SEQUENCE LISTING

<110> BioMarin Pharmaceutical Inc.
Vellard, Michel C
Fitzpatrick, Paul A
Kakkis, Emil D
Wendt, Dan

<120> Compositions of prokaryotic phenylalanine ammonia-lyase and methods of using compositions thereof

<130> 0165 PC10

<150> US 11/451,999
<151> 2006-06-12

<160> 33

<170> PatentIn version 3.4

<210> 1
<211> 1710
<212> DNA
<213> Nostoc punctiforme

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acagccttgt ctcgtttggg tttgccaaag ttgcaattgc aaccgaaaga aggtttagca 660

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<210> 2
<211> 569
<212> PRT
<213> Nostoc punctiforme

<400> 2

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Pro Phe Thr Asn Ser Ser Asp Ser Ile Val Thr Val Gly Asp Arg Asn
20 25 30

Leu Thr Ile Asp Glu Val Val Asn Val Ala Arg His Gly Thr Gln Val
35 40 45

Arg Leu Thr Asp Asn Ala Asp Val Ile Arg Gly Val Gln Ala Ser Cys
50 55 60

Asp Tyr Ile Asn Asn Ala Val Glu Thr Ala Gln Pro Ile Tyr Gly Val
65 70 75 80

Thr Ser Gly Phe Gly Gly Met Ala Asp Val Val Ile Ser Arg Glu Gln
85 90 95

Ala Ala Glu Leu Gln Thr Asn Leu Ile Trp Phe Leu Lys Ser Gly Ala
100 105 110

Gly Asn Lys Leu Ser Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
115 120 125

Ala Asn Ser His Leu Tyr Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
130 135 140

Gln Arg Ile Glu Thr Phe Leu Asn Ala Gly Val Thr Pro His Val Tyr
145 150 155 160

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

Ile Thr Gly Ala Leu Ile Gly Leu Asp Pro Ser Phe Thr Val Asp Phe

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            180                 185                 190

Asp Gly Lys Glu Met Asp Ala Val Thr Ala Leu Ser Arg Leu Gly Leu
        195                 200                 205

Pro Lys Leu Gln Leu Gln Pro Lys Glu Gly Leu Ala Met Met Asn Gly
    210                 215                 220

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Ala Lys
225                 230                 235                 240

Val Leu Leu Ala Leu Thr Met Gly Val His Ala Leu Ala Ile Gln Gly
                245                 250                 255

Leu Tyr Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Gln Cys Lys
            260                 265                 270

Pro His Pro Gly Gln Leu Trp Thr Ala Asp Gln Met Phe Ser Leu Leu
        275                 280                 285

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

Arg Gly Lys Asp Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Ala
305                 310                 315                 320

Gln Phe Ile Gly Pro Ile Val Asp Gly Val Ser Glu Ile Thr Lys Gln
                325                 330                 335

Ile Glu Val Glu Met Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
            340                 345                 350

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

Gly Val Thr Met Asp Arg Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
    370                 375                 380

His Ile Asp Val Gln Ile Ala Leu Leu Val Ser Pro Glu Phe Ser Asn
385                 390                 395                 400

Gly Leu Pro Pro Ser Leu Val Gly Asn Ser Asp Arg Lys Val Asn Met
                405                 410                 415

Gly Leu Lys Gly Leu Gln Ile Ser Gly Asn Ser Ile Met Pro Leu Leu
            420                 425                 430

Ser Phe Tyr Gly Asn Ser Leu Ala Asp Arg Phe Pro Thr His Ala Glu
        435                 440                 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Ile Ser Ala Asn Leu
    450                 455                 460
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Thr Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Met Ala Ile Ala Leu
465                 470                 475                 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Met Lys Gly
                485                 490                 495

His Tyr Asp Ala Arg Thr Cys Leu Ser Pro Asn Thr Val Gln Leu Tyr
            500                 505                 510

Thr Ala Val Cys Glu Val Val Gly Lys Pro Leu Thr Ser Val Arg Pro
        515                 520                 525

Tyr Ile Trp Asn Asp Asn Glu Gln Cys Leu Asp Glu His Ile Ala Arg
    530                 535                 540

Ile Ser Ala Asp Ile Ala Gly Gly Gly Leu Ile Val Gln Ala Val Glu
545                 550                 555                 560

