu Glu Pro Lys Gly Gly Leu Arg Gly Gly Arg Asp Arg Leu Asp
 225 230 235 240

Trp Ser His Leu Ala Trp Met Arg Asp Ile Trp Pro Gly Arg Ile Val
 245 250 255

Leu Lys Gly Val Ala His Pro Gly Asp Ala Gln Leu Ala Glu Gln Met
 260 265 270

Gly Leu Asp Gly Val Ile Val Ser Asn His Gly Gly Arg Gln Leu Asp
 275 280 285

Gly Ala Gln Gly Ala Leu Asp Ala Leu Pro Glu Val Val Ala Ala Val
 290 295 300

Gly Pro Asn Phe Pro Val Met Val Asp Gly Gly Phe Arg Arg Gly Ala
 305 310 315 320

Asp Val Leu Lys Ala Ile Ala Leu Gly Ala Arg Met Val Phe Leu Gly
 325 330 335

Arg Pro Phe Leu Tyr Gly Ala Ser Val Ala Gly Gln Ala Gly Val Ala
 340 345 350

Arg Ile Ile Asp Ile Leu Gly Thr Glu Ile Asp Arg Asn Leu Gly Leu
 355 360 365

Leu Gly Cys Arg Asp Leu Ala Glu Leu Gly Ser Asp Phe Ile Val Ser
 370 375 380

Arg Pro
 385

<210> 4
 <211> 1158
 <212> DNA
 <213> *Achromobacter denitrificans*

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 aaccgcgagg cgttcggtc ggtccagttc cgtccgcgcg gcctggtcgg cgtcgcgcag 18
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 cgcaacgcagg ccgtggaact ctggggaagg caataccggc atcctttcgg gatcgcgccc 24
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 ccgtgtctgc ggccctgcg ggccaacgag gtcgacgtgc tggtcgtcac catcgacacg 48
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 cgcaccctgc ttccggaccg gcaggtgccg cgtttctgca acgtggtcgc cgatacgcgc 66
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tggtcgacc tggcctggat gcgcgacatc tggccgggcc gcatcgtcct caaggcgctc 78
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gcccacccg gcgacgcga gctggcgga ccaatgggcc tggacggcgt catcgtctcc 84
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aaccacggcg gacgccagct cgacggcgcg caggcgcccc tggacgcctt gcccgaggtc 90
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gacgtctca aggccatcgc gctgggcgcg cgcattggtt tcctgggcgc cccctttctc 102
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<210> 5

<211> 409

<212> PRT

<213> *Achromobacter denitrificans*

<400> 5

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20 25 30

Asp Asp Phe Glu Ala Ala Ala Arg Arg Arg Leu Pro Arg Pro Ile Phe
35 40 45

Gly Tyr Ile Ala Gly Ala Ala Glu Asp Asn Gln Ser Leu Arg Ser Asn
50 55 60

Arg Glu Ala Phe Gly Arg Tyr Ala Phe Ala Pro Arg Val Leu Val Asp
65 70 75 80

Val Ser Arg Arg Ser Gln Gln Thr Glu Leu Phe Gly Arg Arg Tyr Ala
85 90 95

Ser Pro Phe Gly Ile Ala Pro Met Gly Ile Ser Ala Leu Ser Thr Tyr
100 105 110

Arg Gly Asp Ile Val Leu Ala Arg Ala Ala Arg Glu Gln Gly Ile Pro
115 120 125

Ala Ile Leu Ser Gly Thr Ser Leu Ile Pro Leu Glu Asp Val Ile Arg
130 135 140

Glu Ala Pro Gly Thr Trp Phe Gln Ala Tyr Leu Pro Gly Asp Pro Gln
145 150 155 160

Arg Ile Asp Ala Leu Val Glu Arg Ala Arg Arg Ala Gly Phe Glu Thr
165 170 175

Leu Val Leu Thr Val Asp Ile Pro Val Ser Ala Asn Arg Glu Asn Asn
180 185 190

Val Arg Thr Gly Phe Ser Thr Pro Leu Lys Pro Ser Leu Arg Leu Ala
195 200 205

Trp Asp Gly Val Thr Arg Pro Arg Trp Leu Ala Gly Thr Phe Leu Arg
210 215 220

Thr Leu Leu Lys His Gly Met Pro His Phe Glu Asn Ser Phe Ala Thr
225 230 235 240

Arg Gly Ala Pro Ile Val Ser Ala Ser Val Leu Arg Asp Phe Ser Ala
245 250 255

Arg Asp His Leu Asn Trp Glu His Val Ala Arg Ile Arg Arg Gln Trp
 260 265 270

Pro Gly Ala Leu Ile Ile Lys Gly Ile Leu His Pro Gln Asp Ala Ala
 275 280 285

Leu Ala Arg Ser His Gly Ala Asp Gly Val Ile Val Ser Asn His Gly
 290 295 300

Gly Arg Gln Leu Asp Gly Ala Ile Ser Pro Leu Arg Ala Leu Pro Gly
 305 310 315 320

Val Val Ala Ala Ala Gly Asp Met Thr Val Met Met Asp Ser Gly Ile
 325 330 335

Arg Arg Gly Ser Asp Val Leu Lys Ala Leu Ala Leu Gly Ala Arg His
 340 345 350

Val Phe Val Gly Arg Pro Phe Asn Tyr Ala Ala Ala Val Gly Gly Glu
 355 360 365

Ala Gly Val Ala His Ala Ile Gly Leu Leu Arg Ala Glu Ile Asp Arg
 370 375 380

Asn Met Ala Met Leu Gly Ile Asn Thr Leu Arg Glu Met Asp Ala Gly
 385 390 395 400

Leu Leu Ala Arg Glu Ser Leu Ala Asp
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<210> 6

