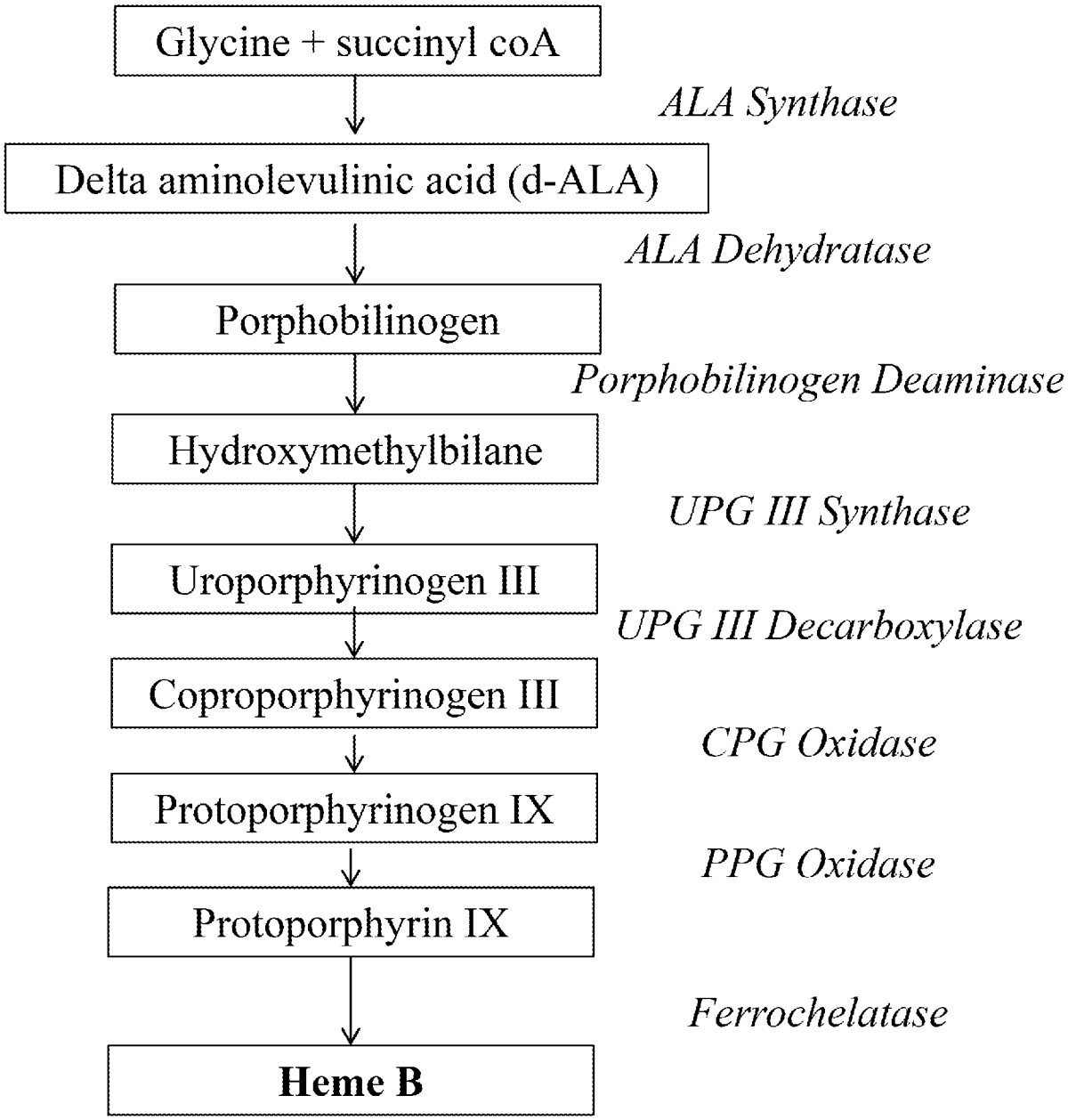
Glycine + succinyl coA
ALA Synthase
Delta aminolevulinic acid (d-ALA)
ALA Dehydratase
Porphobilinogen
Porphobilinogen Deaminase
Hydroxymethylbilane
UPG III Synthase
Uroporphyrinogen III
UPG III Decarboxylase
Coproporphyrinogen III
CPG Oxidase
Protoporphyrinogen IX
PPG Oxidase
Protoporphyrin IX
Ferrochelatase
Heme B