His Ile Phe Ser Ser Leu Lys Ser Thr
                565
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<210> 3
<211> 1704
<212> DNA
<213> Anabaena variabilis

<400> 3

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gtagcgcgta atggcacctt agtgtcttta accaataaca ctgatatttt gcagggtatt    180

caggcatctt gtgattacat taataatgct gttgaatctg gggaaccaat ttatggagtg    240

acatctggtt ttggcggtat ggccaatgtt gccatatccc gtgaacaagc atctgaactc    300

caaaccaact tagtttggtt cctgaaaaca ggtgcaggga acaaattacc cttggcggat    360

gtgcgcgcag ctatgctctt gcgtgcaaac tctcatatgc gcggtgcatc tggcatcaga    420

ttagaactta tcaagcgtat ggagattttc cttaacgctg gtgtcacacc atatgtgtat    480

gagtttggtt caattggtgc aagtggtgat ttagtgccac tatcctacat tactggttca    540

ctgataggct tagatcccag ttttaaggtt gacttcaacg gtaaagaaat ggatgcgcca    600

acagctctac gtcaactgaa tttgtcaccc ttgacattgt tgccgaagga aggcttggcg    660

atgatgaacg gcacttcagt catgacaggt attgcagcaa actgcgtcta cgatactcaa    720

attttaactg cgatcgctat gggcgttcac gctctagata tccaagcttt aaacggaacc    780

aatcaatcat tccatccatt tatccataat tccaaaccac atcctggtca attatgggca    840

gcagatcaga tgatttcttt gttagccaat tcccagttag ttcgtgatga gttagatggt    900

aaacacgatt atcgtgatca cgagttgatt caagatcgtt actcactccg atgccttccc    960

cagtatttgg ggccaatcgt tgatggaatt tcccagattg ccaaacaaat tgaaatcgaa   1020
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atcaactcag tcaccgataa cccactaatt gatgttgata accaagctag ctatcatgga 1080

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ggactaccac catctttatt aggcaaccga gaacgtaaag tcaatatggg actcaaaggt 1260

ctgcaaatat gcggtaactc aattatgcca ctgttgacct tctatggaaa ttccatcgcc 1320

gatcgctttc ctacccatgc agaacaattt aatcagaaca tcaacagtca aggatacact 1380

tcagcgactc tagcccgccg ttctgtggat atcttccaga attatgtggc gatcgctctg 1440

atgtttggag tccaagctgt tgacctccgc acatataaaa agactggtca ttacgatgca 1500

cgcgcctgtc tatcacctgc aactgagcgc ttatattcag cagtccgcca cgtagttgga 1560

caaaaaccaa cttcagatcg cccatatatt tggaatgata atgagcaagg actggatgag 1620

catattgccc ggatttctgc tgatatcgct gctggtggtg tgattgtgca agcagttcaa 1680

gatatcttac cctgcttgca ttaa 1704

<210> 4
<211> 567
<212> PRT
<213> Anabaena variabilis

<400> 4

Met Lys Thr Leu Ser Gln Ala Gln Ser Lys Thr Ser Ser Gln Gln Phe
1 5 10 15

Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
20 25 30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
35 40 45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Cys
50 55 60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65 70 75 80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
85 90 95

Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
100 105 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
115 120 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
130 135 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145 150 155 160

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

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
180 185 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
195 200 205

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

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225 230 235 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
245 250 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
260 265 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
275 280 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr
290 295 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Pro
305 310 315 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
325 330 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
340 345 350

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

Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
370 375 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385 390 395 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
405 410 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu

420 425 430

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
435 440 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
450 455 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465 470 475 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
485 490 495

His Tyr Asp Ala Arg Ala Cys Leu Ser Pro Ala Thr Glu Arg Leu Tyr
500 505 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
515 520 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
530 535 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545 550 555 560

Asp Ile Leu Pro Cys Leu His
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<210> 5
<211> 523
<212> PRT
<213> Streptomyces maritimus