<211> 1227

<212> DNA

<213> *Achromobacter denitrificans*

<400> 6

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cgccgcctgc cgcgcccgat ctteggctac atcgccggcg cggccgaaga caaccagtcg 0	18
ctgcgagca accgcgaggc ctteggccgc tacgcgttcg cggccgcgt gctggtggac 0	24
gtgtcgccc gcagccagca gaccgaactg ttcggacgcc gctacgcctc gcccttcggc 0	30
atcgcccca tgggcatcag cgcgtgtcg acctaccgcg gcgacatcgt gctggcgcg 0	36
gccgcccgcg agcaaggcat cccggccatc ctacgaggga cttecgatgat tccgtggaa 0	42
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cgcatcgacg cgctggtcga acgcgcgcgc cgcgcgggtt tcgaaacct ggtgtgacg 0	54
gtggacatcc cgggtgcggc caatcgcaa aacaacgtgc gcaccggctt ttccagccg 0	60
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gacgtgctca aggccctggc gctgggcgcg cgccacgtgt tcgtgggccg ccccttcaac 108
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tatgcggcgg cggtcggcgg cgaggccggc gtggcgcacg ccatcggcct gctgcgcgcc 114
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gagatcgacc gcaacatggc catgctggga atcaatacat tgcgcgaaat ggacgcaggc 120
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ctgctggccc gcgagagcct ggcagat 122
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<210> 7