Figure 1

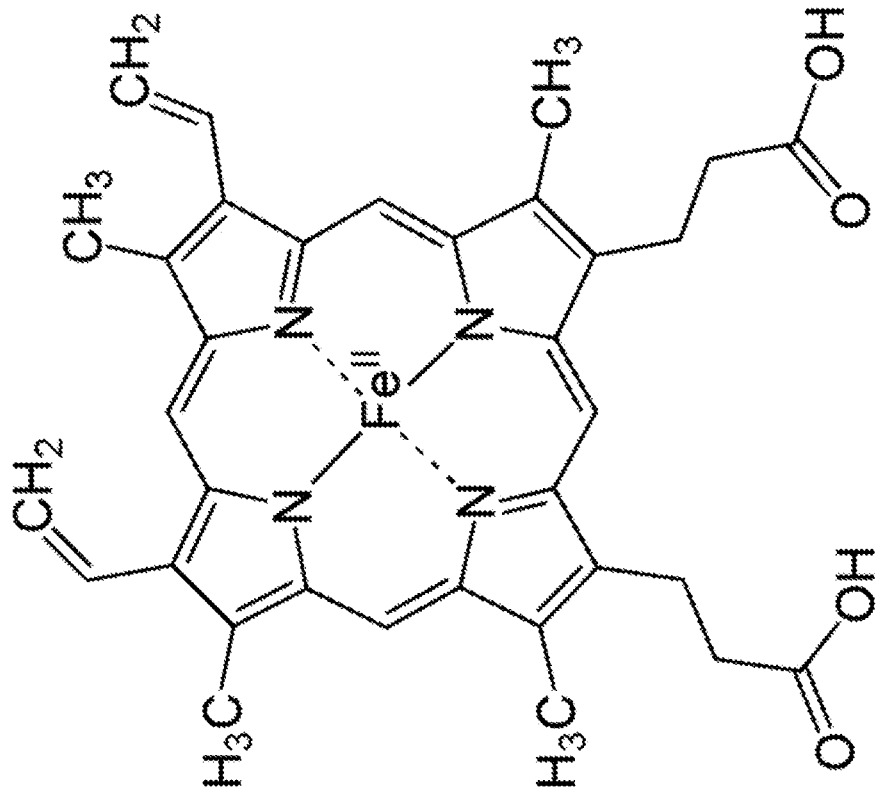

Figure 2

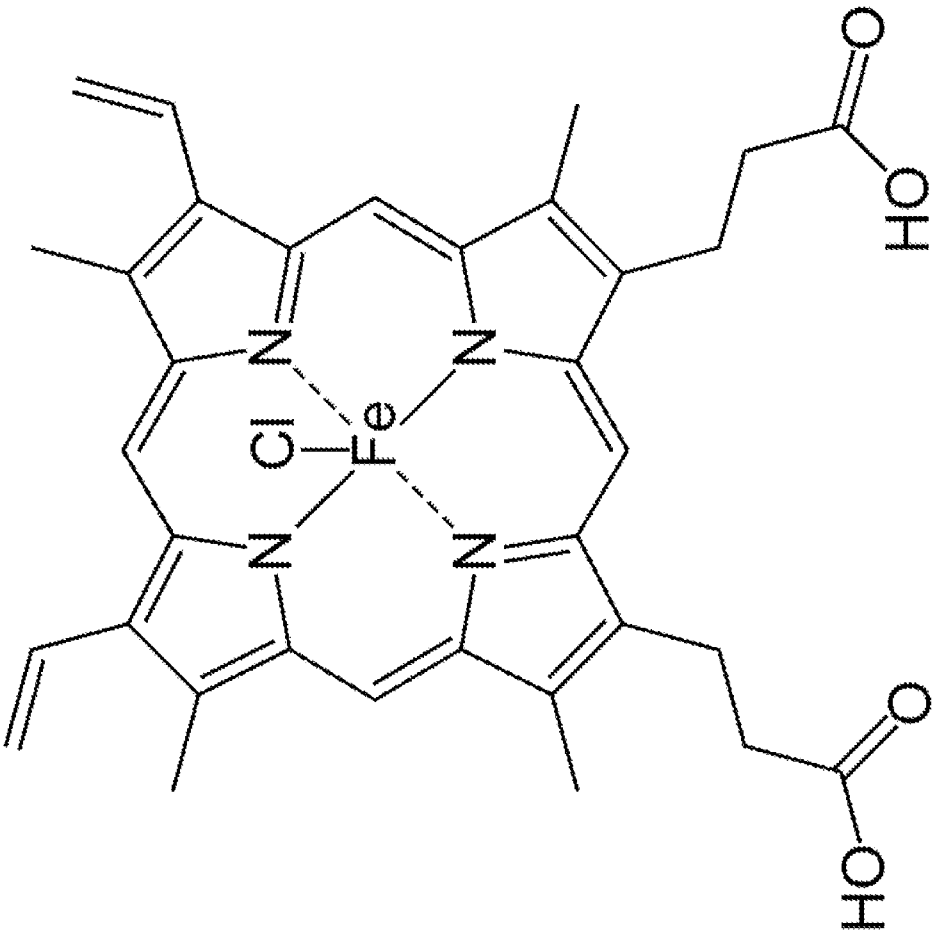

Figure 3

Figure 4

<110> Impossible Foods Inc.

<210> 1
<211> 161
<212> PRT
<213> Vigna radiata

<400> 1
Met Thr Thr Thr Leu Glu Arg Gly Phe Thr Glu Glu Gln Glu Ala Leu
1 5 10 15
Val Val Lys Ser Trp Asn Val Met Lys Lys Asn Ser Gly Glu Leu Gly
20 25 30
Leu Lys Phe Phe Leu Lys Ile Phe Glu Ile Ala Pro Ser Ala Gln Lys
35 40 45
Leu Phe Ser Phe Leu Arg Asp Ser Thr Val Pro Leu Glu Gln Asn Pro
50 55 60
Lys Leu Lys Pro His Ala Val Ser Val Phe Val Met Thr Cys Asp Ser
65 70 75 80
Ala Val Gln Leu Arg Lys Ala Gly Lys Val Thr Val Arg Glu Ser Asn
85 90 95
Leu Lys Lys Leu Gly Ala Thr His Phe Arg Thr Gly Val Ala Asn Glu
100 105 110
His Phe Glu Val Thr Lys Phe Ala Leu Leu Glu Thr Ile Lys Glu Ala
115 120 125
Val Pro Glu Met Trp Ser Pro Ala Met Lys Asn Ala Trp Gly Glu Ala
130 135 140
Tyr Asp Gln Leu Val Asp Ala Ile Lys Tyr Glu Met Lys Pro Pro Ser