<400> 5

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20 25 30

Arg Ser Arg Val Arg Ala Ser Arg Asp Val Leu Val Lys Phe Val Gln
35 40 45

Asp Glu Arg Val Ile Tyr Gly Val Asn Thr Ser Met Gly Gly Phe Val
50 55 60

Asp His Leu Val Pro Val Ser Gln Ala Arg Gln Leu Gln Glu Asn Leu
65 70 75 80

Ile Asn Ala Val Ala Thr Asn Val Gly Ala Tyr Leu Asp Asp Thr Thr
85 90 95

```
Ala Arg Thr Ile Met Leu Ser Arg Ile Val Ser Leu Ala Arg Gly Asn
            100                 105                 110

Ser Ala Ile Thr Pro Ala Asn Leu Asp Lys Leu Val Ala Val Leu Asn
        115                 120                 125

Ala Gly Ile Val Pro Cys Ile Pro Glu Lys Gly Ser Leu Gly Thr Ser
    130                 135                 140

Gly Asp Leu Gly Pro Leu Ala Ala Ile Ala Leu Val Cys Ala Gly Gln
145                 150                 155                 160

Trp Lys Ala Arg Tyr Asn Gly Gln Ile Met Pro Gly Arg Gln Ala Leu
                165                 170                 175

Ser Glu Ala Gly Val Glu Pro Met Glu Leu Ser Tyr Lys Asp Gly Leu
            180                 185                 190

Ala Leu Ile Asn Gly Thr Ser Gly Met Val Gly Leu Gly Thr Met Val
        195                 200                 205

Leu Gln Ala Ala Arg Arg Leu Val Asp Arg Tyr Leu Gln Val Ser Ala
    210                 215                 220

Leu Ser Val Glu Gly Leu Ala Gly Met Thr Lys Pro Phe Asp Pro Arg
225                 230                 235                 240

Val His Gly Val Lys Pro His Arg Gly Gln Arg Gln Val Ala Ser Arg
                245                 250                 255

Leu Trp Glu Gly Leu Ala Asp Ser His Leu Ala Val Asn Glu Leu Asp
            260                 265                 270

Thr Glu Gln Thr Leu Ala Gly Glu Met Gly Thr Val Ala Lys Ala Gly
        275                 280                 285

Ser Leu Ala Ile Glu Asp Ala Tyr Ser Ile Arg Cys Thr Pro Gln Ile
    290                 295                 300

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

Asp Glu Leu Asn Ser Ser Asn Asp Asn Pro Ile Val Leu Pro Glu Glu
                325                 330                 335

Ala Glu Val Phe His Asn Gly His Phe His Gly Gln Tyr Val Ala Met
            340                 345                 350

Ala Met Asp His Leu Asn Met Ala Leu Ala Thr Val Thr Asn Leu Ala
        355                 360                 365
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Asn Arg Arg Val Asp Arg Phe Leu Asp Lys Ser Asn Ser Asn Gly Leu
370 375 380

Pro Ala Phe Leu Cys Arg Glu Asp Pro Gly Leu Arg Leu Gly Leu Met
385 390 395 400

Gly Gly Gln Phe Met Thr Ala Ser Ile Thr Ala Glu Thr Arg Thr Leu
405 410 415

Thr Ile Pro Met Ser Val Gln Ser Leu Thr Ser Thr Ala Asp Phe Gln
420 425 430

Asp Ile Val Ser Phe Gly Phe Val Ala Ala Arg Arg Ala Arg Glu Val
435 440 445

Leu Thr Asn Ala Ala Tyr Val Val Ala Phe Glu Leu Leu Cys Ala Cys
450 455 460

Gln Ala Val Asp Ile Arg Gly Ala Asp Lys Leu Ser Ser Phe Thr Arg
465 470 475 480

Pro Leu Tyr Glu Arg Thr Arg Lys Ile Val Pro Phe Phe Asp Arg Asp
485 490 495

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

Gly Glu Pro Val Asp Ala Ala Val Ala Ala His
515 520

<210> 6
<211> 510
<212> PRT
<213> Pseudomonas putida

<400> 6

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Arg Ala Ile His Ala Ala Pro Val Arg Leu Gln Leu Asp Ala Ser Ala
20 25 30

Ala Pro Ala Ile Asp Ala Ser Val Ala Cys Val Glu Gln Ile Ile Ala
35 40 45

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

Ser Thr Arg Ile Ala Ser His Asp Leu Glu Asn Leu Gln Arg Ser Leu
65 70 75 80

Val Leu Ser His Ala Ala Gly Ile Gly Ala Pro Leu Asp Asp Asp Leu
85 90 95

```
Val Arg Leu Ile Met Val Leu Lys Ile Asn Ser Leu Ser Arg Gly Phe
            100                 105                 110