<211> 364

<212> PRT

<213> Bacillus sphaericus

<400> 7

Met Glu Ile Phe Lys Tyr Met Glu Lys Tyr Asp Tyr Glu Gln Leu Val
1 5 10 15

Phe Cys Gln Asp Glu Ala Ser Gly Leu Lys Ala Ile Ile Ala Ile His
20 25 30

Asp Thr Thr Leu Gly Pro Ala Leu Gly Gly Ala Arg Met Trp Thr Tyr
35 40 45

Ala Thr Glu Glu Asn Ala Ile Glu Asp Ala Leu Arg Leu Ala Arg Gly
50 55 60

Met Thr Tyr Lys Asn Ala Ala Ala Gly Leu Asn Leu Gly Gly Gly Lys
65 70 75 80

Thr Val Ile Ile Gly Asp Pro Phe Lys Asp Lys Asn Glu Glu Met Phe
85 90 95

Arg Ala Leu Gly Arg Phe Ile Gln Gly Leu Asn Gly Arg Tyr Ile Thr

100

105

110

Gly Glu Asp Val Gly Thr Thr Val Thr Asp Met Asp Leu Ile His Glu
 115 120 125

Glu Thr Asn Tyr Val Thr Gly Ile Ser Pro Ala Phe Gly Ser Ser Gly
 130 135 140

Asn Pro Ser Pro Val Thr Ala Tyr Gly Val Tyr Arg Gly Met Lys Ala
 145 150 155 160

Ala Ala Lys Glu Ala Phe Gly Thr Asp Met Leu Glu Gly Arg Thr Ile
 165 170 175

Ser Val Gln Gly Leu Gly Asn Val Ala Tyr Lys Leu Cys Glu Tyr Leu
 180 185 190

His Asn Glu Gly Ala Lys Leu Val Val Thr Asp Ile Asn Gln Ala Ala
 195 200 205

Ile Asp Arg Val Val Asn Asp Phe Gly Ala Thr Ala Val Ala Pro Asp
 210 215 220

Glu Ile Tyr Ser Gln Glu Val Asp Ile Phe Ser Pro Cys Ala Leu Gly
 225 230 235 240

Ala Ile Leu Asn Asp Glu Thr Ile Pro Gln Leu Lys Ala Lys Val Ile
 245 250 255

Ala Gly Ser Ala Asn Asn Gln Leu Gln Asp Ser Arg His Gly Asp Tyr
 260 265 270

Leu His Glu Leu Gly Ile Val Tyr Ala Pro Asp Tyr Val Ile Asn Ala
 275 280 285

Gly Gly Val Ile Asn Val Ala Asp Glu Leu Tyr Gly Tyr Asn Arg Glu

290 295 300

Arg Ala Leu Lys Arg Val Asp Gly Ile Tyr Asp Ser Ile Glu Lys Ile
 305 310 315 320

Phe Glu Ile Ser Lys Arg Asp Ser Ile Pro Thr Tyr Val Ala Ala Asn
 325 330 335

Arg Leu Ala Glu Glu Arg Ile Ala Arg Val Ala Lys Ser Arg Ser Gln
 340 345 350

Phe Leu Lys Asn Glu Lys Asn Ile Leu Asn Gly Arg
 355 360

<210> 8
 <211> 1095
 <212> DNA
 <213> Bacillus sphaericus

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ggtggtgctc gtatgtggac ctacgcgaca gaagaaaatg cgattgagga tgcattaaga 18
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ttagcacgcg ggatgacata taaaaatgca gctgctggtt taaaccttgg cgggtgaaaa 24
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acggtcatta ttggggaccc atttaaagat aaaaacgaag aaatgttccg tgctttaggt 30
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cgtttcattc aaggattaaa cggtcgctat attaccggtg aagatgttgg tacaaccgta 36
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acagatatgg atttaatcca tgaggaaaca aattacgtta caggatatat gccagcgttt 42
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ggttcacggt gtaatccttc accagtaact gcttatggcg tttatcgtgg catgaaagca 48
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gcggcgaaag aagcatttgg tacggatatg ctagaaggtc gtactatatc ggtacaaggg 0	54
ctaggaaacg tagcttacaa gctttgcgag tatttacata atgaaggcgc aaaacttgta 0	60
gtaacagata ttaaccaagc ggctattgat cgtgttgca atgattttgg cgctacagca 0	66
gttgacactg atgaaatcta ttcacaagaa gtcgatattt tctcaccgtg tgcacttggc 0	72
gcaattttaa atgacgaaac gattccgcaa ttaaaagcaa aagtatttgc tggttctgct 0	78
aataaccaac tacaagattc acgacatgga gattatttac acgagctagg cattgtttat 0	84
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tttgaaattt ccaaacgtga tagtattcca acatatgttg cggcaaactg tttggcagaa 0	102
gaacgtattg ctcgtgtagc gaaatcgct agtcagttct taaaaaatga aaaaaatatt 0	108
ttgaacggcc gttaa 5	109

<210> 9

<211> 30

<212> DNA

<213> Artificial Sequence

<220>

<223> Designed oligonucleotide primer for PCR

<400> 9

ccatatgagc cggctggacc gctgcctgtc

0

3

<210> 10
 <211> 31
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

<400> 10
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 1

<210> 11
 <211> 32
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

<400> 11
 ccatatgaac tcaaagaaac tcttgatc ag 3
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<210> 12
 <211> 31
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

<400> 12
 ggatccctaa gggcgcgaca cgatgaagtc g 3
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<210> 13
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 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

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<210> 14
<211> 31
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

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1

<210> 15
<211> 1176
<212> DNA
<213> Artificial Sequence

<220>
<223> Polynucleotide encoding Oxidase

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atgccgcgt gcgtagaagg ttatgtgtgt ggtggtagc aagatggc atctctggc 12
0

gagtctgtgc gcgcgtggg cgatgtggc ttccgtccg gtggcctgc ttagtaggac 18
0

cagcgaatt ccaaagtga gctgtacgt cagacctac cgatgccgt cggtttcgc 24
0

cctactggct tctctctat cgttatgcac gaatgcgac tggccctggc ccaggcggc 30
0

cagcatgcgg aaatccctt tatcatctc ggcgcgtcca gcgttcgct ggaacgtctg 36
0

caacaggcaa ccggcaaag ctgttggtat caggcgtacc tgccgggcaa caccgaacgc 42
0

atcggtgcc tgctgggtc tctgcgtcag gccgaaatc cggttctggt agttaccac 48

0

gacacttgcg tcggtgctaa ccgcgagaac ctgcaacgcc tggcgttcac cgttccattc 54
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aagatgtccg cgagcgtagt tctggacggc ctgcgccacc cgcgttggag cctgaacgta 60
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ttcatgcgta ctctgctggg ctctggtgtt ccgcgtttca gcaacctgtg cgaagaaatt 66
0

ggcccaccaa tcaccagga cccgccaac ggttccgtg gcgaacgtga caaactgtct 72
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tgggagcaca tccgttggat tcgtgaaaac tggcctggca aactggttct gaaaggcgtg 78
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atgcaccag acgatgcg cgagcgtgt gttgcagggt ctgacgggtg gatcgttagc 84
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aatcatggtg gtcgtcagct ggatggctgc atttctccgc tgcaagcact gccggaatt 90
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gtagctgctg tccgcgagg ctttccggtg atggttgatg gcggtttccg tcgtggttcc 96
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gatgtctga aggctgttgc tctgggcgt cgtatggtgt ttacgggtcg tccgcagctg 102
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ttcggtgccg ctgtgggtgg tcaggctggc atccgtaaag tcgcggcaat tttccgttct 108
0

gaaatctcta ccgacctggc actgctgggt tgctctccc tggcagatgt aactccggac 114
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ctgattgcac cgatccgtcc ggccagcccg gcttaa 117
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<210> 16

<211> 1161

<212> DNA

<213> Artificial Sequence

<220>

<223> Polynucleotide encoding Oxidase

<400> 16

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ccacacgcgg tattcggta tgtgaacggt ggcaccgaag attgtctgac gctgcaagct 0	12
aaccgtgaag cattccgtag cgtacaattt cccccgcgcg gtctggtagg tgtagcgag 0	18
cgtactcagg cgggtggaact gtggggtcgt cagtaccgtc acccgttcgg tategccccg 0	24
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gaagegaaga tccctttcgt actgtctggt ctgtccacc ttgctatgga aaccgttcgc 0	36
caggcagatg ccgacttctg gtatcagggc tacattccgg gcgataaaga tgttatcgaa 0	42
ccgtctctgc gccgtctgcg cgccaacgaa gttgatgttc tggttgtgac tatcgacacc 0	48
ccggtgggtg ctaaccgcga gaacaaccaa cgcaacggt tcaccatccc gttcaaattc 0	54
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ggctaccgta tcaactgaaga accgaaaggt ggctgcgtg gtggccgtga tcgcctggat 0	72
tggteccacc tggcgtggat gcgcgatatt tggccgggtc gcatcgtcct gaaaggcgtt 0	78
gcgcaccctg gtgacgcga gctggctgaa cagatgggcc tggacggtgt gattgtgagc 0	84
aatcatggcg gtcgtcagct ggatggcgca cagggtgctc tggacgtct gccggaggtt 0	90
gtcgcggctg ttggtccgaa cttcccgtc atggttgacg gtggctttcg tcgtggcgca 0	96