145 150 155 160
Ser

<210> 2
<211> 133
<212> PRT
<213> Methylacidiphilum infernorum

<400> 2
Met Ile Asp Gln Lys Glu Lys Glu Leu Ile Lys Glu Ser Trp Lys Arg
1 5 10 15
Ile Glu Pro Asn Lys Asn Glu Ile Gly Leu Leu Phe Tyr Ala Asn Leu
20 25 30
Phe Lys Glu Glu Pro Thr Val Ser Val Leu Phe Gln Asn Pro Ile Ser
35 40 45
Ser Gln Ser Arg Lys Leu Met Gln Val Leu Gly Ile Leu Val Gln Gly

```
    50                  55                  60
Ile Asp Asn Leu Glu Gly Leu Ile Pro Thr Leu Gln Asp Leu Gly Arg
65                  70                  75                  80
Arg His Lys Gln Tyr Gly Val Val Asp Ser His Tyr Pro Leu Val Gly
                85                  90                  95
Asp Cys Leu Leu Lys Ser Ile Gln Glu Tyr Leu Gly Gln Gly Phe Thr
            100                 105                 110
Glu Glu Ala Lys Ala Ala Trp Thr Lys Val Tyr Gly Ile Ala Ala Gln
        115                 120                 125
Val Met Thr Ala Glu
    130
```

