eolf-seql

SEQUENCE LISTING

<110> CureVac AG

<120> Immobilized poly(N)polymerase

<130> C9810WO2 / RN

<150> PCT/EP2015/059611
<151> 30.04.2015

<150> GB1507504.7
<151> 30.04.2015

<160> 203

<170> PatentIn version 3.5

<210> 1
<211> 454
<212> PRT
<213> Escherichia coli

<400> 1

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95
```

```
Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285
```

```
Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 2
<211> 438
<212> PRT

<213> Thermus aquaticus

<400> 2

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110


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


Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140


Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160


Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175
```

```
Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Cys Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365
```

```
Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly
        435
```

<210> 3
<211> 435
<212> PRT
<213> Meiothermus silvanus

<400> 3

```
Met Leu Val Ala Ile Arg Arg Val His Leu Ser Pro Phe Pro Phe Pro
1               5                   10                  15

Ala Gln Gly Tyr Leu Val Gly Gly Ala Val Arg Asp Leu Met Leu Gly
            20                  25                  30

Lys Arg Pro Lys Asp Leu Asp Phe Val Val Pro Asn Pro Glu Glu Ala
        35                  40                  45

Ala Arg Asp Leu Ala His Arg Leu Gly Gly Ser Ile Phe Pro Leu Asp
    50                  55                  60

Glu Lys Arg Arg Phe Trp Arg Val Val Ala Pro Gly Thr Thr Tyr Asp
65                  70                  75                  80

Tyr Ala Pro Met Pro Gln Gly Leu Glu Val Asp Leu Leu Arg Arg Asp
```

```
                85                  90                  95

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

Leu Pro Ile Ala Arg Tyr Asp Leu Glu His Arg Leu Leu Arg Ala Ile
        115                 120                 125

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

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

Trp Ile Tyr Glu His Ala Gln Tyr Leu Arg Glu Ser Gly Ala Leu Pro
                165                 170                 175

Ala Trp Glu Arg Val Gly Glu Glu Leu Ser Gln Ile Leu Arg His Pro
            180                 185                 190

Ala Ala Ala Val Gly Phe Leu Arg Leu Glu Arg Ala Gly Leu Leu Glu
        195                 200                 205

Val Tyr Leu Pro Glu Leu Ala Ala Gly Ile Gly Val Glu Gln His Gly
    210                 215                 220

Ala His His Leu Asp Val Trp Arg His Ser Leu Glu Val Leu Ala Gln
225                 230                 235                 240

Leu Thr Leu Leu Arg Pro Asp Ala His Leu Ala Leu Arg Trp Ala Ala
                245                 250                 255

Leu Leu His Asp Val Ala Lys Pro Gln Thr Arg Gln Trp Ser Pro Glu
            260                 265                 270

Lys Gly Arg Tyr Thr Phe Tyr Gly His Asp Ala Leu Gly Ala Glu Gln
```

```
        275                 280                 285

Ala Arg Gln Ile Leu Asn Arg Leu Arg Gln Pro Ser Glu Val Val Ala
    290                 295                 300

Glu Ala Val Arg Leu Val Arg Leu His Met Gln His Pro Pro Gln Gly
305                 310                 315                 320

Gly Arg Glu Leu Arg Arg Phe Leu His Arg Arg Arg Glu Ala Leu Pro
                325                 330                 335

Glu Leu Ile Trp Leu Gln Leu Ala Asp Met Thr Gly Ile Leu Gly Tyr
            340                 345                 350

Arg Glu Arg Val Glu Glu Leu Arg Glu Gln Leu Gln Ala Ile Glu Ser
        355                 360                 365

Leu Ala Glu Gly Thr Pro Ser Pro Lys Pro Leu Leu Asp Gly Arg Glu
    370                 375                 380

Val Met Arg Leu Leu Gly Leu Glu Pro Gly Pro Lys Val Gly Glu Ala
385                 390                 395                 400

Leu Ala Ala Leu Leu Glu Ala Gln Ala Ile Gly Glu Val Gln Ser Arg
                405                 410                 415

Thr Glu Ala Ala Ser Phe Leu Arg Asp Ala Phe Gly Glu Asp Lys Gly
            420                 425                 430

Arg Met Ser
        435
```

<210> 4
<211> 454
<212> PRT
<213> Shigella flexneri

<400> 4

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190
```

```
Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Ser Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380
```

```
Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Thr
    450


<210>  5
<211>  454
<212>  PRT
<213>  Shigella dysenteriae

<400>  5

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80
```

```
Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270
```

```
Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Lys Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 6
<211> 454
<212> PRT
<213> Citrobacter koseri

<400> 6

```
Met Leu Asn Arg Glu Glu Ser Glu Ala Glu Leu Ala Val Ala Arg Pro
1               5                  10                  15


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


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Asp Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Asp Ser Asp Arg Ala Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Asp Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Phe Glu Thr Tyr Lys Lys Leu Arg
                245                 250                 255

Glu Tyr Ser Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Ala Met Glu Arg Ile Ile Ala Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Asn Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Met Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Glu Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Asn Asn Ala Glu Leu Gln Arg Leu Ala Gln Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Asp Pro Ala Pro Arg Arg Arg His Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 7
<211> 454
<212> PRT
<213> Salmonella bongori

<400> 7

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

His Met Thr Ile Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
```

```
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Asp Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Ser Glu Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu
                165                 170                 175

Lys Glu Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Asn Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Lys Leu Arg
```

```
                245                 250                 255

Glu Tyr Asn Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Ala Met Glu Arg Ile Ile Ala Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Glu Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Met Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Glu Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Phe Asp Leu Leu Glu Leu Arg Ala Gln Val Glu
385                 390                 395                 400

Asn Asn Ala Glu Leu Gln Arg Leu Ala Lys Trp Trp Ser Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Glu Gln Lys Gly Met Leu Asn Glu Leu Asp Asp
            420                 425                 430

Asp Pro Ala Pro Arg Arg Arg Arg Pro Arg Pro Arg Arg Arg Ala Pro
```

435 440 445

Arg Arg Glu Gly Ala Ala
450

<210> 8
<211> 443
<212> PRT
<213> Salmonella enterica

<400> 8

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

His Met Thr Ile Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Leu Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Tyr Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Asp Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Ser Glu Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

```
Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu
                165                 170                 175

Gln Glu Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Asn Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Ala Met Glu Arg Ile Ile Ala Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Asn Arg Ile Arg Asn Glu Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Met Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu
                325                 330                 335
```

```
Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Phe Asp Leu Leu Glu Leu Arg Ala Gln Val Glu
385                 390                 395                 400

Asn Asn Thr Glu Leu Gln Arg Leu Ala Gln Trp Trp Ala Glu Phe Gln
                405                 410                 415

Ala Ser Ala Pro Pro Glu Gln Lys Gly Met Leu Asn Glu Leu Asp Asp
            420                 425                 430

Asp Pro Ala Pro Arg Arg Arg Arg Ser Arg Pro
        435                 440
```

<210> 9
<211> 453
<212> PRT
<213> Trabulsiella guamensis

<400> 9

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Ile Val Val Ala Arg Pro
1               5                   10                  15

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

Ile Ser Glu Asn Ala Leu Lys Val Leu Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45
```

```
Tyr Glu Ala Tyr Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Ser Ala Thr Pro Asp Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Ser Ser Ile Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Ile Asn Asp Val Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240
```

```
Lys Leu Leu Gln Ala Gly Tyr Gly Phe Glu Thr Trp Asn Leu Leu Arg
                245                 250                 255

Glu Tyr Ser Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Ala Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Glu Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Met Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Ile Thr Thr Leu Val Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro
    370                 375                 380

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

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

Val Ala Ala Pro Pro Glu Gln Lys Asp Met Leu Thr Asp Leu Gly Asp
            420                 425                 430
```

```
Glu Pro Ala Arg Arg Arg His Arg Arg Pro Arg Lys Arg Thr Pro Arg
        435                 440                 445


Pro Gly Ser Pro Ala
    450
```

<210> 10
<211> 454
<212> PRT
<213> Kluyvera ascorbata

<400> 10

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Asn Ala Val Ala Lys Pro
1               5                   10                  15


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


Ile Ser Glu Asn Ala Leu Lys Val Leu Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Tyr Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Ser Ala Thr Pro Asp Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Asp Gly Gln Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125
```

```
Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu
                165                 170                 175

Ile Asp Gly Val Ile Arg Leu Ile Gly Asp Pro Glu Thr Arg Tyr Arg
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Asp Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Met Asn Asp Val Pro Pro Ala Arg Leu Phe Glu Glu Ala Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Phe Glu Thr Tyr Lys Leu Leu Arg
                245                 250                 255

Glu Tyr Asn Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asp Gly Asp Ser Pro Met Glu Arg Ile Ile Ser Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile Arg Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Met Ala Gln
305                 310                 315                 320
```

Lys Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu
325 330 335

Ala Met Asn Glu Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
340 345 350

Lys Arg Ile Thr Thr Leu Val Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro
370 375 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Ala Glu
385 390 395 400

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

Val Val Ala Pro Pro Ala Gln Lys Asp Met Leu Asn Glu Leu Gly Asp
420 425 430

Glu Pro Asp Thr Arg Arg Arg His Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Ser Ser
450

<210> 11
<211> 436
<212> PRT
<213> Citrobacter freundii

<400> 11

Met Thr Val Ile Pro Arg Glu Gln His Ser Ile Ser Arg Lys Asp Ile
1 5 10 15

Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly Tyr

```
            20                  25                  30

Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly Lys
        35                  40                  45

Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Asp Gln Val
    50                  55                  60

Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg Leu
65                  70                  75                  80

Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe Arg
                85                  90                  95

Gly His His Glu Gly Ser Glu Ala Asp Arg Thr Thr Ser Gln Arg Gly
            100                 105                 110

Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu Glu
        115                 120                 125

Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser Val
    130                 135                 140

Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Gln Asp Leu Glu
145                 150                 155                 160

Glu Gly Ile Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg Glu
                165                 170                 175

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

Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala Thr
        195                 200                 205

Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ala Leu Lys
```

```
    210                 215                 220

Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Lys Leu Arg Glu
225                 230                 235                 240

Tyr Ser Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe Thr
                245                 250                 255

Glu Asp Gly Asp Ser Pro Met Glu Arg Ile Ile Ala Gln Val Leu Lys
            260                 265                 270

Asn Thr Asp Asn Arg Ile Asn Asn Asp Met Arg Val Asn Pro Ala Phe
        275                 280                 285

Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Ala Ala Gln Lys
    290                 295                 300

Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu Ala
305                 310                 315                 320

Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro Lys
                325                 330                 335

Arg Leu Thr Ser Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg Met
            340                 345                 350

Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro Lys
        355                 360                 365

Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu Asn
    370                 375                 380

Asn Ala Glu Leu Gln Arg Leu Ala Gln Trp Trp Gly Glu Phe Gln Val
385                 390                 395                 400

Ser Ala Pro Pro Glu Gln Lys Gly Met Leu Asn Glu Leu Asp Glu Glu
```

405 410 415

Pro Glu Arg Arg Arg His Arg Arg Pro Arg Lys Arg Ala Pro Arg Arg
420 425 430

Glu Gly Ser Ala
435

<210> 12
<211> 447
<212> PRT
<213> Enterobacter cloacae

<400> 12

Met Ala Asn Asp Ala Ile Ala Gln Pro His Met Ser Val Ile Pro Arg
1 5 10 15

Glu Gln His Thr Ile Ser Arg Lys Asp Ile Ser Glu Asn Ala Leu Lys
20 25 30

Val Leu Tyr Arg Leu Asn Lys Ala Gly Tyr Glu Ala Tyr Leu Val Gly
35 40 45

Gly Gly Val Arg Asp Leu Leu Leu Gly Lys Lys Pro Lys Asp Phe Asp
50 55 60

Val Thr Thr Ser Ala Thr Pro Glu Gln Val Arg Lys Leu Phe Arg Asn
65 70 75 80

Cys Arg Leu Val Gly Arg Arg Phe Arg Leu Ala His Val Met Phe Gly
85 90 95

Pro Glu Ile Ile Glu Val Ala Thr Phe Arg Gly His His Glu Ala Gly
100 105 110

Ala Ser Asp Arg Thr Thr Ser Gln Arg Gly Gln Asn Gly Met Leu Leu
115 120 125

```
Arg Asp Asn Ile Phe Gly Ser Ile Glu Glu Asp Ala Gln Arg Arg Asp
    130                 135                 140

Phe Thr Ile Asn Ser Leu Tyr Tyr Ser Val Ala Asp Phe Thr Val Arg
145                 150                 155                 160

Asp Tyr Val Gly Gly Met Gln Asp Leu Lys Glu Gly Leu Ile Arg Leu
                165                 170                 175

Ile Gly Thr Pro Glu Thr Arg Tyr Arg Glu Asp Pro Val Arg Met Leu
            180                 185                 190

Arg Ala Val Arg Phe Ala Ala Lys Leu Asn Met Arg Ile Ser Pro Glu
        195                 200                 205

Thr Ala Glu Pro Ile Pro Arg Leu Ala Thr Leu Ile Asn Asp Val Pro
    210                 215                 220

Pro Ala Arg Leu Phe Glu Glu Ala Leu Lys Leu Leu Gln Ala Gly His
225                 230                 235                 240

Gly Phe Asp Thr Tyr Asn Leu Leu Arg Glu Tyr Asn Leu Phe Gln Pro
                245                 250                 255

Leu Phe Pro Thr Ile Thr Arg Tyr Phe Thr Glu Asn Gly Asp Ser Pro
            260                 265                 270

Met Glu Arg Met Ile Ala Gln Val Leu Lys Asn Thr Asp Thr Arg Ile
        275                 280                 285

Arg Asn Asp Met Arg Val Asn Pro Ala Phe Leu Phe Ala Ala Met Phe
    290                 295                 300

Trp Tyr Pro Leu Leu Glu Thr Ala Gln Arg Ile Thr Gln Glu Ser Gly
305                 310                 315                 320
```

```
Leu Ala Tyr Tyr Asp Ala Phe Ala Leu Ala Ala Asn Asp Val Leu Asp
                325                 330                 335

Glu Gly Cys Arg Thr Leu Ala Ile Pro Lys Arg Ile Thr Thr Leu Val
            340                 345                 350

Arg Asp Ile Trp Gln Leu Gln Leu Arg Met Ser Arg Arg Gln Gly Lys
        355                 360                 365

Arg Ala Trp Lys Leu Met Glu His Pro Lys Phe Arg Ala Ala Phe Asp
    370                 375                 380

Leu Leu Ser Leu Arg Ala Glu Ile Glu Arg Asn Gln Glu Leu Gln Arg
385                 390                 395                 400

Leu Ser Gln Trp Trp Ala Glu Phe Gln Val Ser Ala Pro Pro Glu Gln
                405                 410                 415

Lys Asp Met Leu Thr Gly Leu Asp Glu Glu Pro Glu Pro Arg Arg Arg
            420                 425                 430

His Arg Arg Pro Arg Lys Arg Ala Pro Arg Arg Glu Gly Thr Ala
        435                 440                 445
```

<210> 13
<211> 436
<212> PRT
<213> Enterococcus gallinarum

<400> 13

```
Met Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp Ile
1               5                   10                  15

Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly Tyr
            20                  25                  30
```

```
Glu Ser Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly Lys
        35                  40                  45

Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Asp Gln Val
    50                  55                  60

Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg Leu
65                  70                  75                  80

Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe Arg
                85                  90                  95

Gly His His Glu Gly His Thr Thr Asp Arg Val Thr Ser Gln Arg Gly
            100                 105                 110

Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu Glu
        115                 120                 125

Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser Val
    130                 135                 140

Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu Gln
145                 150                 155                 160

Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg Glu
                165                 170                 175

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

Met Thr Ile Ser Pro Glu Thr Ala Glu Pro Leu Pro Arg Leu Ala Ala
        195                 200                 205

Leu Leu His Asp Val Pro Pro Ala Arg Leu Phe Glu Glu Val Leu Lys
    210                 215                 220
```

```
Leu Leu Gln Ala Gly Tyr Gly Tyr Gln Thr Tyr Met Leu Leu Arg Glu
225                 230                 235                 240


Tyr Ser Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe Thr
                245                 250                 255


Glu Arg Gly Asp Ser Pro Met Glu Arg Ile Ile Ser Gln Val Leu Lys
            260                 265                 270


Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala Phe
        275                 280                 285


Leu Phe Ala Val Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln Lys
    290                 295                 300


Ile Ala Gln Glu Ser Gly Leu Ala Tyr Tyr Asp Ala Phe Ala Leu Ala
305                 310                 315                 320


Met Asn Asp Val Leu Asp Glu Ala Cys Arg Thr Leu Ala Ile Pro Lys
                325                 330                 335


Arg Ile Thr Thr Leu Ile Arg Asp Ile Trp Gln Leu Gln Leu Arg Met
            340                 345                 350


Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Met Glu His Pro Lys
        355                 360                 365


Phe Arg Ala Ala Tyr Asp Leu Leu Glu Leu Arg Ala Gly Ala Glu Asn
    370                 375                 380


Asn His Glu Leu Gln Arg Leu Thr Lys Trp Trp Gly Glu Phe Gln Val
385                 390                 395                 400


Ala Ala Pro Pro Ala Gln Lys Asp Met Leu Asn Asp Leu Gly Asp Asp
                405                 410                 415
```

```
Pro Ala Pro Arg Arg Arg His Arg Arg Pro Arg Lys Arg Ala Pro Arg
            420                 425                 430


Gln Gly Ser Ala
        435
```

<210> 14
<211> 455
<212> PRT
<213> Grimontia indica

<400> 14

```
Met Asn Arg Asp Asn Lys Thr Arg Ala Ile Asp Asp Leu Lys Leu Glu
1               5                   10                  15


Val Ile Pro Arg Gln Glu His Gly Ile Ser Arg Lys Asp Ile Ser Glu
            20                  25                  30


Asn Ala Leu Lys Val Leu Tyr Arg Leu Asn Lys Ala Gly Phe Glu Ala
        35                  40                  45


Tyr Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Asn Lys Gln Pro
    50                  55                  60


Lys Asp Phe Asp Ile Ala Thr Asn Ala Thr Pro Glu Glu Val Arg Lys
65                  70                  75                  80


Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg Leu Ala His
                85                  90                  95


Ile Leu Phe Gly Arg Asp Val Ile Glu Val Ala Thr Phe Arg Gly His
            100                 105                 110


His Gly Ala Asp Lys Gly Asp Lys Ser Ala Ser Gln Ser Asn Asp Gly
        115                 120                 125
```

```
Met Leu Leu Arg Asp Asn Val Tyr Gly Thr Ile Asp Glu Asp Ala Glu
    130                 135                 140

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

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

Ile Arg Leu Ile Gly Asp Pro Glu Thr Arg Tyr Arg Glu Asp Pro Val
            180                 185                 190

Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu Asp Met Gln Ile
        195                 200                 205

Asn Glu Ala Thr Ala Ala Pro Ile Pro Ala Leu Ala His Leu Leu Arg
    210                 215                 220

Asp Ile Pro Ala Ala Arg Leu Phe Glu Glu Ser Leu Lys Leu Leu Gln
225                 230                 235                 240