gacgttctga aagcaattgc gctgggtgcg cgtatggttt ttctgggtcg cccattcctg 102
0

tacggcgcat ctgtggcggg ccaggctggt gtagcacgta tcattgacat tctgggcacg 108
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gagatcgacc gtaacctggg cctgctgggc tgcgtgacc tggccgagct gggttctgac 114
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tttategttt ctcgtccgta a 116
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<210> 17

<211> 1230

<212> DNA

<213> Artificial Sequence

<220>

<223> Polynucleotide encoding Oxidase

<400> 17

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cgtcgcctgc cgcgccgat ttccggttat atcgcaggcg ccgccgaaga taaccagtct 18
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ctgcgtagca atcgcgaagc gtccggccgc tacgcattcg ctccgcgtgt actggttgac 24
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gtatcccgtc gttctcagca gactgaactg ttcggccgtc gttacgcgag cccgttcggc 30
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attgcgcga tgggtatctc tgctctgagc acctaccgtg gcgacatcgt actggtcgt 36
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gcggcccgctg aacagggtat cccagctatc ctgtccggtg cgtctctgat tccgtggaa 42
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gacgtgattc gcgaagcacc gggcacctgg ttccaagcat atctgccggg tgatccacag 48
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cgcacgcag cactggtcga gcgcgccgt cgtgccggct tcgagactct ggtgctgacc 54
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gttgacatcc cggctcgcg taacctgaa aacaacgttc gcaccggctt ctctaccccg 60
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ctgaaaccga gcctgcgcct ggcatgggat ggcgtaactc gtccgcgttg gctggcaggt 66
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acttttctgc gtacctgct gaaacatggt atgccgactc tcgaaaactc cttcgcgacc 72
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cgtggcgcac cgatcgtgag cgcctccgtg ctgcgtgact ttagcgcacg tgaccacctg 78
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attctgcacc ctcaggatgc cgtcttgga cgttctcacg gtgctgatgg cgttatcggt 90
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tccaatcatg gtggccgtca gctggatggc gcgatctctc cactgcgtgc gctgccaggt 96
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gttggtggcg ctgcgggtga tatgaccgtg atgatggaca gcggtatccg tcgcggttct 102
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gatgtcctga aagctctggc gctgggtgcc cgccatgttt tcgtgggtcg cccgtttaac 108
0

tacgtgctg cggttggtgg cgaagcgggc gtagccacg cgatcggctc gctgcgtgcc 114
0

gaaattgacc gcaacatggc gatgctgggc atcaacacgc tgcgcgaaat ggatgcgggc 120
0

ctgctggcgc gtgaatccct ggctgactaa 123
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<210> 18
<211> 25
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 18
gccatgaaa tcttcaagta tatgg

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<210> 19
 <211> 30
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

<400> 19
 gggcccgggt taacggccgt tcaaaatatt 3
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<210> 20
 <211> 27
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for mutagenesis

<400> 20
 gtcgctatat taccggtgaa gatgttg 2
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<210> 21
 <211> 27
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for mutagenesis

<400> 21
 caacatcttc accgtaata tagcgac 2
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<210> 22
 <211> 26
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Designed oligonucleotide primer for mutagenesis

<400> 22
gatagtattc caacctatgt tgcggc 2
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<210> 23
<211> 26
<212> DNA
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<220>
<223> Designed oligonucleotide primer for mutagenesis

<400> 23
gccgcaacat aggttggaat actatc 2
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<210> 24
<211> 28
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 24
gggcatatgg aaatcttcaa gtatatgg 2
8

<210> 25
<211> 27
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 25
ggatccttaa cggccgttca aaatatt 2
7

<210> 26
<211> 1206

<212> DNA

<213> Artificial Sequence

<220>

<223> Polynucleotide encoding Formate Dehydrogenase

<400> 26

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gcacgcgatg atctgccgaa aatcgaatgc tatccggacg gccagaccct gccgaccca 12
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cgtgcgattg acttccagcc ggggtgctctg ctgggtagcg tatctggtga actgggtctg 18
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cgtaaatacc tggaaagcaa cggccacgaa ctggtcgtta cctcttccaa agacgggtgac 24
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aattccgtac tggaccgtga actggcagat gcggaaattg ttatcagcca gccgttctgg 30
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ccagcgtata tgacggctga acgtatcaag cgcgcgaaaa aactgaaaat gattgtgact 36
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gcgggcattg gctccgacca cacggatctg caagcagcga tggaaacagg tatcacctg 42
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gcagaagtta cttactgcaa ctccaactcc gtggcggaac atgttatgat gaccaccctg 48
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gctctggtac gtaactacct gccatcctac cagtgggtac tgaaaggtgg ttggaacatc 54
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gcagattgtg ttgaacgttc ttacgatctg gaaggcatgc acgtcggtag ttagcggcc 60
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ctggatcgtc accgcctgcc ggaatctgtg gagaaagagc tgaacctgac ccaccacact 72
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atcaataaccg cccgtggcaa actgtgtgac cgtgatgccg tcgcggcagc cctggaatct 90
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ggccaactgg cgggtacgg cggcgacgtt tggtttccgc agccggcacc ggcggtatcat 96
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ccgtggcgta gcatgcega ccacggtatg actccgcata ttagcggcac ctctctgtct 102
0