<210> 3
<211> 139
<212> PRT
<213> Aquifex aeolicus

<400> 3

```
Met Leu Ser Glu Glu Thr Ile Arg Val Ile Lys Ser Thr Val Pro Leu
 1               5                  10                  15
Leu Lys Glu His Gly Thr Glu Ile Thr Ala Arg Met Tyr Glu Leu Leu
            20                  25                  30
Phe Ser Lys Tyr Pro Lys Thr Lys Glu Leu Phe Ala Gly Ala Ser Glu
        35                  40                  45
Glu Gln Pro Lys Lys Leu Ala Asn Ala Ile Ile Ala Tyr Ala Thr Tyr
    50                  55                  60
Ile Asp Arg Leu Glu Glu Leu Asp Asn Ala Ile Ser Thr Ile Ala Arg
65                  70                  75                  80
Ser His Val Arg Arg Asn Val Lys Pro Glu His Tyr Pro Leu Val Lys
                85                  90                  95
Glu Cys Leu Leu Gln Ala Ile Glu Glu Val Leu Asn Pro Gly Glu Glu
            100                 105                 110
Val Leu Lys Ala Trp Glu Glu Ala Tyr Asp Phe Leu Ala Lys Thr Leu
        115                 120                 125
Ile Thr Leu Glu Lys Lys Leu Tyr Ser Gln Pro
    130                 135
```

<210> 4
<211> 145
<212> PRT
<213> Glycine max

<400> 4

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

```
Ser Ile Leu Glu Lys Ala Pro Ala Ala Lys Asp Leu Phe Ser Phe Leu
        35                  40                  45
Ser Asn Gly Val Asp Pro Ser Asn Pro Lys Leu Thr Gly His Ala Glu
    50                  55                  60
Lys Leu Phe Gly Leu Val Arg Asp Ser Ala Gly Gln Leu Lys Ala Asn
65                  70                  75                  80
Gly Thr Val Val Ala Asp Ala Ala Leu Gly Ser Ile His Ala Gln Lys
                85                  90                  95
Ala Ile Thr Asp Pro Gln Phe Val Val Val Lys Glu Ala Leu Leu Lys
            100                 105                 110
Thr Ile Lys Glu Ala Val Gly Asp Lys Trp Ser Asp Glu Leu Ser Ser
        115                 120                 125
Ala Trp Glu Val Ala Tyr Asp Glu Leu Ala Ala Ala Ile Lys Lys Ala
    130                 135                 140
Phe
145
```

<210> 5
<211> 162
<212> PRT
<213> Hordeum vulgare

<400> 5

```
Met Ser Ala Ala Glu Gly Ala Val Val Phe Ser Glu Glu Lys Glu Ala
 1               5                  10                  15
Leu Val Leu Lys Ser Trp Ala Ile Met Lys Lys Asp Ser Ala Asn Leu
            20                  25                  30
Gly Leu Arg Phe Phe Leu Lys Ile Phe Glu Ile Ala Pro Ser Ala Arg
        35                  40                  45
Gln Met Phe Pro Phe Leu Arg Asp Ser Asp Val Pro Leu Glu Thr Asn
    50                  55                  60
Pro Lys Leu Lys Thr His Ala Val Ser Val Phe Val Met Thr Cys Glu
65                  70                  75                  80
Ala Ala Ala Gln Leu Arg Lys Ala Gly Lys Ile Thr Val Arg Glu Thr
                85                  90                  95
Thr Leu Lys Arg Leu Gly Gly Thr His Leu Lys Tyr Gly Val Ala Asp
            100                 105                 110
Gly His Phe Glu Val Thr Arg Phe Ala Leu Leu Glu Thr Ile Lys Glu
        115                 120                 125
Ala Leu Pro Ala Asp Met Trp Gly Pro Glu Met Arg Asn Ala Trp Gly
    130                 135                 140
Glu Ala Tyr Asp Gln Leu Val Ala Ala Ile Lys Gln Glu Met Lys Pro
145                 150                 155                 160
Ala Glu
```