Ser Gly Asn Gly Leu Asp Thr Tyr Arg Leu Leu Arg Asp Tyr Asn Leu
                245                 250                 255

Phe Ser Pro Leu Phe Pro Ile Leu Asp Glu His Phe Thr Glu Asp Arg
            260                 265                 270

Ser Ser Lys Cys Glu Lys Met Leu Glu Leu Val Leu Lys Ser Thr Asp
        275                 280                 285

Asp Arg Val Ala Asn Asp Gln Arg Ile Asn Pro Ala Phe Met Tyr Ala
    290                 295                 300

Ala Met Leu Trp Tyr Pro Leu Glu Thr Arg Ala Glu Glu Ile Ala Phe
305                 310                 315                 320
```

Glu Ser Gly Leu Ser Tyr Tyr Asp Ala Phe Met Val Ala Ala Asn Asp
325 330 335

Ile Leu Asp Glu Gln Val Lys Ser Ile Ala Ile Pro Arg Arg Phe Thr
340 345 350

Ala Met Ile Arg Asp Ile Trp Gln Leu Gln Leu Arg Leu Ser Arg Arg
355 360 365

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

Ala Phe Asp Phe Leu Glu Met Arg Gly Lys Ile Glu Gly Gly Gln Leu
385 390 395 400

Glu Glu Leu Ala Thr Trp Trp Asp Asp Phe Gln Arg Ala Asn Arg Asp
405 410 415

Asp Arg His Asp Met Val Gln Val Leu Asn Lys Ala Ser Ala Ala Lys
420 425 430

Lys Thr Arg Arg Arg Arg Lys Thr Lys Pro Arg Ser Arg Lys Pro Lys
435 440 445

Pro Lys Ser Asn Thr Glu Ser
450 455

<210> 15
<211> 457
<212> PRT
<213> Salinivibrio costicola

<400> 15

Met Asn Arg Asp Gly Lys Thr Arg Ala Ile Glu Asp Leu Lys Leu Glu
1 5 10 15

Val Ile Pro Arg Lys Ala His Gly Ile Ser Arg Lys Gly Ile Ser Glu

```
            20                  25                  30

Asn Ala Leu Lys Val Leu Tyr Arg Leu His Lys Ala Gly Tyr Glu Ala
        35                  40                  45

Tyr Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Asp Arg Glu Pro
    50                  55                  60

Lys Asp Phe Asp Ile Ala Thr Asn Ala Thr Pro Asp Glu Val Arg Lys
65                  70                  75                  80

Leu Phe Arg Asn Cys Arg Leu Ile Gly Arg Arg Phe Arg Leu Ala His
                85                  90                  95

Ile Leu Phe Gly Arg Asp Val Ile Glu Val Ala Thr Phe Arg Gly His
            100                 105                 110

His Gly Lys Ser Glu Pro Asp Lys Lys Asp Lys Gln Thr Ala Arg Ser
        115                 120                 125

Glu Asp Gly Met Leu Leu Arg Asp Asn Val Tyr Gly Thr Ile Asp Glu
    130                 135                 140

Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Gly Leu Tyr Tyr Asn Ile
145                 150                 155                 160

Ala Asp Phe Ser Ile Arg Asp Tyr Ala Gly Gly Leu Asp Asp Leu Asn
                165                 170                 175

Asn Arg Val Val Arg Leu Ile Gly Asp Pro Glu Thr Arg Tyr Arg Glu
            180                 185                 190

Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Val Lys Leu Asp
        195                 200                 205

Met Thr Ile Asn Asp Ala Thr Ala Ala Pro Met Val Glu Leu Ala Pro
```

```
    210                 215                 220

Leu Leu Gln Asp Ile Pro Ala Ala Arg Met Phe Glu Glu Ser Leu Lys
225                 230                 235                 240

Leu Leu Gln Ala Gly Gln Gly Leu Ala Thr Tyr Gln Met Leu Arg Glu
                245                 250                 255

Tyr Asn Leu Phe Gln Gln Leu Phe Pro Ala Val Ala Ala His Phe Thr
            260                 265                 270

Glu Ala Gln Thr Ser Gln Thr Glu Gln Met Leu Glu Gln Val Leu Arg
        275                 280                 285

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

Leu Phe Ala Ala Met Leu Trp Tyr Pro Leu Val Thr Arg Ala Glu Glu
305                 310                 315                 320

Met Ala Phe Glu Ser Gly Leu Ser Tyr Tyr Asp Ala Phe Met Val Ala
                325                 330                 335

Ala Ser Asp Ile Val Asp Glu Gln Val Lys Thr Val Ala Ile Pro Arg
            340                 345                 350

Arg Phe Thr Ala Met Val Arg Glu Val Trp Gln Leu Gln Met Arg Met
        355                 360                 365

Thr Arg Arg Thr Gly Ala Arg Ala Phe Lys Thr Leu Glu Glu Lys Lys
    370                 375                 380

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

Asp Asp Thr Glu Ala Leu Cys Ala Trp Trp Arg Asp Phe Gln Arg Ala
```

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405 410 415

Asp Gln Gly Gly Arg Gln Lys Met Val Arg Ala Ile Asn Lys Val Ser
420 425 430

Asn Thr Arg Ser Pro Lys Ser Arg Arg Arg Lys Gly Pro Pro Arg Arg
435 440 445

Arg Lys Pro Gln Ser Asn Ser Asp Ala
450 455

<210> 16
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A

<400> 16

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

```
Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285
```

```
Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 17
<211> 455
<212> PRT

<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346A 455C

<400> 17

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
```

```
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
```

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355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 18
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346A 455 (6xG)C

<400> 18

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

```
Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240
```

```
Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430
```

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435   440   445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450   455   460

<210> 19
<211> 439
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190A 439C

<400> 19

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1   5   10   15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20   25   30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35   40   45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50   55   60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85   90   95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100   105   110

Gly Ala Glu Glu Asp Leu Asn Arg Arg Leu Leu Val Pro Val Gln Glu

```
        115                 120                 125

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ala Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
```

305 310 315 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
325 330 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
340 345 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
355 360 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
370 375 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385 390 395 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
405 410 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
420 425 430

Ala Pro Asp His Pro Gly Cys
435

<210> 20
<211> 445
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190A 439(6xG)C

<400> 20

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1 5 10 15

```
Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ala Lys Arg
            180                 185                 190

Ala Pro Phe Gly Leu His Leu Leu Glu Arg Thr Gly Leu Leu Gly Ile
        195                 200                 205
```

```
Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400
```

```
Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415


Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430


Ala Pro Asp His Pro Gly Gly Gly Gly Gly Gly Gly Cys
        435                 440                 445
```

<210> 21
<211> 436
<212> PRT
<213> Artificial sequence

<220>
<223> Meiothermus silvanus polynucleotide adenylyltransferase 436C

<400> 21

```
Met Leu Val Ala Ile Arg Arg Val His Leu Ser Pro Phe Pro Phe Pro
1               5                   10                  15


Ala Gln Gly Tyr Leu Val Gly Gly Ala Val Arg Asp Leu Met Leu Gly
            20                  25                  30


Lys Arg Pro Lys Asp Leu Asp Phe Val Val Pro Asn Pro Glu Glu Ala
        35                  40                  45


Ala Arg Asp Leu Ala His Arg Leu Gly Gly Ser Ile Phe Pro Leu Asp
    50                  55                  60


Glu Lys Arg Arg Phe Trp Arg Val Val Ala Pro Gly Thr Thr Tyr Asp
65                  70                  75                  80


Tyr Ala Pro Met Pro Gln Gly Leu Glu Val Asp Leu Leu Arg Arg Asp
                85                  90                  95


Phe Thr Leu Asn Ala Leu Ala Val Asn Glu Gln Gly Leu Val Leu Gly
```

```
            100                 105                 110

Leu Pro Ile Ala Arg Tyr Asp Leu Glu His Arg Leu Leu Arg Ala Ile
        115                 120                 125

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

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

Trp Ile Tyr Glu His Ala Gln Tyr Leu Arg Glu Ser Gly Ala Leu Pro
                165                 170                 175

Ala Trp Glu Arg Val Gly Glu Glu Leu Ser Gln Ile Leu Arg His Pro
            180                 185                 190

Ala Ala Ala Val Gly Phe Leu Arg Leu Glu Arg Ala Gly Leu Leu Glu
        195                 200                 205

Val Tyr Leu Pro Glu Leu Ala Ala Gly Ile Gly Val Glu Gln His Gly
    210                 215                 220

Ala His His Leu Asp Val Trp Arg His Ser Leu Glu Val Leu Ala Gln
225                 230                 235                 240

Leu Thr Leu Leu Arg Pro Asp Ala His Leu Ala Leu Arg Trp Ala Ala
                245                 250                 255

Leu Leu His Asp Val Ala Lys Pro Gln Thr Arg Gln Trp Ser Pro Glu
            260                 265                 270

Lys Gly Arg Tyr Thr Phe Tyr Gly His Asp Ala Leu Gly Ala Glu Gln
        275                 280                 285

Ala Arg Gln Ile Leu Asn Arg Leu Arg Gln Pro Ser Glu Val Val Ala
```

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290 295 300

Glu Ala Val Arg Leu Val Arg Leu His Met Gln His Pro Pro Gln Gly
305 310 315 320

Gly Arg Glu Leu Arg Arg Phe Leu His Arg Arg Arg Glu Ala Leu Pro
325 330 335

Glu Leu Ile Trp Leu Gln Leu Ala Asp Met Thr Gly Ile Leu Gly Tyr
340 345 350

Arg Glu Arg Val Glu Glu Leu Arg Glu Gln Leu Gln Ala Ile Glu Ser
355 360 365

Leu Ala Glu Gly Thr Pro Ser Pro Lys Pro Leu Leu Asp Gly Arg Glu
370 375 380

Val Met Arg Leu Leu Gly Leu Glu Pro Gly Pro Lys Val Gly Glu Ala
385 390 395 400

Leu Ala Ala Leu Leu Glu Ala Gln Ala Ile Gly Glu Val Gln Ser Arg
405 410 415

Thr Glu Ala Ala Ser Phe Leu Arg Asp Ala Phe Gly Glu Asp Lys Gly
420 425 430

Arg Met Ser Cys
435

<210> 22
<211> 442
<212> PRT
<213> Artificial sequence

<220>
<223> Meiothermus silvanus polynucleotide adenylyltransferase 436 (6xG)C

<400> 22