gcccagacc gttacgggc tggcaccgc gagatcctgg aatgttattt cgagaaccgc 108
0

ccgatccgta acgaatatct gatcgtgcag aacggcaagc tggctggtgt cgggtgtcac 114
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agctattctg ctggtaacgc aactggcggc agcgaggaag ctgcacgttt caagaaatct 120
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gcttaa 120
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<210> 27
<211> 30
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 27
ccatatgtct cgcctggacc gctgtctgag 3
0

<210> 28
<211> 28
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 28
ggatccttaa gccgggctgg ccggacgg 2
8

<210> 29
 <211> 31
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Designed oligonucleotide primer for PCR

<400> 29
 ccatatgaac tccaagaaac tgctgtctat c 3
 1

<210> 30
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 <212> DNA
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<220>
 <223> Designed oligonucleotide primer for PCR

<400> 30
 ggatccttac ggacgagaaa cgataaag 2
 8

<210> 31
 <211> 30
 <212> DNA
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<220>
 <223> Designed oligonucleotide primer for PCR

<400> 31
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<210> 32
 <211> 31
 <212> DNA
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<220>
 <223> Designed oligonucleotide primer for PCR

<400> 32
actcgaggtc agccagggat tcacgcgcca g 3
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<210> 33
<211> 31
<212> DNA
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<400> 33
ccatatgagc acgtcagacg atatccataa c 3
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<210> 34
<211> 32
<212> DNA
<213> Artificial Sequence

<220>
<223> Designed oligonucleotide primer for PCR

<400> 34
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2

<210> 35
<211> 31
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<220>
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<400> 35
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<210> 36
<211> 30
<212> DNA
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<220>

<223> Designed oligonucleotide primer for PCR

<400> 36

actcgagagc agatttcttg aaacgtgcag

3

0

<210> 37

<211> 24

<212> DNA

<213> Artificial Sequence

<220>

<223> Designed oligonucleotide primer for PCR

<400> 37

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4

<210> 38

<211> 28

<212> DNA

<213> Artificial Sequence

<220>

<223> Designed oligonucleotide primer for PCR

<400> 38

ctcagagtta acggccgttc aaaatatt

2

8

<210> 39

<211> 364

<212> PRT

<213> Bacillus sphaericus

<400> 39

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

Asp Thr Thr Leu Gly Pro Ala Leu Gly Gly Ala Arg Met Trp Thr Tyr
 35 40 45

Ala Thr Glu Glu Asn Ala Ile Glu Asp Ala Leu Arg Leu Ala Arg Gly
 50 55 60

Met Thr Tyr Lys Asn Ala Ala Ala Gly Leu Asn Leu Gly Gly Gly Lys
 65 70 75 80

Thr Val Ile Ile Gly Asp Pro Phe Lys Asp Lys Asn Glu Glu Met Phe
 85 90 95

Arg Ala Leu Gly Arg Phe Ile Gln Gly Leu Asn Gly Arg Tyr Ile Thr
 100 105 110

Ala Glu Asp Val Gly Thr Thr Val Thr Asp Met Asp Leu Ile His Glu
 115 120 125

Glu Thr Asn Tyr Val Thr Gly Ile Ser Pro Ala Phe Gly Ser Ser Gly
 130 135 140

Asn Pro Ser Pro Val Thr Ala Tyr Gly Val Tyr Arg Gly Met Lys Ala
 145 150 155 160

Ala Ala Lys Glu Ala Phe Gly Thr Asp Met Leu Glu Gly Arg Thr Ile
 165 170 175

Ser Val Gln Gly Leu Gly Asn Val Ala Tyr Lys Leu Cys Glu Tyr Leu
 180 185 190

His Asn Glu Gly Ala Lys Leu Val Val Thr Asp Ile Asn Gln Ala Ala
 195 200 205

Ile Asp Arg Val Val Asn Asp Phe Gly Ala Thr Ala Val Ala Pro Asp
 210 215 220

Glu Ile Tyr Ser Gln Glu Val Asp Ile Phe Ser Pro Cys Ala Leu Gly
 225 230 235 240

Ala Ile Leu Asn Asp Glu Thr Ile Pro Gln Leu Lys Ala Lys Val Ile
 245 250 255

Ala Gly Ser Ala Asn Asn Gln Leu Gln Asp Ser Arg His Gly Asp Tyr
 260 265 270

Leu His Glu Leu Gly Ile Val Tyr Ala Pro Asp Tyr Val Ile Asn Ala
 275 280 285

Gly Gly Val Ile Asn Val Ala Asp Glu Leu Tyr Gly Tyr Asn Arg Glu
 290 295 300

Arg Ala Leu Lys Arg Val Asp Gly Ile Tyr Asp Ser Ile Glu Lys Ile
 305 310 315 320

Phe Glu Ile Ser Lys Arg Asp Ser Ile Pro Thr Tyr Val Ala Ala Asn
 325 330 335

Arg Leu Ala Glu Glu Arg Ile Ala Arg Val Ala Lys Ser Arg Ser Gln
 340 345 350

Phe Leu Lys Asn Glu Lys Asn Ile Leu Asn Gly Arg
 355 360

<210> 40

<211> 1095

<212> DNA

<213> *Bacillus sphaericus*

<400> 40

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gaagcatctg gggtaaaagc gattatcgct atccatgaca caacacttgg accagcatta 12