Ser Gly Ile Arg Arg Lys Val Ile Asp Ala Leu Ile Ala Leu Val Asn
        115                 120                 125

Ala Glu Val Tyr Pro His Ile Pro Leu Lys Gly Ser Val Gly Ala Ser
    130                 135                 140

Gly Asp Leu Ala Pro Leu Ala Thr Met Ser Leu Val Leu Leu Gly Glu
145                 150                 155                 160

Gly Lys Ala Arg Tyr Lys Gly Gln Trp Leu Ser Ala Thr Glu Ala Leu
                165                 170                 175

Ala Val Ala Gly Leu Glu Pro Leu Thr Leu Ala Ala Lys Glu Gly Leu
            180                 185                 190

Ala Leu Leu Asn Gly Thr Gln Ala Ser Thr Ala Tyr Ala Leu Arg Gly
        195                 200                 205

Leu Phe Tyr Ala Glu Asp Leu Tyr Ala Ala Ala Ile Ala Cys Gly Gly
    210                 215                 220

Leu Ser Val Glu Ala Val Leu Gly Ser Arg Ser Pro Phe Asp Ala Arg
225                 230                 235                 240

Ile His Glu Ala Arg Gly Gln Arg Gly Gln Ile Asp Thr Ala Ala Cys
                245                 250                 255

Phe Arg Asp Leu Leu Gly Asp Ser Ser Glu Val Ser Leu Ser His Lys
            260                 265                 270

Asn Cys Asp Lys Val Gln Asp Pro Tyr Ser Leu Arg Cys Gln Pro Gln
        275                 280                 285

Val Met Gly Ala Cys Leu Thr Gln Leu Arg Gln Ala Ala Glu Val Leu
    290                 295                 300

Gly Ile Glu Ala Asn Ala Val Ser Asp Asn Pro Leu Val Phe Ala Ala
305                 310                 315                 320

Glu Gly Asp Val Ile Ser Gly Gly Asn Phe His Ala Glu Pro Val Ala
                325                 330                 335

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

Ser Glu Arg Arg Ile Ser Leu Met Met Asp Lys His Met Ser Gln Leu
        355                 360                 365
```

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Pro Pro Phe Leu Val Glu Asn Gly Gly Val Asn Ser Gly Phe Met Ile
    370                 375                 380

Ala Gln Val Thr Ala Ala Ala Leu Ala Ser Glu Asn Lys Ala Leu Ser
385                 390                 395                 400

His Pro His Ser Val Asp Ser Leu Pro Thr Ser Ala Asn Gln Glu Asp
                405                 410                 415

His Val Ser Met Ala Pro Ala Ala Gly Lys Arg Leu Trp Glu Met Ala
            420                 425                 430

Glu Asn Thr Arg Gly Val Pro Ala Ile Glu Trp Leu Gly Ala Cys Gln
        435                 440                 445

Gly Leu Asp Leu Arg Lys Gly Leu Lys Thr Ser Ala Lys Leu Glu Lys
    450                 455                 460

Ala Arg Gln Ala Leu Arg Ser Glu Val Ala His Tyr Asp Arg Asp Arg
465                 470                 475                 480

Phe Phe Ala Pro Asp Ile Glu Lys Ala Val Glu Leu Leu Ala Lys Gly
                485                 490                 495

Ser Leu Thr Gly Leu Leu Pro Ala Gly Val Leu Pro Ser Leu
            500                 505                 510
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<210> 7
<211> 567
<212> PRT
<213> Artificial

<220>
<223> Cysteine to serine substitution at position 64 in Anabaena variabilis PAL

<400> 7

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Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
            20                  25                  30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
        35                  40                  45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Ser
    50                  55                  60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65                  70                  75                  80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
```

```
                85                  90                  95

Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
            100                 105                 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
        115                 120                 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
    130                 135                 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145                 150                 155                 160

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

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
            180                 185                 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
        195                 200                 205

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

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225                 230                 235                 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
                245                 250                 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
            260                 265                 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
        275                 280                 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr
    290                 295                 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Pro
305                 310                 315                 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
                325                 330                 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
            340                 345                 350

Asp Asn Gln Ala Ser Tyr His Gly Gly Asn Phe Leu Gly Gln Tyr Val
        355                 360                 365
```

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Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
    370                 375                 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385                 390                 395                 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
                405                 410                 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu
            420                 425                 430