```
Met Leu Val Ala Ile Arg Arg Val His Leu Ser Pro Phe Pro Phe Pro
1               5                   10                  15

Ala Gln Gly Tyr Leu Val Gly Gly Ala Val Arg Asp Leu Met Leu Gly
            20                  25                  30

Lys Arg Pro Lys Asp Leu Asp Phe Val Val Pro Asn Pro Glu Glu Ala
        35                  40                  45

Ala Arg Asp Leu Ala His Arg Leu Gly Gly Ser Ile Phe Pro Leu Asp
    50                  55                  60

Glu Lys Arg Arg Phe Trp Arg Val Val Ala Pro Gly Thr Thr Tyr Asp
65                  70                  75                  80

Tyr Ala Pro Met Pro Gln Gly Leu Glu Val Asp Leu Leu Arg Arg Asp
                85                  90                  95

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

Leu Pro Ile Ala Arg Tyr Asp Leu Glu His Arg Leu Leu Arg Ala Ile
        115                 120                 125

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

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

Trp Ile Tyr Glu His Ala Gln Tyr Leu Arg Glu Ser Gly Ala Leu Pro
                165                 170                 175

Ala Trp Glu Arg Val Gly Glu Glu Leu Ser Gln Ile Leu Arg His Pro
            180                 185                 190
```

```
Ala Ala Ala Val Gly Phe Leu Arg Leu Glu Arg Ala Gly Leu Leu Glu
        195                 200                 205

Val Tyr Leu Pro Glu Leu Ala Ala Gly Ile Gly Val Glu Gln His Gly
    210                 215                 220

Ala His His Leu Asp Val Trp Arg His Ser Leu Glu Val Leu Ala Gln
225                 230                 235                 240

Leu Thr Leu Leu Arg Pro Asp Ala His Leu Ala Leu Arg Trp Ala Ala
                245                 250                 255

Leu Leu His Asp Val Ala Lys Pro Gln Thr Arg Gln Trp Ser Pro Glu
            260                 265                 270

Lys Gly Arg Tyr Thr Phe Tyr Gly His Asp Ala Leu Gly Ala Glu Gln
        275                 280                 285

Ala Arg Gln Ile Leu Asn Arg Leu Arg Gln Pro Ser Glu Val Val Ala
    290                 295                 300

Glu Ala Val Arg Leu Val Arg Leu His Met Gln His Pro Pro Gln Gly
305                 310                 315                 320

Gly Arg Glu Leu Arg Arg Phe Leu His Arg Arg Arg Glu Ala Leu Pro
                325                 330                 335

Glu Leu Ile Trp Leu Gln Leu Ala Asp Met Thr Gly Ile Leu Gly Tyr
            340                 345                 350

Arg Glu Arg Val Glu Glu Leu Arg Glu Gln Leu Gln Ala Ile Glu Ser
        355                 360                 365

Leu Ala Glu Gly Thr Pro Ser Pro Lys Pro Leu Leu Asp Gly Arg Glu
    370                 375                 380
```

```
Val Met Arg Leu Leu Gly Leu Glu Pro Gly Pro Lys Val Gly Glu Ala
385                 390                 395                 400


Leu Ala Ala Leu Leu Glu Ala Gln Ala Ile Gly Glu Val Gln Ser Arg
                405                 410                 415


Thr Glu Ala Ala Ser Phe Leu Arg Asp Ala Phe Gly Glu Asp Lys Gly
            420                 425                 430


Arg Met Ser Gly Gly Gly Gly Gly Gly Cys
        435                 440
```

<210> 23
<211> 1955
<212> RNA
<213> Artificial sequence

<220>
<223> hemagglutinin influenza A virus 5'-TOP-UTR GC-optimized polyA_signal poly(C)_signal

<400> 23

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ggggcgcugc cuacggaggu ggcagccauc uccuucucgg caucaagcuu accaugaagg       60

ccauccuggu gguccuccug uacaccuucg ccaccgcgaa cgccgacacg cugugcaucg      120

gcuaccacgc caacaacagc accgacaccg uggacaccgu gcucgagaag aacgucacgg      180

ugacccacuc cgugaaccug cuggaggaca agcacaacgg gaagcucugc aagcugcggg      240

gcgucgcccc gcugcaccuc gggaagugca acaucgccgg cuggauccug gggaacccgg      300

agugcgagag ccuguccacc gcgagcuccu ggagcuacau cguggagacc uccagcuccg      360

acaacggcac gugcuacccc ggcgacuuca ucgacuacga ggagcuccgc gagcagcuga      420

gcuccgugag cuccuucgag cgguucgaga ucuuccccaa gaccagcucc uggcccaacc      480

acgacagcaa caaggggguc accgccgccu gcccgcacgc cggcgcgaag uccuucuaca      540

agaaccugau cuggcucgug aagaagggga acagcuaccc caagcugucc aagagcuaca      600
```

ucaacgacaa gggcaaggag gugcuggucc ucugggggau ccaccacccc agcaccuccg 660

ccgaccagca gagccuguac cagaacgccg acgccuacgu guucgugggc uccagccgcu 720

acuccaagaa guucaagccc gagaucgcca uccggccgaa gguccgcgac caggagggcc 780

ggaugaacua cuacuggacg cugguggagc ccggggacaa gaucaccuuc gaggcgaccg 840

gcaaccucgu gguccccccgc uacgccuucg ccauggagcg gaacgccggg agcggcauca 900

ucaucuccga cacccccgug cacgacugca acacgaccug ccagaccccg aagggcgcca 960

ucaacaccag ccugcccuuc cagaacaucc accccaucac gaucgggaag ugccccaagu 1020

acgugaaguc caccaagcug cgccucgcga ccggccugcg gaacgucccg agcauccagu 1080

cccgcgggcu guucggcgcc aucgccgggu ucaucgaggg cggcuggacc gggauggugg 1140

acggcuggua cggguaccac caccagaacg agcagggcag cgguacgccc gccgaccuca 1200

aguccacgca gaacgcgauc gacgagauca ccaacaaggu gaacagcguc aucgagaaga 1260

ugaacaccca guucaccgcc gugggcaagg aguucaacca ccuggagaag cggaucgaga 1320

accugaacaa gaaggucgac gacggcuucc ucgacaucug gacguacaac gccgagcugc 1380

uggugcuccu ggagaacgag cgcacccugg acuaccacga cuccaacgug aagaaccucu 1440

acgagaaggu ccggagccag cugaagaaca acgccaagga gaucgggaac ggcugcuucg 1500

aguucuacca caagugcgac aacaccugca uggaguccgu gaagaacggg accuacgacu 1560

accccaagua cagcgaggag gccaagcuga accgcgagga gaucgacggc gugaagcucg 1620

aguccacgcg gaucuaccag auccuggcga ucuacagcac cgucgccagc ucccuggugc 1680

ucguggucag ccuggggccc aucuccuucu ggaugugcag caacggcucc cugcagugcc 1740

gcaucugcau cugaccacua gugcaucaca uuuaaaagca ucucagccua ccaugagaau 1800

aagagaaaga aaaugaagau caauagcuua uucaucucuu uuucuuuuuc guugguguaa 1860

agccaacacc cugucuaaaa aacauaaauu ucuuuaauca uuuugccucu uuucucugug 1920

cuucaauuaa uaaaaaaugg aaagaaccua gaucu 1955

<210> 24

<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S

<400> 24

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 25
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S

<400> 25

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

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420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala
450

<210> 26
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A

<400> 26

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala
    450
```

<210> 27
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V

<400> 27

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala
450

<210> 28
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V

<400> 28

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala
    450

<210> 29
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V

<400> 29

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100   105   110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115   120   125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

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325 330 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
340 345 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala
450

<210> 30
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A

<400> 30

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala
450

<210> 31
<211> 454
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S

<400> 31

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

275 280 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
290 295 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305 310 315 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
325 330 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
340 345 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala
450

<210> 32

<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346S 455C

<400> 32

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

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

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Ser Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
```

<210> 33
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346S 455C

<400> 33

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

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420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 34
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346S 455C

<400> 34

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
```

<210> 35
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346A 455C

<400> 35

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 36
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346S 455C

<400> 36

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
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Arg Arg Glu Gly Thr Ala Cys
    450                 455


<210>  37
<211>  455
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88S C256A C346A 455C

<400>  37

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
```

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 38
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346A 455C

<400> 38

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

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Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 39
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346V 455C

<400> 39

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 40

<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346V 455C

<400> 40

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Cys
    450                 455


<210>  41
<211>  455
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88V C256A C346V 455C

<400>  41

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 42
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346A 455C

<400> 42

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 43
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346V 455C

<400> 43

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 44
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346A 455C

<400> 44

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

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Arg Arg Glu Gly Thr Ala Cys
    450                 455


<210>  45
<211>  455
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88A C256V C346A 455C