0

ggtggtgctc gtatgtggac ctacgcgaca gaagaaaatg cgattgagga tgcattaaga 18
0

ttagcacgcg ggatgacata taaaaatgca gctgctgggt taaaccttgg cggtggaana 24
0

acggtcatta ttggggaccc atttaaagat aaaaacgaag aaatgttccg tgctttaggt 30
0

cgtttcattc aaggattaaa cggtcgctat attaccgctg aagatgttgg tacaaccgta 36
0

acagatatgg atttaacca tgaggaaaca aattacgtta caggtatata gccagcgttt 42
0

ggttcacggt gtaatccttc accagtaact gcttatggcg tttatcgtgg catgaaagca 48
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gcggcgaaag aagcatttgg tacggatatg ctagaaggtc gtactatata ggtacaaggg 54
0

ctaggaaacg tagcttaca gctttgcgag tatttacata atgaagggtc aaaacttgta 60
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gtaacagata ttaaccaagc ggctattgat cgtgttgtca atgattttgg cgctacagca 66
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gcaattttta atgacgaaac gattccgcaa ttaaaagcaa aagtatttgc tggttctgct 78
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aataaccaac tacaagattc acgacatgga gattatttac acgagctagg cattgtttat 84
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gcacctgact atgtcattaa tgcaggtggg gtaataaatg tcgcggacga attatatggc 90
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tataatcgtg aacgagcggt gaaacgtgta gatggtattt acgatagtat tgaaaaaatc 96
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tttgaaattt ccaaacgtga tagtattcca acatatgttg cggcaaatcg ttggcagaa 102
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gaacgtattg ctcgtgtagc gaaatcgctg agtcagttct taaaaaatga aaaaaatatt 108

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ttgaacggcc gttaa

109

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<210> 41

<211> 726

<212> PRT

<213> Escherichia coli

<400> 41

Met Ser Thr Ser Asp Asp Ile His Asn Thr Thr Ala Thr Gly Lys Cys
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Pro Phe His Gln Gly Gly His Asp Gln Ser Ala Gly Ala Gly Thr Thr
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Thr Arg Asp Trp Trp Pro Asn Gln Leu Arg Val Asp Leu Leu Asn Gln
 35 40 45