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
        435                 440                 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
    450                 455                 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465                 470                 475                 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
                485                 490                 495

His Tyr Asp Ala Arg Ala Cys Leu Ser Pro Ala Thr Glu Arg Leu Tyr
            500                 505                 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
        515                 520                 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
    530                 535                 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545                 550                 555                 560

Asp Ile Leu Pro Cys Leu His
                565
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<210> 8
<211> 567
<212> PRT
<213> Artificial

<220>
<223> Cysteine to serine substitution at position 318 in Anabaena variabilis PAL

<400> 8

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Met Lys Thr Leu Ser Gln Ala Gln Ser Lys Thr Ser Ser Gln Gln Phe
1               5                   10                  15
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Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
20 25 30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
35 40 45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Cys
50 55 60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65 70 75 80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
85 90 95

Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
100 105 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
115 120 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
130 135 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145 150 155 160

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

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
180 185 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
195 200 205

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

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225 230 235 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
245 250 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
260 265 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
275 280 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr

```
    290                 295                 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Ser Leu Pro
305                 310                 315                 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
                325                 330                 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
            340                 345                 350

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

Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
    370                 375                 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385                 390                 395                 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
                405                 410                 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu
            420                 425                 430

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
        435                 440                 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
    450                 455                 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465                 470                 475                 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
                485                 490                 495

His Tyr Asp Ala Arg Ala Cys Leu Ser Pro Ala Thr Glu Arg Leu Tyr
            500                 505                 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
        515                 520                 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
    530                 535                 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545                 550                 555                 560

Asp Ile Leu Pro Cys Leu His
                565
```

<210> 9
<211> 567
<212> PRT
<213> Artificial

<220>
<223> Cysteine to serine substitution at position 503 in Anabaena variabilis PAL

<400> 9

```
Met Lys Thr Leu Ser Gln Ala Gln Ser Lys Thr Ser Ser Gln Gln Phe
1               5                   10                  15

Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
            20                  25                  30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
        35                  40                  45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Cys
    50                  55                  60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65                  70                  75                  80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
                85                  90                  95

Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
            100                 105                 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
        115                 120                 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
    130                 135                 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145                 150                 155                 160

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

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
            180                 185                 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
        195                 200                 205

Ser Pro Leu Thr Leu Leu Pro Lys Glu Gly Leu Ala Met Met Asn Gly
    210                 215                 220
```

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225 230 235 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
245 250 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
260 265 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
275 280 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr
290 295 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Pro
305 310 315 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
325 330 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
340 345 350

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

Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
370 375 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385 390 395 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
405 410 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu
420 425 430

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
435 440 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
450 455 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465 470 475 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
485 490 495

His Tyr Asp Ala Arg Ala Ser Leu Ser Pro Ala Thr Glu Arg Leu Tyr

500 505 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
515 520 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
530 535 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545 550 555 560

Asp Ile Leu Pro Cys Leu His
565

<210> 10
<211> 567
<212> PRT
<213> Artificial

<220>
<223> Cysteine to serine substition at position 565 in Anabaena variabilis PAL

<400> 10

Met Lys Thr Leu Ser Gln Ala Gln Ser Lys Thr Ser Ser Gln Gln Phe
1 5 10 15

Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
20 25 30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
35 40 45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Cys
50 55 60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65 70 75 80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
85 90 95

Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
100 105 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
115 120 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
130 135 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145 150 155 160

```
Glu Phe Gly Ser Ile Gly Ala Ser Gly Asp Leu Val Pro Leu Ser Tyr
                165                 170                 175

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
            180                 185                 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
        195                 200                 205

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

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225                 230                 235                 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
                245                 250                 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
            260                 265                 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
        275                 280                 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr
    290                 295                 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Pro
305                 310                 315                 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
                325                 330                 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
            340                 345                 350

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

Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
    370                 375                 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385                 390                 395                 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
                405                 410                 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu
            420                 425                 430
```

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
435 440 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
450 455 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465 470 475 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
485 490 495

His Tyr Asp Ala Arg Ala Cys Leu Ser Pro Ala Thr Glu Arg Leu Tyr
500 505 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
515 520 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
530 535 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545 550 555 560

Asp Ile Leu Pro Ser Leu His
565

<210> 11
<211> 567
<212> PRT
<213> Artificial

<220>
<223> Cysteine to serine substitutions at positions 565 and 503 in Anabaena variabilis PAL