<210> 6

<211> 1153
<212> PRT
<213> Magnaporthe oryzae

<400> 6

```
Met Asp Gly Ala Val Arg Leu Asp Trp Thr Gly Leu Asp Leu Thr Gly
 1               5                  10                  15
His Glu Ile His Asp Gly Val Pro Ile Ala Ser Arg Val Gln Val Met
            20                  25                  30
Val Ser Phe Pro Leu Phe Lys Asp Gln His Ile Ile Met Ser Ser Lys
        35                  40                  45
Glu Ser Pro Ser Arg Lys Ser Ser Thr Ile Gly Gln Ser Thr Arg Asn
    50                  55                  60
Gly Ser Cys Gln Ala Asp Thr Gln Lys Gly Gln Leu Pro Pro Val Gly
65                  70                  75                  80
Glu Lys Pro Lys Pro Val Lys Glu Asn Pro Met Lys Lys Leu Lys Glu
                85                  90                  95
Met Ser Gln Arg Pro Leu Pro Thr Gln His Gly Asp Gly Thr Tyr Pro
            100                 105                 110
Thr Glu Lys Lys Leu Thr Gly Ile Gly Glu Asp Leu Lys His Ile Arg
        115                 120                 125
Gly Tyr Asp Val Lys Thr Leu Leu Ala Met Val Lys Ser Lys Leu Lys
    130                 135                 140
Gly Glu Lys Leu Lys Asp Asp Lys Thr Met Leu Met Glu Arg Val Met
145                 150                 155                 160
Gln Leu Val Ala Arg Leu Pro Thr Glu Ser Lys Lys Arg Ala Glu Leu
                165                 170                 175
Thr Asp Ser Leu Ile Asn Glu Leu Trp Glu Ser Leu Asp His Pro Pro
            180                 185                 190
Leu Asn Tyr Leu Gly Pro Glu His Ser Tyr Arg Thr Pro Asp Gly Ser
        195                 200                 205
Tyr Asn His Pro Phe Asn Pro Gln Leu Gly Ala Ala Gly Ser Arg Tyr
    210                 215                 220
Ala Arg Ser Val Ile Pro Thr Val Thr Pro Pro Gly Ala Leu Pro Asp
225                 230                 235                 240
Pro Gly Leu Ile Phe Asp Ser Ile Met Gly Arg Thr Pro Asn Ser Tyr
                245                 250                 255
Arg Lys His Pro Asn Asn Val Ser Ser Ile Leu Trp Tyr Trp Ala Thr
            260                 265                 270
Ile Ile Ile His Asp Ile Phe Trp Thr Asp Pro Arg Asp Ile Asn Thr
        275                 280                 285
Asn Lys Ser Ser Ser Tyr Leu Asp Leu Ala Pro Leu Tyr Gly Asn Ser
    290                 295                 300
Gln Glu Met Gln Asp Ser Ile Arg Thr Phe Lys Asp Gly Arg Met Lys
305                 310                 315                 320
Pro Asp Cys Tyr Ala Asp Lys Arg Leu Ala Gly Met Pro Pro Gly Val
                325                 330                 335
Ser Val Leu Leu Ile Met Phe Asn Arg Phe His Asn His Val Ala Glu
            340                 345                 350
```