His Ser Asn Arg Ser Asn Pro Leu Gly Glu Asp Phe Asp Tyr Arg Lys
 50 55 60

Glu Phe Ser Lys Leu Asp Tyr Tyr Gly Leu Lys Lys Asp Leu Lys Ala
 65 70 75 80

Leu Leu Thr Glu Ser Gln Pro Trp Trp Pro Ala Asp Trp Gly Ser Tyr
 85 90 95

Ala Gly Leu Phe Ile Arg Met Ala Trp His Gly Ala Gly Thr Tyr Arg
 100 105 110

Ser Ile Asp Gly Arg Gly Gly Ala Gly Arg Gly Gln Gln Arg Phe Ala
 115 120 125

Pro Leu Asn Ser Trp Pro Asp Asn Val Ser Leu Asp Lys Ala Arg Arg
 130 135 140

Leu Leu Trp Pro Ile Lys Gln Lys Tyr Gly Gln Lys Ile Ser Trp Ala
 145 150 155 160

Asp Leu Phe Ile Leu Ala Gly Asn Val Ala Leu Glu Asn Ser Gly Phe
 165 170 175

Arg Thr Phe Gly Phe Gly Ala Gly Arg Glu Asp Val Trp Glu Pro Asp
 180 185 190

Leu Asp Val Asn Trp Gly Asp Glu Lys Ala Trp Leu Thr His Arg His
 195 200 205

Pro Glu Ala Leu Ala Lys Ala Pro Leu Gly Ala Thr Glu Met Gly Leu
 210 215 220

Ile Tyr Val Asn Pro Glu Gly Pro Asp His Ser Gly Glu Pro Leu Ser
 225 230 235 240

Ala Ala Ala Ala Ile Arg Ala Thr Phe Gly Asn Met Gly Met Asn Asp
 245 250 255

Glu Glu Thr Val Ala Leu Ile Ala Gly Gly His Thr Leu Gly Lys Thr
 260 265 270

His Gly Ala Gly Pro Thr Ser Asn Val Gly Pro Asp Pro Glu Ala Ala
 275 280 285

Pro Ile Glu Glu Gln Gly Leu Gly Trp Ala Ser Thr Tyr Gly Ser Gly
 290 295 300

Val Gly Ala Asp Ala Ile Thr Ser Gly Leu Glu Val Val Trp Thr Gln
 305 310 315 320

Thr Pro Thr Gln Trp Ser Asn Tyr Phe Phe Glu Asn Leu Phe Lys Tyr
 325 330 335

Glu Trp Val Gln Thr Arg Ser Pro Ala Gly Ala Ile Gln Phe Glu Ala
 340 345 350

Val Asp Ala Pro Glu Ile Ile Pro Asp Pro Phe Asp Pro Ser Lys Lys
 355 360 365

Arg Lys Pro Thr Met Leu Val Thr Asp Leu Thr Leu Arg Phe Asp Pro
 370 375 380

Glu Phe Glu Lys Ile Ser Arg Arg Phe Leu Asn Asp Pro Gln Ala Phe
 385 390 395 400

Asn Glu Ala Phe Ala Arg Ala Trp Phe Lys Leu Thr His Arg Asp Met
 405 410 415

Gly Pro Lys Ser Arg Tyr Ile Gly Pro Glu Val Pro Lys Glu Asp Leu
 420 425 430

Ile Trp Gln Asp Pro Leu Pro Gln Pro Ile Tyr Asn Pro Thr Glu Gln
 435 440 445

Asp Ile Ile Asp Leu Lys Phe Ala Ile Ala Asp Ser Gly Leu Ser Val
 450 455 460

Ser Glu Leu Val Ser Val Ala Trp Ala Ser Ala Ser Thr Phe Arg Gly
 465 470 475 480

Gly Asp Lys Arg Gly Gly Ala Asn Gly Ala Arg Leu Ala Leu Met Pro
 485 490 495

Gln Arg Asp Trp Asp Val Asn Ala Ala Ala Val Arg Ala Leu Pro Val
 500 505 510

Leu Glu Lys Ile Gln Lys Glu Ser Gly Lys Ala Ser Leu Ala Asp Ile
 515 520 525

Ile Val Leu Ala Gly Val Val Gly Val Glu Lys Ala Ala Ser Ala Ala
 530 535 540

Gly Leu Ser Ile His Val Pro Phe Ala Pro Gly Arg Val Asp Ala Arg
 545 550 555 560

Gln Asp Gln Thr Asp Ile Glu Met Phe Glu Leu Leu Glu Pro Ile Ala
 565 570 575

Asp Gly Phe Arg Asn Tyr Arg Ala Arg Leu Asp Val Ser Thr Thr Glu
 580 585 590

Ser Leu Leu Ile Asp Lys Ala Gln Gln Leu Thr Leu Thr Ala Pro Glu
 595 600 605

Met Thr Ala Leu Val Gly Gly Met Arg Val Leu Gly Gly Asn Phe Asp
 610 615 620

Gly Ser Lys Asn Gly Val Phe Thr Asp Arg Val Gly Val Leu Ser Asn
 625 630 635 640

Asp Phe Phe Val Asn Leu Leu Asp Met Arg Tyr Glu Trp Lys Ala Thr
 645 650 655

Asp Glu Ser Lys Glu Leu Phe Glu Gly Arg Asp Arg Glu Thr Gly Glu
 660 665 670

Val Lys Phe Thr Ala Ser Arg Ala Asp Leu Val Phe Gly Ser Asn Ser
 675 680 685

Val Leu Arg Ala Val Ala Glu Val Tyr Ala Ser Ser Asp Ala His Glu
 690 695 700

Lys Phe Val Lys Asp Phe Val Ala Ala Trp Val Lys Val Met Asn Leu
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Asp Arg Phe Asp Leu Leu
725

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<210> 42
<211> 2181
<212> DNA
<213> Escherichia coli

<400> 42
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ggcggtcacg accagagtgc gggggcgggc acaaccactc gcgactggtg gccaaatcaa      12
0

cttcgtgttg acctgttaaa ccaacattct aatcgttcta acccactggg tgaggacttt      18
0

gactaccgca aagaattcag caaattagat tactacggcc tgaaaaaaga tctgaaagcc      24
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ctgttgacag aatctcaacc gtggtggcca gccgactggg gcagttacgc cggctctgtt      30
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attcgtatgg cctggcacgg cgcggggact taccgttcaa tcgatggacg cggtggcgcg      36
0

ggtcgtggtc agcaacgttt tgcaccgctg aactcctggc cggataacgt aagcctcgat      42
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aaagcgcgtc gcctgttgtg gccaatcaaa cagaaatatg gtcagaaaat ctctggggcc      48
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gacctgttta tcctcgcggg taacgtggcg ctagaaaact ccggttccg taccttcggt      54
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tttggtgccg gtcgtgaaga cgtctgggaa ccggatctgg atgttaactg gggatgatgaa      60
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aaagcctggc tgactcaccg tcatccggaa gcgctggcga aagcaccgct gggtgcaacc      66
0

gagatgggtc tgatttacgt taaccgggaa ggcccggatc acagcggcga accgctttct      72
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gcggcagcag ctatccgcgc gaccttcggc aacatgggca tgaacgacga agaaaccgtg      78