<400> 11

Met Lys Thr Leu Ser Gln Ala Gln Ser Lys Thr Ser Ser Gln Gln Phe
1 5 10 15

Ser Phe Thr Gly Asn Ser Ser Ala Asn Val Ile Ile Gly Asn Gln Lys
20 25 30

Leu Thr Ile Asn Asp Val Ala Arg Val Ala Arg Asn Gly Thr Leu Val
35 40 45

Ser Leu Thr Asn Asn Thr Asp Ile Leu Gln Gly Ile Gln Ala Ser Cys
50 55 60

Asp Tyr Ile Asn Asn Ala Val Glu Ser Gly Glu Pro Ile Tyr Gly Val
65 70 75 80

Thr Ser Gly Phe Gly Gly Met Ala Asn Val Ala Ile Ser Arg Glu Gln
85 90 95

```
Ala Ser Glu Leu Gln Thr Asn Leu Val Trp Phe Leu Lys Thr Gly Ala
            100                 105                 110

Gly Asn Lys Leu Pro Leu Ala Asp Val Arg Ala Ala Met Leu Leu Arg
        115                 120                 125

Ala Asn Ser His Met Arg Gly Ala Ser Gly Ile Arg Leu Glu Leu Ile
    130                 135                 140

Lys Arg Met Glu Ile Phe Leu Asn Ala Gly Val Thr Pro Tyr Val Tyr
145                 150                 155                 160

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

Ile Thr Gly Ser Leu Ile Gly Leu Asp Pro Ser Phe Lys Val Asp Phe
            180                 185                 190

Asn Gly Lys Glu Met Asp Ala Pro Thr Ala Leu Arg Gln Leu Asn Leu
        195                 200                 205

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

Thr Ser Val Met Thr Gly Ile Ala Ala Asn Cys Val Tyr Asp Thr Gln
225                 230                 235                 240

Ile Leu Thr Ala Ile Ala Met Gly Val His Ala Leu Asp Ile Gln Ala
                245                 250                 255

Leu Asn Gly Thr Asn Gln Ser Phe His Pro Phe Ile His Asn Ser Lys
            260                 265                 270

Pro His Pro Gly Gln Leu Trp Ala Ala Asp Gln Met Ile Ser Leu Leu
        275                 280                 285

Ala Asn Ser Gln Leu Val Arg Asp Glu Leu Asp Gly Lys His Asp Tyr
    290                 295                 300

Arg Asp His Glu Leu Ile Gln Asp Arg Tyr Ser Leu Arg Cys Leu Pro
305                 310                 315                 320

Gln Tyr Leu Gly Pro Ile Val Asp Gly Ile Ser Gln Ile Ala Lys Gln
                325                 330                 335

Ile Glu Ile Glu Ile Asn Ser Val Thr Asp Asn Pro Leu Ile Asp Val
            340                 345                 350

Asp Asn Gln Ala Ser Tyr His Gly Gly Asn Phe Leu Gly Gln Tyr Val
        355                 360                 365
```

Gly Met Gly Met Asp His Leu Arg Tyr Tyr Ile Gly Leu Leu Ala Lys
370 375 380

His Leu Asp Val Gln Ile Ala Leu Leu Ala Ser Pro Glu Phe Ser Asn
385 390 395 400

Gly Leu Pro Pro Ser Leu Leu Gly Asn Arg Glu Arg Lys Val Asn Met
405 410 415

Gly Leu Lys Gly Leu Gln Ile Cys Gly Asn Ser Ile Met Pro Leu Leu
420 425 430

Thr Phe Tyr Gly Asn Ser Ile Ala Asp Arg Phe Pro Thr His Ala Glu
435 440 445

Gln Phe Asn Gln Asn Ile Asn Ser Gln Gly Tyr Thr Ser Ala Thr Leu
450 455 460

Ala Arg Arg Ser Val Asp Ile Phe Gln Asn Tyr Val Ala Ile Ala Leu
465 470 475 480

Met Phe Gly Val Gln Ala Val Asp Leu Arg Thr Tyr Lys Lys Thr Gly
485 490 495

His Tyr Asp Ala Arg Ala Ser Leu Ser Pro Ala Thr Glu Arg Leu Tyr
500 505 510

Ser Ala Val Arg His Val Val Gly Gln Lys Pro Thr Ser Asp Arg Pro
515 520 525

Tyr Ile Trp Asn Asp Asn Glu Gln Gly Leu Asp Glu His Ile Ala Arg
530 535 540

Ile Ser Ala Asp Ile Ala Ala Gly Gly Val Ile Val Gln Ala Val Gln
545 550 555 560

Asp Ile Leu Pro Ser Leu His
565

<210> 12
<211> 38
<212> DNA
<213> Artificial

<220>
<223> Nostoc punctiforme PAL primer 1 (forward)