Figure 4 (Continued)

```
Asn Leu Ala Leu Ile Asn Glu Gly Gly Arg Phe Asn Lys Pro Ser Asp
        355                 360                 365
Leu Leu Glu Gly Glu Ala Arg Glu Ala Ala Trp Lys Lys Tyr Asp Asn
    370                 375                 380
Asp Leu Phe Gln Val Ala Arg Leu Val Thr Ser Gly Leu Tyr Ile Asn
385                 390                 395                 400
Ile Thr Leu Val Asp Tyr Val Arg Asn Ile Val Asn Leu Asn Arg Val
                405                 410                 415
Asp Thr Thr Trp Thr Leu Asp Pro Arg Gln Asp Ala Gly Ala His Val
            420                 425                 430
Gly Thr Ala Asp Gly Ala Glu Arg Gly Thr Gly Asn Ala Val Ser Ala
        435                 440                 445
Glu Phe Asn Leu Cys Tyr Arg Trp His Ser Cys Ile Ser Glu Lys Asp
    450                 455                 460
Ser Lys Phe Val Glu Ala Gln Phe Gln Asn Ile Phe Gly Lys Pro Ala
465                 470                 475                 480
Ser Glu Val Arg Pro Asp Glu Met Trp Lys Gly Phe Ala Lys Met Glu
                485                 490                 495
Gln Asn Thr Pro Ala Asp Pro Gly Gln Arg Thr Phe Gly Gly Phe Lys
            500                 505                 510
Arg Gly Pro Asp Gly Lys Phe Asp Asp Asp Asp Leu Val Arg Cys Ile
        515                 520                 525
Ser Glu Ala Val Glu Asp Val Ala Gly Ala Phe Gly Ala Arg Asn Val
    530                 535                 540
Pro Gln Ala Met Lys Val Val Glu Thr Met Gly Ile Ile Gln Gly Arg
545                 550                 555                 560
Lys Trp Asn Val Ala Gly Leu Asn Glu Phe Arg Lys His Phe His Leu
                565                 570                 575
Lys Pro Tyr Ser Thr Phe Glu Asp Ile Asn Ser Asp Pro Gly Val Ala
            580                 585                 590
Glu Ala Leu Arg Arg Leu Tyr Asp His Pro Asp Asn Val Glu Leu Tyr
        595                 600                 605
Pro Gly Leu Val Ala Glu Glu Asp Lys Gln Pro Met Val Pro Gly Val
    610                 615                 620
Gly Ile Ala Pro Thr Tyr Thr Ile Ser Arg Val Val Leu Ser Asp Ala
625                 630                 635                 640
Val Cys Leu Val Arg Gly Asp Arg Phe Tyr Thr Thr Asp Phe Thr Pro
                645                 650                 655
Arg Asn Leu Thr Asn Trp Gly Tyr Lys Glu Val Asp Tyr Asp Leu Ser
            660                 665                 670
Val Asn His Gly Cys Val Phe Tyr Lys Leu Phe Ile Arg Ala Phe Pro
        675                 680                 685
Asn His Phe Lys Gln Asn Ser Val Tyr Ala His Tyr Pro Met Val Val
    690                 695                 700
Pro Ser Glu Asn Lys Arg Ile Leu Glu Ala Leu Gly Arg Ala Asp Leu
705                 710                 715                 720
Phe Asp Phe Glu Ala Pro Lys Tyr Ile Pro Pro Arg Val Asn Ile Thr
                725                 730                 735
Ser Tyr Gly Gly Ala Glu Tyr Ile Leu Glu Thr Gln Glu Lys Tyr Lys
```