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gcgctgattg cgggtgggtca tacgctgggt aaaaccacg gtgccggtcc gacatcaaat 84
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gtaggtcctg atccagaagc tgcaccgatt gaagaacaag gtttaggttg ggcgagcact 90
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tacggcagcg gcgttggcgc agatgccatt acctctggtc tggaagtagt ctggaccag 96
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acgccgaccc agtggagcaa ctatttcttc gagaacctgt tcaagtatga gtgggtacag 102
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acccgcagcc cggctggcgc aatccagttc gaagcggtag acgcaccgga aattatcccg 108
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gatccgtttg atccgtcgaa gaaacgtaaa ccgacaatgc tggtagccga cctgacgctg 114
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cgttttgac ctgagttcga gaagatctct cgtcgtttcc tcaacgatcc gcaggcgttc 120
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ggtctgtctg ttagtgagct ggtatcgggt gcctgggcat ctgcttctac cttccgtggt 144
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ggcgacaaac gcggtgggtgc caacggtgcg cgtctggcat taatgccga gcgcgactgg 150
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gatgtgaacg ccgcagccgt tcgtgctctg cctgttctgg agaaaatcca gaaagagtct 156
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aactatcgcg ctcgtctgga cgtttcacc accgagtcac tgctgatcga caaagcacag 180
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caactgacgc tgaccgcgcc ggaaatgact gcgctggtgg gcggcatgcg tgtactgggt 186
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ggcaacttcg atggcagcaa aaacggcgtc ttcactgacc gcgttggcgt attgagcaat 192
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gacttcttcg tgaacttgct ggatatgcgt tacgagtgga aagcgaccga cgaatcgaaa 198
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gagctgttcg aaggccgtga ccgtgaaacc ggcgaaatga aatttacggc cagccgtgcg 204
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gatctggtgt ttggttctaa ctccgtcctg cgtgcggtgg cggaagtta cgccagtagc 210
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gatgcccacg agaagtttgt taaagacttc gtggcggcat gggtgaaagt gatgaacctc 216
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gaccgtttcg acctgctgta a 218
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<210> 43

<211> 401

<212> PRT

<213> Bacillus sp.

<400> 43

Met Ala Lys Ile Val Cys Val Leu Tyr Asp Asp Pro Val Thr Gly Tyr
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Pro Lys Thr Tyr Ala Arg Asp Asp Leu Pro Lys Ile Glu Cys Tyr Pro
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Asp Gly Gln Thr Leu Pro Thr Pro Arg Ala Ile Asp Phe Gln Pro Gly
35 40 45

Ala Leu Leu Gly Ser Val Ser Gly Glu Leu Gly Leu Arg Lys Tyr Leu
50 55 60

Glu Ser Asn Gly His Glu Leu Val Val Thr Ser Ser Lys Asp Gly Asp
65 70 75 80

Asn Ser Val Leu Asp Arg Glu Leu Ala Asp Ala Glu Ile Val Ile Ser
85 90 95

Gln Pro Phe Trp Pro Ala Tyr Met Thr Ala Glu Arg Ile Lys Arg Ala
100 105 110

Lys Lys Leu Lys Met Ile Val Thr Ala Gly Ile Gly Ser Asp His Thr
115 120 125

Asp Leu Gln Ala Ala Met Glu His Gly Ile Thr Val Ala Glu Val Thr
130 135 140

Tyr Cys Asn Ser Asn Ser Val Ala Glu His Val Met Met Thr Thr Leu
145 150 155 160

Ala Leu Val Arg Asn Tyr Leu Pro Ser Tyr Gln Trp Val Leu Lys Gly
165 170 175

Gly Trp Asn Ile Ala Asp Cys Val Glu Arg Ser Tyr Asp Leu Glu Gly
180 185 190

Met His Val Gly Thr Val Ala Ala Gly Arg Ile Gly Leu Arg Val Leu
195 200 205

Arg Leu Met Lys Pro Phe Gly Thr His Leu His Tyr Leu Asp Arg His
210 215 220

Arg Leu Pro Glu Ser Val Glu Lys Glu Leu Asn Leu Thr His His Thr
225 230 235 240

Ser Leu Glu Ser Leu Ala Lys Val Cys Asp Val Val Thr Leu Asn Cys
245 250 255

Pro Leu His Pro Glu Thr Glu His Met Ile Asn Ala Asp Ser Leu Lys
 260 265 270

His Phe Lys Arg Gly Ala Tyr Leu Ile Asn Thr Ala Arg Gly Lys Leu
 275 280 285

Cys Asp Arg Asp Ala Val Ala Ala Ala Leu Glu Ser Gly Gln Leu Ala
 290 295 300

Gly Tyr Gly Gly Asp Val Trp Phe Pro Gln Pro Ala Pro Ala Asp His
 305 310 315 320

Pro Trp Arg Ser Met Pro His His Gly Met Thr Pro His Ile Ser Gly
 325 330 335

Thr Ser Leu Ser Ala Gln Thr Arg Tyr Ala Ala Gly Thr Arg Glu Ile
 340 345 350

Leu Glu Cys Tyr Phe Glu Asn Arg Pro Ile Arg Asn Glu Tyr Leu Ile
 355 360 365

Val Gln Asn Gly Lys Leu Ala Gly Val Gly Ala His Ser Tyr Ser Ala
 370 375 380

Gly Asn Ala Thr Gly Gly Ser Glu Glu Ala Ala Arg Phe Lys Lys Ser
 385 390 395 400

Ala

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 <211> 20
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 <213> Artificial Sequence

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<223> Designed amino acid sequence

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Met	Gly	Ser	Ser	His	His	His	His	His	His	Ser	Ser	Gly	Leu	Val	Pro
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Arg	Gly	Ser	His
			20

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<211> 8

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<220>

<223> Designed amino acid sequence

<400> 45

Leu	Glu	His	His	His	His	His	His
1				5			