<400> 12
cactgtcata tgaatataac atctctacaa cagaacat 38

<210> 13
<211> 45
<212> DNA
<213> Artificial

<220>
<223> Nostoc punctiforme PAL primer 2 (reverse)

<400> 13
gacagtggcg gccgctcacg ttgactttaa gctcgaaaaa atatg 45

<210> 14
<211> 38
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer 1 (forward, N-terminal fragment)

<400> 14
cactgtgcta gcatgaagac actatctcaa gcacaaag 38

<210> 15
<211> 49
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer 2 (reverse, N-terminal fragment)

<400> 15
ggaaatttcc tccatgatag ctggcttggt tatcaacatc aattagtgg 49

<210> 16
<211> 49
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer 3 (forward, C-terminal fragment)

<400> 16
ccactaattg atgttgataa ccaagccagc tatcatggag gaaatttcc 49

<210> 17
<211> 41
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer 4 (reverse, C-terminal fragment)

<400> 17
cactgtgcgg ccgcttaatg caagcagggt aagatatctt g 41

<210> 18
<211> 35
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL forward primer

<400> 18
cactgtcata tgaagacact atctcaagca caaag 35

<210> 19

<211> 36
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL reverse primer

<400> 19
cactgtctcg agatgcaagc agggtaagat atcttg 36

<210> 20
<211> 38
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create 5' NheI site and delete internal NheI site (forward, N-terminal)

<400> 20
cactgtgcta gcatgaagac actatctcaa gcacaaag 38

<210> 21
<211> 49
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create 5' NheI site and delete internal NheI site (reverse, N-terminal)

<400> 21
ggaaatttcc tccatgatag ctggcttggt tatcaacatc aattagtgg 49

<210> 22
<211> 49
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create 5' NheI site and delete internal NheI site (forward, C-terminal fragment)

<400> 22
ccactaattg atgttgataa ccaagccagc tatcatggag gaaatttcc 49

<210> 23
<211> 41
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create 5' NheI site and delete internal NheI site (reverse, C-terminal fragment)

<400> 23
acagtggcgg ccgcttaatg caagcagggt aagatatctt g 41

<210> 24
<211> 38
<212> DNA
<213> Artificial

<220>

<223> Anabaena variabilis PAL primer to create 5' NheI site and 3' SmaI site (forward)

<400> 24
cactgtgaat tcatgaagac actatctcaa gcacaaag 38

<210> 25
<211> 37
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create 5' NheI site and 3' SmaI site (reverse)

<400> 25
cactgtcccg ggttaatgca agcagggtaa gatatct 37

<210> 26
<211> 41
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 503 (forward)

<400> 26
gtcattacga tgcacgcgcc tctctatcac ctgcaactga g 41

<210> 27
<211> 41
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 503 (reverse)

<400> 27
ctcagttgca ggtgatagag aggcgcgtgc atcgtaatga c 41

<210> 28
<211> 42
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 565 (forward)

<400> 28
cagttcaaga tatcttaccc tccttgcatt aacccgggct gc 42

<210> 29
<211> 42
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 565 (reverse)

<400> 29

gcagcccggg ttaatgcaag gagggtaaga tatcttgaac tg 42

<210> 30
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 64 (forward)

<400> 30
gcagggtatt caggcatctt ctgattacat taataatgct gttg 44

<210> 31
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 64 (reverse)

<400> 31
caacagcatt attaatgtaa tcagaagatg cctgaatacc ctgc 44

<210> 32
<211> 43
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 318 (forward)

<400> 32
caagatcgtt actcactccg atcccttccc cagtatttgg ggc 43

<210> 33
<211> 43
<212> DNA
<213> Artificial

<220>
<223> Anabaena variabilis PAL primer to create cysteine to serine substitution at position 318 (reverse)

<400> 33
gccccaaata ctggggaagg gatcggagtg agtaacgatc ttg 43