<400>  45

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
```

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

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325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 46
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346V 455C

<400> 46

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 47
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346V 455C

<400> 47

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 48

<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346V 455C

<400> 48

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

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

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 49
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346S 455C

<400> 49

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

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420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 50
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346A 455C

<400> 50

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 51
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346S 455C

<400> 51

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 52
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346S 455C

<400> 52

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

```
Arg Arg Glu Gly Thr Ala Cys
    450                 455


<210>  53
<211>  455
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88V C256S C346A 455C

<400>  53

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
```

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 54
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346S 455C

<400> 54

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

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Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 55
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346S 455C

<400> 55

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 56

<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346V 455C

<400> 56

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Cys
    450                 455
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<210> 57
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346V 455C

<400> 57

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Cys
450 455

<210> 58
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346S 455 (6xG)C

<400> 58

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


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


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320


Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335


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


Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460


<210>  59
<211>  461
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88A C256S C346S 455 (6xG)C
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<400> 59

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 60
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346S 455 (6xG)C

<400> 60

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450   455   460

<210> 61
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346A 455 (6xG)C

<400> 61

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100   105   110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115   120   125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 62
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346S 455 (6xG)C

<400> 62

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

```
Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460


<210>  63
<211>  461
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88S C256A C346A 455 (6xG)C

<400>  63

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 64

<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346A 455 (6xG)C

<400> 64

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Ala Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 65
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346V 455 (6xG)C

<400> 65

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 66
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346V 455 (6xG)C

<400> 66

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 67
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346V 455 (6xG)C

<400> 67

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 68
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346A 455 (6xG)C

<400> 68

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450   455   460

<210> 69
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346V 455 (6xG)C

<400> 69

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100   105   110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115   120   125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 70
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346A 455 (6xG)C

<400> 70

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

```
Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460


<210>  71
<211>  461
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88A C256V C346A 455 (6xG)C

<400>  71

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 72

<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346V 455 (6xG)C

<400> 72

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 73
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346V 455 (6xG)C

<400> 73

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 74
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346V 455 (6xG)C

<400> 74

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


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


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 75
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346S 455 (6xG)C

<400> 75

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 76
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346A 455 (6xG)C

<400> 76

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 77
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346S 455 (6xG)C

<400> 77

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 78
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346S 455 (6xG)C

<400> 78

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

```
Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460


<210>  79
<211>  461
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88V C256S C346A 455 (6xG)C

<400>  79

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 80

<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346S 455 (6xG)C

<400> 80

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Ser Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 81
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346S 455 (6xG)C

<400> 81

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 82
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346V 455 (6xG)C

<400> 82

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


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


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450                 455                 460
```

<210> 83
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346V 455 (6xG)C

<400> 83

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
450 455 460

<210> 84
<211> 461
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB (6xG)C

<400> 84

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Gly Gly Cys
    450   455   460

<210> 85
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346A 455 (flexLinker)C

<400> 85

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100   105   110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115   120   125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

eolf-seql

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 86
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346S 455 (flexLinker)C

<400> 86

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190
```

```
Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380
```

```
Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465
```

<210> 87
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346S 455 (flexLinker)C

<400> 87

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
```

```
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ser
```

```
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
```

eolf-seql

435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 88
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346S 455(flexLinker)C

<400> 88

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320


Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335


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


Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465


<210>  89
<211>  465
<212>  PRT
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<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346A 455 (flexLinker)C

<400> 89

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
```

```
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
```

eolf-seql

355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 90
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346S 455 (flexLinker)C

<400> 90

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

```
Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220
```

```
Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415
```

```
Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465
```

<210> 91
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346A 455 (flexLinker)C

<400> 91

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
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465

<210> 92
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346A 455 (flexLinker)C

<400> 92

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

```
Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335
```

```
Ala Met Asn Asp Val Leu Asp Glu Ala Ala Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
465
```

<210> 93
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346V 455 (flexLinker)C

<400> 93

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
```

```
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
```

```
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
```

eolf-seql

385 390 395 400

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 94
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346V 455 (flexLinker)C

<400> 94

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450   455   460

Cys
465

<210> 95
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346V 455 (flexLinker)C

<400> 95

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100   105   110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg

```
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
```

305 310 315 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 96
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346A 455 (flexLinker)C

<400> 96

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175
```

```
Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365
```

```
Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
465
```

<210> 97
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346V 455 (flexLinker)C

<400> 97

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 98
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346A 455 (flexLinker)C

<400> 98

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

```
Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285
```

```
Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
465
```

<210> 99
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346A 455 (flexLinker)C

<400> 99

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
```

```
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Ala Arg Ser Leu Ala Ile Pro
```

eolf-seql

340 345 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 100
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346V 455 (flexLinker)C

<400> 100

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

```
Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465
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<210> 101
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346V 455 (flexLinker)C

<400> 101

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
```

```
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
```

```
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
```

eolf-seql

450 455 460

Cys
465

<210> 102
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346V 455 (flexLinker)C

<400> 102

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

```
Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320
```

```
Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
465
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<210> 103
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346S 455 (flexLinker)C

<400> 103

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 104
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346A 455 (flexLinker)C

<400> 104

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

```
Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240
```

```
Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430
```

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435   440   445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450   455   460

Cys
465

<210> 105
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346S 455 (flexLinker)C

<400> 105

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1   5   10   15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20   25   30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35   40   45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50   55   60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65   70   75   80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85   90   95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe

```
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
```

```
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

Cys
465
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<210> 106

<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346S 455 (flexLinker)C

<400> 106

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160
```

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Ser Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465
```

<210> 107
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346A 455 (flexLinker)C

<400> 107

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
```

```
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
```

```
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
```

eolf-seql

405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 108
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346S 455 (flexLinker)C

<400> 108

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

```
Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270
```

```
Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460
```

Cys
465

<210> 109
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346S 455 (flexLinker)C

<400> 109

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 110
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346V 455 (flexLinker)C

<400> 110

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190
```

```
Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380
```

```
Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465
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<210> 111
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346V 455 (flexLinker)C

<400> 111

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
```

```
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
```

```
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
```

eolf-seql

435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

Cys
465

<210> 112
<211> 465
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB (flexLinker)C

<400> 112

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320


Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335


Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350


Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


Cys
465


<210>  113
<211>  471
<212>  PRT
```

<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346A 455 (flexLinker+HIS)C

<400> 113

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
```

```
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
```

eolf-seql

```
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 114
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346S 455 (flexLinker+HIS)C

<400> 114

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30
```

```
Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220
```

```
Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415
```

```
Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470


<210>  115
<211>  471
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88A C256S C346S 455 (flexLinker+HIS)C

<400>  115

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
```

465 470

<210> 116
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346S 455 (flexLinker+HIS)C

<400> 116

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

```
Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335
```

```
Ala Met Asn Asp Val Leu Asp Glu Ala Ser Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 117
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346A 455 (flexLinker+HIS)C

<400> 117

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
```

```
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
```

195 200 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
210 215 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225 230 235 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
260 265 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
275 280 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
290 295 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305 310 315 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu

385 390 395 400

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 118
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346S 455 (flexLinker+HIS)C

<400> 118

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

```
Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255
```

```
Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445
```

```
Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470
```

<210> 119
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256A C346A 455 (flexLinker+HIS)C

<400> 119

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
```

```
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
```

305 310 315 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 120
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346A 455 (flexLinker+HIS)C

<400> 120

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175
```

```
Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365
```

```
Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 121
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346V 455 (flexLinker+HIS)C

<400> 121

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
```

```
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
```

```
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
```

eolf-seql

420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 122
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346V 455 (flexLinker+HIS)C

<400> 122

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

```
Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285
```

```
Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 123
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346V 455 (flexLinker+HIS)C

<400> 123

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
```

```
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
```

eolf-seql

340 345 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 124
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346A 455 (flexLinker+HIS)C

<400> 124

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

```
Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205
```

```
Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400
```

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 125
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256A C346V 455 (flexLinker+HIS)C

<400> 125

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln

```
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
```

```
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
```

450 455 460

His His His His His His Cys
465 470

<210> 126
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346A 455 (flexLinker+HIS)C

<400> 126

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

```
Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320
```

```
Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 127
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346A 455 (flexLinker+HIS)C

<400> 127

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
```

```
            180                 185                 190

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
```

eolf-seql

370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 128
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256S C346V 455 (flexLinker+HIS)C

<400> 128

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

```
Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240
```

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430
```

```
Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470


<210>  129
<211>  471
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88S C256A C346V 455 (flexLinker+HIS)C

<400>  129

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
```

```
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
```

```
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 130

<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256S C346V 455 (flexLinker+HIS)C

<400> 130

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

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

```
Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

Ala Met Asn Asp Val Leu Asp Glu Ala Val Arg Ser Leu Ala Ile Pro
            340                 345                 350
```

```
Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470


<210>  131
<211>  471
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88S C256V C346S 455 (flexLinker+HIS)C

<400>  131

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
```

```
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
```

```
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
```

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405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 132
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256V C346A 455 (flexLinker+HIS)C

<400> 132

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

```
Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270
```

```
Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460
```

His His His His His His Cys
465 470

<210> 133
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88A C256V C346S 455 (flexLinker+HIS)C

<400> 133

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Ala Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu

```
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
```

```
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 134
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346S 455 (flexLinker+HIS)C

<400> 134

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

Lys Asp Gly Val Ile Arg Leu Ile Gly Asn Pro Glu Thr Arg Tyr Arg
            180                 185                 190
```

```
Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380
```

```
Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu
385                 390                 395                 400


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470
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<210> 135
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346A 455 (flexLinker+HIS)C

<400> 135

```
Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
```

```
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ser
```

```
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
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eolf-seql

435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 136
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256A C346S 455 (flexLinker+HIS)C

<400> 136

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

```
Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175


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


Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205


Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220


Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240


Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Ala
                245                 250                 255


Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270


Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285


Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300
```

```
Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320


Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335


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


Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365


Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380


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


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470


<210>  137
<211>  471
<212>  PRT
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<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256V C346S 455 (flexLinker+HIS)C

<400> 137

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Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                  10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95


Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110


Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125


Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140


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


Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
```

```
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
```

eolf-seql

355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
405 410 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
420 425 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
435 440 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
450 455 460

His His His His His His Cys
465 470

<210> 138
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88V C256S C346V 455 (flexLinker+HIS)C

<400> 138

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

```
Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Val Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220
```

```
Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

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

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415
```

```
Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470


<210>  139
<211>  471
<212>  PRT
<213>  Artificial sequence

<220>
<223>  Escherichia coli pcnB C88S C256V C346V 455 (flexLinker+HIS)C

<400>  139

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1               5                   10                  15


Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30


Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45


Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60


Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80


Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
```

```
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Val
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
```

```
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
```

465 470

<210> 140
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB (flexLinker+HIS)C

<400> 140

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro
1 5 10 15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
20 25 30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
35 40 45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
50 55 60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65 70 75 80

Val Arg Lys Leu Phe Arg Asn Cys Arg Leu Val Gly Arg Arg Phe Arg
85 90 95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
100 105 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
115 120 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
130 135 140

```
Glu Asp Ala Gln Arg Arg Asp Phe Thr Ile Asn Ser Leu Tyr Tyr Ser
145                 150                 155                 160

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
        195                 200                 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
    210                 215                 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225                 230                 235                 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Cys
                245                 250                 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
            260                 265                 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
        275                 280                 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
    290                 295                 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305                 310                 315                 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
                325                 330                 335
```

```
Ala Met Asn Asp Val Leu Asp Glu Ala Cys Arg Ser Leu Ala Ile Pro
            340                 345                 350

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
        355                 360                 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
    370                 375                 380

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

Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415

Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430

Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445

Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460

His His His His His His Cys
465                 470
```

<210> 141
<211> 439
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190S 439C

<400> 141

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
```

```
1               5                   10                  15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ser Lys Arg
            180                 185                 190

Ala Pro Phe Gly Leu His Leu Leu Glu Arg Thr Gly Leu Leu Gly Ile
```

```
        195                 200                 205

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
```

eolf-seql

385 390 395 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
405 410 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
420 425 430

Ala Pro Asp His Pro Gly Cys
435

<210> 142
<211> 439
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190V 439C

<400> 142

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1 5 10 15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
20 25 30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
35 40 45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
50 55 60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
85 90 95

```
Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Val Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285
```

```
Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Cys
        435
```

<210> 143
<211> 445
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190S 439(6xG)C

<400> 143

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                  10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110


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


Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140


Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160


Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175


Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ser Lys Arg
```

```
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
```

```
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Gly Gly Cys
        435                 440                 445
```

<210> 144
<211> 445
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190V 439(6xG)C

<400> 144

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60

Glu Arg Gly His Tyr Arg Leu Val Ala Gly Ala Leu Thr Leu Asp Phe
65                  70                  75                  80
```

```
Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Val Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270
```

```
Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Gly Gly Cys
        435                 440                 445
```

<210> 145
<211> 445
<212> PRT

<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase 439(6xG)C

<400> 145

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110


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


Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140


Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160


Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
```

```
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Cys Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
```

355 360 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
370 375 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385 390 395 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
405 410 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
420 425 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Gly Gly Cys
435 440 445

<210> 146
<211> 448
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190A 439(flex linker)C

<400> 146

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1 5 10 15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
20 25 30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
35 40 45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
50 55 60

```
Glu Arg Gly His Tyr Arg Leu Val Ala Gly Ala Leu Thr Leu Asp Phe
65                  70                  75                  80

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ala Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255
```

```
Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Cys
        435                 440                 445
```

<210> 147
<211> 448
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190S 439(flex linker)C

<400> 147

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110


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


Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140


Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
```

```
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ser Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
```

```
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Cys
        435                 440                 445
```

<210> 148
<211> 448
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190V 439(flex linker)C

<400> 148

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45
```

```
Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Val Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240
```

```
Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430
```

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Cys
        435   440   445

<210> 149
<211> 448
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase 439(flex linker)C

<400> 149

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1   5   10   15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20   25   30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35   40   45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50   55   60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85   90   95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100   105   110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu

```
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Cys Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
```

325 330 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
340 345 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
355 360 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
370 375 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385 390 395 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
405 410 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
420 425 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Cys
435 440 445

<210> 150
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190A 439(flex linker+HIS)C

<400> 150

Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1 5 10 15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
20 25 30

```
Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ala Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220
```

```
His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240


Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255


Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270


Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285


Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300


Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320


Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335


Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350


Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365


Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380


Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400


Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415
```

```
Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430


Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
        435                 440                 445


His His His His His His Cys
    450                 455
```

<210> 151
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190S 439(flex linker+HIS)C

<400> 151

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
```

```
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Ser Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
```

```
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
        435                 440                 445

His His His His His His Cys
    450                 455
```

<210> 152
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase C190V 439(flex linker+HIS)C

<400> 152

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                  10                  15


Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30


Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45


Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
    50                  55                  60


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


Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95


Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110


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


Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140


Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160


Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175
```

```
Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Val Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365
```

```
Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
        435                 440                 445

His His His His His His Cys
    450                 455
```

<210> 153
<211> 455
<212> PRT
<213> Artificial sequence

<220>
<223> Thermus aquaticus poly(A) polymerase 439(flex linker+HIS)C

<400> 153

```
Met Leu Arg Leu Ile Ala His Arg Asp Phe Pro Phe Tyr Thr Pro Lys
1               5                   10                  15

Gly Ala Ile Pro Val Gly Gly Ala Leu Arg Asp Leu Leu Leu Gly Glu
            20                  25                  30

Arg Pro Leu Asp Leu Asp Phe Ala Ala Trp Asp Pro Glu Lys Ala Ala
        35                  40                  45

Glu Glu Ala Lys Gly Arg Tyr Gly Gly Thr Leu Phe Pro Leu Asp Pro
```

```
    50                  55                  60

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

Thr Pro Leu Glu Gly Ser Pro Glu Glu Asp Leu Leu Arg Arg Asp Tyr
                85                  90                  95

Arg Val Asn Ala Leu Leu Trp Leu Lys Gly Arg Val Phe Gly Leu Pro
            100                 105                 110

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

Glu Asn Leu Tyr Ala Asp Pro Leu Arg Ser Leu Arg Gly Val Arg Leu
    130                 135                 140

Ala Ala Thr Leu Gly Leu Gly Leu Pro Pro Glu Thr Arg Arg Ala Leu
145                 150                 155                 160

Ala Arg His Ala Arg Phe Leu Gln Glu Asn Pro Ser Ala Leu Pro Ala
                165                 170                 175

Arg Glu Arg Val Arg Glu Glu Leu Ala Lys Leu Leu Leu Cys Lys Arg
            180                 185                 190

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

Tyr Leu Pro Glu Leu Thr His Leu Val Gly Leu His Gln Gly Gly Val
    210                 215                 220

His His Leu Pro Ala Trp Glu His Thr Leu Ser Val Leu Phe His Leu
225                 230                 235                 240

Leu Trp Leu Trp Pro Glu Ala Pro Leu Glu Ala Arg Leu Ala Ala Leu
```

```
                245                 250                 255

Tyr His Asp Ala Gly Lys Pro Leu Thr Arg Arg Tyr Asp Pro Glu Val
            260                 265                 270

Gly Arg Tyr Arg Phe Phe Gly His Ala Glu Val Gly Ala Glu Met Ala
        275                 280                 285

Lys Ala Ala Leu Phe Trp Leu Arg Phe Pro Lys Glu Val Val Glu Lys
    290                 295                 300

Ala Ala His Leu Val Arg Arg His Met Asp Arg Pro Pro Glu Gly Thr
305                 310                 315                 320

Lys Ala Leu Arg Arg Phe Tyr Phe Lys Arg Arg Asp Leu Leu Pro Ala
                325                 330                 335

Leu Pro Tyr Leu Met Ala Ala Asp Arg Leu Ala Ala Lys Gly Val Glu
            340                 345                 350

Ala Glu Ala Trp Pro Leu Leu Glu Ala Tyr Arg Glu Ala Leu Lys Thr
        355                 360                 365

Pro Leu Pro Gln Glu Pro Leu Leu Ser Gly Glu Glu Val Met Ala Leu
    370                 375                 380

Leu Gly Leu Arg Pro Gly Pro Leu Val Gly Glu Ala Leu Arg Ala Leu
385                 390                 395                 400

Leu Glu Ala Gln Ala Glu Gly Ser Val Ala Ser Gln Glu Glu Ala Arg
                405                 410                 415

Arg Phe Leu Leu Tyr Trp Arg Asp Gly Arg Thr Ala Gln Ala Thr Pro
            420                 425                 430

Ala Pro Asp His Pro Gly Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
```

435 440 445

His His His His His His Cys
450 455

<210> 154
<211> 446
<212> PRT
<213> Artificial sequence

<220>
<223> Meiothermus silvanus polynucleotide adenylyltransferase 436 (flex linker)C

<400> 154

Met Leu Val Ala Ile Arg Arg Val His Leu Ser Pro Phe Pro Phe Pro
1 5 10 15

Ala Gln Gly Tyr Leu Val Gly Gly Ala Val Arg Asp Leu Met Leu Gly
20 25 30

Lys Arg Pro Lys Asp Leu Asp Phe Val Val Pro Asn Pro Glu Glu Ala
35 40 45

Ala Arg Asp Leu Ala His Arg Leu Gly Gly Ser Ile Phe Pro Leu Asp
50 55 60

Glu Lys Arg Arg Phe Trp Arg Val Val Ala Pro Gly Thr Thr Tyr Asp
65 70 75 80

Tyr Ala Pro Met Pro Gln Gly Leu Glu Val Asp Leu Leu Arg Arg Asp
85 90 95

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

Leu Pro Ile Ala Arg Tyr Asp Leu Glu His Arg Leu Leu Arg Ala Ile
115 120 125

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

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

Trp Ile Tyr Glu His Ala Gln Tyr Leu Arg Glu Ser Gly Ala Leu Pro
                165                 170                 175

Ala Trp Glu Arg Val Gly Glu Glu Leu Ser Gln Ile Leu Arg His Pro
            180                 185                 190

Ala Ala Ala Val Gly Phe Leu Arg Leu Glu Arg Ala Gly Leu Leu Glu
        195                 200                 205

Val Tyr Leu Pro Glu Leu Ala Ala Gly Ile Gly Val Glu Gln His Gly
    210                 215                 220

Ala His His Leu Asp Val Trp Arg His Ser Leu Glu Val Leu Ala Gln
225                 230                 235                 240

Leu Thr Leu Leu Arg Pro Asp Ala His Leu Ala Leu Arg Trp Ala Ala
                245                 250                 255

Leu Leu His Asp Val Ala Lys Pro Gln Thr Arg Gln Trp Ser Pro Glu
            260                 265                 270

Lys Gly Arg Tyr Thr Phe Tyr Gly His Asp Ala Leu Gly Ala Glu Gln
        275                 280                 285

Ala Arg Gln Ile Leu Asn Arg Leu Arg Gln Pro Ser Glu Val Val Ala
    290                 295                 300

Glu Ala Val Arg Leu Val Arg Leu His Met Gln His Pro Pro Gln Gly
305                 310                 315                 320
```

```
Gly Arg Glu Leu Arg Arg Phe Leu His Arg Arg Arg Glu Ala Leu Pro
                325                 330                 335

Glu Leu Ile Trp Leu Gln Leu Ala Asp Met Thr Gly Ile Leu Gly Tyr
            340                 345                 350

Arg Glu Arg Val Glu Glu Leu Arg Glu Gln Leu Gln Ala Ile Glu Ser
        355                 360                 365

Leu Ala Glu Gly Thr Pro Ser Pro Lys Pro Leu Leu Asp Gly Arg Glu
    370                 375                 380

Val Met Arg Leu Leu Gly Leu Glu Pro Gly Pro Lys Val Gly Glu Ala
385                 390                 395                 400

Leu Ala Ala Leu Leu Glu Ala Gln Ala Ile Gly Glu Val Gln Ser Arg
                405                 410                 415

Thr Glu Ala Ala Ser Phe Leu Arg Asp Ala Phe Gly Glu Asp Lys Gly
            420                 425                 430

Arg Met Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Cys
        435                 440                 445
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<210> 155
<211> 452
<212> PRT
<213> Artificial sequence

<220>
<223> Meiothermus silvanus polynucleotide adenylyltransferase 436 (flex linker+HIS)C

<400> 155

```
Met Leu Val Ala Ile Arg Arg Val His Leu Ser Pro Phe Pro Phe Pro
1               5                   10                  15
```

```
Ala Gln Gly Tyr Leu Val Gly Gly Ala Val Arg Asp Leu Met Leu Gly
            20                  25                  30

Lys Arg Pro Lys Asp Leu Asp Phe Val Val Pro Asn Pro Glu Glu Ala
        35                  40                  45

Ala Arg Asp Leu Ala His Arg Leu Gly Gly Ser Ile Phe Pro Leu Asp
    50                  55                  60

Glu Lys Arg Arg Phe Trp Arg Val Val Ala Pro Gly Thr Thr Tyr Asp
65                  70                  75                  80

Tyr Ala Pro Met Pro Gln Gly Leu Glu Val Asp Leu Leu Arg Arg Asp
                85                  90                  95

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

Leu Pro Ile Ala Arg Tyr Asp Leu Glu His Arg Leu Leu Arg Ala Ile
        115                 120                 125

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

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

Trp Ile Tyr Glu His Ala Gln Tyr Leu Arg Glu Ser Gly Ala Leu Pro
                165                 170                 175

Ala Trp Glu Arg Val Gly Glu Glu Leu Ser Gln Ile Leu Arg His Pro
            180                 185                 190

Ala Ala Ala Val Gly Phe Leu Arg Leu Glu Arg Ala Gly Leu Leu Glu
        195                 200                 205
```

```
Val Tyr Leu Pro Glu Leu Ala Ala Gly Ile Gly Val Glu Gln His Gly
    210                 215                 220

Ala His His Leu Asp Val Trp Arg His Ser Leu Glu Val Leu Ala Gln
225                 230                 235                 240

Leu Thr Leu Leu Arg Pro Asp Ala His Leu Ala Leu Arg Trp Ala Ala
                245                 250                 255

Leu Leu His Asp Val Ala Lys Pro Gln Thr Arg Gln Trp Ser Pro Glu
            260                 265                 270

Lys Gly Arg Tyr Thr Phe Tyr Gly His Asp Ala Leu Gly Ala Glu Gln
        275                 280                 285

Ala Arg Gln Ile Leu Asn Arg Leu Arg Gln Pro Ser Glu Val Val Ala
    290                 295                 300

Glu Ala Val Arg Leu Val Arg Leu His Met Gln His Pro Pro Gln Gly
305                 310                 315                 320

Gly Arg Glu Leu Arg Arg Phe Leu His Arg Arg Arg Glu Ala Leu Pro
                325                 330                 335

Glu Leu Ile Trp Leu Gln Leu Ala Asp Met Thr Gly Ile Leu Gly Tyr
            340                 345                 350

Arg Glu Arg Val Glu Glu Leu Arg Glu Gln Leu Gln Ala Ile Glu Ser
        355                 360                 365

Leu Ala Glu Gly Thr Pro Ser Pro Lys Pro Leu Leu Asp Gly Arg Glu
    370                 375                 380

Val Met Arg Leu Leu Gly Leu Glu Pro Gly Pro Lys Val Gly Glu Ala
385                 390                 395                 400
```

Leu Ala Ala Leu Leu Glu Ala Gln Ala Ile Gly Glu Val Gln Ser Arg
405 410 415

Thr Glu Ala Ala Ser Phe Leu Arg Asp Ala Phe Gly Glu Asp Lys Gly
420 425 430

Arg Met Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser His His His
435 440 445

His His His Cys
450

<210> 156
<211> 26
<212> PRT
<213> Artificial sequence

<220>
<223> linker

<400> 156

Ser Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly
1 5 10 15

Gly Gly Gly Ser Gly Gly Gly Ser Leu Gln
20 25

<210> 157
<211> 12
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker_AEAAAKEAAAKA

<400> 157

Ala Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys Ala
1 5 10

<210> 158
<211> 46
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker

<400> 158

Ala Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys
1 5 10 15

Glu Ala Ala Ala Lys Ala Leu Glu Ala Glu Ala Ala Ala Lys Glu Ala
20 25 30

Ala Ala Lys Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys Ala
35 40 45

<210> 159
<211> 5
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker (EAAAK)1

<400> 159

Glu Ala Ala Ala Lys
1 5

<210> 160
<211> 10
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker (EAAAK)2

<400> 160

Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys

1 5 10

<210> 161
<211> 15
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker (EAAAK)3

<400> 161

Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys Glu Ala Ala Ala Lys
1 5 10 15

<210> 162
<211> 4
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-GGG(GC)

<400> 162

Gly Gly Gly Gly
1

<210> 163
<211> 5
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-GGGGG(GC)

<400> 163

Gly Gly Gly Gly Gly
1 5

<210> 164
<211> 6
<212> PRT

<213> Artificial sequence

<220>
<223> Gly-linker (G)6

<400> 164

Gly Gly Gly Gly Gly Gly
1   5

<210> 165
<211> 8
<212> PRT
<213> Artificial sequence

<220>
<223> Gly-linker (G)8

<400> 165

Gly Gly Gly Gly Gly Gly Gly Gly
1   5

<210> 166
<211> 5
<212> PRT
<213> Artificial sequence

<220>
<223> Linker GGGS

<400> 166

Gly Gly Gly Gly Ser
1   5

<210> 167
<211> 6
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-G4SG

<400> 167

Gly Gly Gly Gly Ser Gly
1 5

<210> 168
<211> 9
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-G4SG4(GC)

<400> 168

Gly Gly Gly Gly Ser Gly Gly Gly Gly
1 5

<210> 169
<211> 10
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-(G4S)2

<400> 169

Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
1 5 10

<210> 170
<211> 10
<212> PRT
<213> Artificial sequence

<220>
<223> Linker (GGGGS)2

<400> 170

Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
1 5 10

<210> 171

<211> 15
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-(GGGGS)3

<400> 171

Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
1 5 10 15

<210> 172
<211> 20
<212> PRT
<213> Artificial sequence

<220>
<223> Linker (GGGGS)4

<400> 172

Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly
1 5 10 15

Gly Gly Gly Ser
20

<210> 173
<211> 16
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-GGGSGGGGSGGGGSGG(GC)

<400> 173

Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly
1 5 10 15

<210> 174
<211> 15
<212> PRT

<213> Artificial sequence

<220>
<223> Linker-GGSGGGGSGGGGSGG

<400> 174

Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser Gly Gly
1 5 10 15

<210> 175
<211> 4
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-GSG

<400> 175

Gly Ser Gly Ser
1

<210> 176
<211> 21
<212> PRT
<213> Artificial sequence

<220>
<223> Linker(GC)

<400> 176

Gly Ser Gly Gly Gly Gly Ser Ala Trp Ser His Pro Gln Phe Glu Lys
1 5 10 15

Gly Gly Gly Gly Ser
20

<210> 177
<211> 5
<212> PRT
<213> Artificial sequence

<220>
<223> Rigid-linker

<400> 177

Pro Ala Pro Ala Pro
1   5

<210> 178
<211> 11
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-PPPGSRHDKIH(GC)

<400> 178

Pro Pro Pro Gly Ser Arg His Asp Lys Ile His
1   5   10

<210> 179
<211> 4
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-SGG(GC)

<400> 179

Ser Gly Gly Gly
1

<210> 180
<211> 4
<212> PRT
<213> Artificial sequence

<220>
<223> Linker-SGS

<400> 180

Gly Ser Gly Ser

1

<210> 181
<211> 17
<212> PRT
<213> Artificial sequence

<220>
<223> 19-A

<400> 181

Glu Trp Leu Lys Ala Phe Tyr Glu Lys Val Leu Glu Lys Leu Lys Glu
1 5 10 15

Leu

<210> 182
<211> 15
<212> PRT
<213> Artificial sequence

<220>
<223> Avi-Tag

<400> 182

Gly Leu Asn Asp Ile Phe Glu Ala Gln Lys Ile Glu Trp His Glu
1 5 10 15

<210> 183
<211> 26
<212> PRT
<213> Artificial sequence

<220>
<223> Calmodulin Tag

<400> 183

Lys Arg Arg Trp Lys Lys Asn Phe Ile Ala Val Ser Ala Ala Asn Arg
1 5 10 15

Phe Lys Lys Ile Ser Ser Ser Gly Ala Leu
            20   25

<210> 184
<211> 13
<212> PRT
<213> Artificial sequence

<220>
<223> E-tag

<400> 184

Gly Ala Pro Val Pro Tyr Pro Asp Pro Leu Glu Pro Arg
1   5   10

<210> 185
<211> 16
<212> PRT
<213> Artificial sequence

<220>
<223> ELK16-Tag

<400> 185

Leu Glu Leu Glu Leu Lys Leu Lys Leu Glu Leu Glu Leu Lys Leu Lys
1   5   10   15

<210> 186
<211> 8
<212> PRT
<213> Artificial sequence

<220>
<223> FLAG tag

<400> 186

Asp Tyr Lys Asp Asp Asp Asp Lys
1   5

<210> 187

<211> 6
<212> PRT
<213> Artificial sequence

<220>
<223> Poly-Glutamate-Tag

<400> 187

Glu Glu Glu Glu Glu Glu
1 5

<210> 188
<211> 9
<212> PRT
<213> Artificial sequence

<220>
<223> HA-tag

<400> 188

Tyr Pro Tyr Asp Val Pro Asp Tyr Ala
1 5

<210> 189
<211> 6
<212> PRT
<213> Artificial sequence

<220>
<223> HIS tag

<400> 189

His His His His His His
1 5

<210> 190
<211> 16
<212> PRT
<213> Artificial sequence

<220>
<223> Isopeptag

<400> 190

Thr Asp Lys Asp Met Thr Ile Thr Phe Thr Asn Lys Lys Asp Ala Glu
1 5 10 15

<210> 191
<211> 10
<212> PRT
<213> Artificial sequence

<220>
<223> Myc Tag

<400> 191

Glu Gln Lys Leu Ile Ser Glu Glu Asp Leu
1 5 10

<210> 192
<211> 15
<212> PRT
<213> Artificial sequence

<220>
<223> S-tag

<400> 192

Lys Glu Thr Ala Ala Ala Lys Phe Glu Arg Gln His Met Asp Ser
1 5 10 15

<210> 193
<211> 38
<212> PRT
<213> Artificial sequence

<220>
<223> SBP tag

<400> 193

Met Asp Glu Lys Thr Thr Gly Trp Arg Gly Gly His Val Val Glu Gly
1 5 10 15

Leu Ala Gly Glu Leu Glu Gln Leu Arg Ala Arg Leu Glu His His Pro
            20   25   30

Gln Gly Gln Arg Glu Pro
        35

<210> 194
<211> 13
<212> PRT
<213> Artificial sequence

<220>
<223> Spy Tag

<400> 194

Ala His Ile Val Met Val Asp Ala Tyr Lys Pro Thr Lys
1   5   10

<210> 195
<211> 13
<212> PRT
<213> Artificial sequence

<220>
<223> SofTag 1

<400> 195

Ser Leu Ala Glu Leu Leu Asn Ala Gly Leu Gly Gly Ser
1   5   10

<210> 196
<211> 8
<212> PRT
<213> Artificial sequence

<220>
<223> Sof Tag 2

<400> 196

Thr Gln Asp Pro Ser Arg Val Gly

1 5

<210> 197
<211> 8
<212> PRT
<213> Artificial sequence

<220>
<223> Strep-II-Tag

<400> 197

Trp Ser His Pro Gln Phe Glu Lys
1 5

<210> 198
<211> 11
<212> PRT
<213> Artificial sequence

<220>
<223> T7 Epitope tag

<400> 198

Met Ala Ser Met Thr Gly Gly Gln Gln Met Gly
1 5 10

<210> 199
<211> 14
<212> PRT
<213> Artificial sequence

<220>
<223> V5 Tag

<400> 199

Gly Lys Pro Ile Pro Asn Pro Leu Leu Gly Leu Asp Ser Thr
1 5 10

<210> 200
<211> 11
<212> PRT

<213> Artificial sequence

<220>
<223> VSV Tag

<400> 200

Tyr Thr Asp Ile Glu Met Asn Arg Leu Gly Lys
1 5 10

<210> 201
<211> 8
<212> PRT
<213> Artificial sequence

<220>
<223> Xpress Tag

<400> 201

Asp Leu Tyr Asp Asp Asp Asp Lys
1 5

<210> 202
<211> 60
<212> RNA
<213> Artificial sequence

<220>
<223> RNA template

<400> 202
gccaccuccg cugaugaggc cucgaccgau aggucgaggu cgaggccgaa aggcagcgcc 60

<210> 203
<211> 471
<212> PRT
<213> Artificial sequence

<220>
<223> Escherichia coli pcnB C88S C256R C346A 455 (flexLinker+HIS)C

<400> 203

Met Leu Ser Arg Glu Glu Ser Glu Ala Glu Gln Ala Val Ala Arg Pro

```
1               5                   10                  15

Gln Val Thr Val Ile Pro Arg Glu Gln His Ala Ile Ser Arg Lys Asp
            20                  25                  30

Ile Ser Glu Asn Ala Leu Lys Val Met Tyr Arg Leu Asn Lys Ala Gly
        35                  40                  45

Tyr Glu Ala Trp Leu Val Gly Gly Gly Val Arg Asp Leu Leu Leu Gly
    50                  55                  60

Lys Lys Pro Lys Asp Phe Asp Val Thr Thr Asn Ala Thr Pro Glu Gln
65                  70                  75                  80

Val Arg Lys Leu Phe Arg Asn Ser Arg Leu Val Gly Arg Arg Phe Arg
                85                  90                  95

Leu Ala His Val Met Phe Gly Pro Glu Ile Ile Glu Val Ala Thr Phe
            100                 105                 110

Arg Gly His His Glu Gly Asn Val Ser Asp Arg Thr Thr Ser Gln Arg
        115                 120                 125

Gly Gln Asn Gly Met Leu Leu Arg Asp Asn Ile Phe Gly Ser Ile Glu
    130                 135                 140

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

Val Ala Asp Phe Thr Val Arg Asp Tyr Val Gly Gly Met Lys Asp Leu
                165                 170                 175

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

Glu Asp Pro Val Arg Met Leu Arg Ala Val Arg Phe Ala Ala Lys Leu
```

195 200 205

Gly Met Arg Ile Ser Pro Glu Thr Ala Glu Pro Ile Pro Arg Leu Ala
210 215 220

Thr Leu Leu Asn Asp Ile Pro Pro Ala Arg Leu Phe Glu Glu Ser Leu
225 230 235 240

Lys Leu Leu Gln Ala Gly Tyr Gly Tyr Glu Thr Tyr Lys Leu Leu Arg
245 250 255

Glu Tyr His Leu Phe Gln Pro Leu Phe Pro Thr Ile Thr Arg Tyr Phe
260 265 270

Thr Glu Asn Gly Asp Ser Pro Met Glu Arg Ile Ile Glu Gln Val Leu
275 280 285

Lys Asn Thr Asp Thr Arg Ile His Asn Asp Met Arg Val Asn Pro Ala
290 295 300

Phe Leu Phe Ala Ala Met Phe Trp Tyr Pro Leu Leu Glu Thr Ala Gln
305 310 315 320

Lys Ile Ala Gln Glu Ser Gly Leu Thr Tyr His Asp Ala Phe Ala Leu
325 330 335

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

Lys Arg Leu Thr Thr Leu Thr Arg Asp Ile Trp Gln Leu Gln Leu Arg
355 360 365

Met Ser Arg Arg Gln Gly Lys Arg Ala Trp Lys Leu Leu Glu His Pro
370 375 380

Lys Phe Arg Ala Ala Tyr Asp Leu Leu Ala Leu Arg Ala Glu Val Glu

```
                                    eolf-seql
385                 390                 395                 400


Arg Asn Ala Glu Leu Gln Arg Leu Val Lys Trp Trp Gly Glu Phe Gln
                405                 410                 415


Val Ser Ala Pro Pro Asp Gln Lys Gly Met Leu Asn Glu Leu Asp Glu
            420                 425                 430


Glu Pro Ser Pro Arg Arg Arg Thr Arg Arg Pro Arg Lys Arg Ala Pro
        435                 440                 445


Arg Arg Glu Gly Thr Ala Gly Gly Gly Gly Ser Gly Gly Gly Gly Ser
    450                 455                 460


His His His His His His Cys
465                 470
```