Figure 4 (Continued)

```
                740                 745                 750
Val Thr Trp His Glu Gly Leu Gly Phe Leu Met Gly Glu Gly Gly Leu
        755                 760                 765
Lys Phe Met Leu Ser Gly Asp Asp Pro Leu His Ala Gln Gln Arg Lys
    770                 775                 780
Cys Met Ala Ala Gln Leu Tyr Lys Asp Gly Trp Thr Glu Ala Val Lys
785                 790                 795                 800
Ala Phe Tyr Ala Gly Met Met Glu Glu Leu Leu Val Ser Lys Ser Tyr
                805                 810                 815
Phe Leu Gly Asn Asn Lys His Arg His Val Asp Ile Ile Arg Asp Val
            820                 825                 830
Gly Asn Met Val His Val His Phe Ala Ser Gln Val Phe Gly Leu Pro
        835                 840                 845
Leu Lys Thr Ala Lys Asn Pro Thr Gly Val Phe Thr Glu Gln Glu Met
    850                 855                 860
Tyr Gly Ile Leu Ala Ala Ile Phe Thr Thr Ile Phe Phe Asp Leu Asp
865                 870                 875                 880
Pro Ser Lys Ser Phe Pro Leu Arg Thr Lys Thr Arg Glu Val Cys Gln
                885                 890                 895
Lys Leu Ala Lys Leu Val Glu Ala Asn Val Lys Leu Ile Asn Lys Ile
            900                 905                 910
Pro Trp Ser Arg Gly Met Phe Val Gly Lys Pro Ala Lys Asp Glu Pro
        915                 920                 925
Leu Ser Ile Tyr Gly Lys Thr Met Ile Lys Gly Leu Lys Ala His Gly
    930                 935                 940
Leu Ser Asp Tyr Asp Ile Ala Trp Ser His Val Val Pro Thr Ser Gly
945                 950                 955                 960
Ala Met Val Pro Asn Gln Ala Gln Val Phe Ala Gln Ala Val Asp Tyr
                965                 970                 975
Tyr Leu Ser Pro Ala Gly Met His Tyr Ile Pro Glu Ile His Met Val
            980                 985                 990
Ala Leu Gln Pro Ser Thr Pro Glu Thr Asp Ala Leu Leu Leu Gly Tyr
        995                 1000                1005
Ala Met Glu Gly Ile Arg Leu Ala Gly Thr Phe Gly Ser Tyr Arg Glu
    1010                1015                1020
Ala Ala Val Asp Asp Val Val Lys Glu Asp Asn Gly Arg Gln Val Pro
1025                1030                1035                1040
Val Lys Ala Gly Asp Arg Val Phe Val Ser Phe Val Asp Ala Ala Arg
                1045                1050                1055
Asp Pro Lys His Phe Pro Asp Pro Glu Val Val Asn Pro Arg Arg Pro
            1060                1065                1070
Ala Lys Lys Tyr Ile His Tyr Gly Val Gly Pro His Ala Cys Leu Gly
        1075                1080                1085
Arg Asp Ala Ser Gln Ile Ala Ile Thr Glu Met Phe Arg Cys Leu Phe
    1090                1095                1100
Arg Arg Arg Asn Val Arg Arg Val Pro Gly Pro Gln Gly Glu Leu Lys
1105                1110                1115                1120
Lys Val Pro Arg Pro Gly Gly Phe Tyr Val Tyr Met Arg Glu Asp Trp
                1125                1130                1135
```

Figure 4 (Continued)

```
Gly Gly Leu Phe Pro Phe Pro Val Thr Met Arg Val Met Trp Asp Asp
            1140                1145                1150
Glu
```

<210> 7
<211> 530
<212> PRT
<213> Fusarium oxysporum

<400> 7

```
Met Lys Gly Ser Ala Thr Leu Ala Phe Ala Leu Val Gln Phe Ser Ala
 1               5                  10                  15
Ala Ser Gln Leu Val Trp Pro Ser Lys Trp Asp Glu Val Glu Asp Leu
            20                  25                  30
Leu Tyr Met Gln Gly Gly Phe Asn Lys Arg Gly Phe Ala Asp Ala Leu
        35                  40                  45
Arg Thr Cys Glu Phe Gly Ser Asn Val Pro Gly Thr Gln Asn Thr Ala
    50                  55                  60
Glu Trp Leu Arg Thr Ala Phe His Asp Ala Ile Thr His Asp Ala Lys
65                  70                  75                  80
Ala Gly Thr Gly Gly Leu Asp Ala Ser Ile Tyr Trp Glu Ser Ser Arg
                85                  90                  95
Pro Glu Asn Pro Gly Lys Ala Phe Asn Asn Thr Phe Gly Phe Phe Ser
            100                 105                 110
Gly Phe His Asn Pro Arg Ala Thr Ala Ser Asp Leu Thr Ala Leu Gly
        115                 120                 125
Thr Val Leu Ala Val Gly Ala Cys Asn Gly Pro Arg Ile Pro Phe Arg
    130                 135                 140
Ala Gly Arg Ile Asp Ala Tyr Lys Ala Gly Pro Ala Gly Val Pro Glu
145                 150                 155                 160
Pro Ser Thr Asn Leu Lys Asp Thr Phe Ala Ala Phe Thr Lys Ala Gly
                165                 170                 175
Phe Thr Lys Glu Glu Met Thr Ala Met Val Ala Cys Gly His Ala Ile
            180                 185                 190
Gly Gly Val His Ser Val Asp Phe Pro Glu Ile Val Gly Ile Lys Ala
        195                 200                 205
Asp Pro Asn Asn Asp Thr Asn Val Pro Phe Gln Lys Asp Val Ser Ser
    210                 215                 220
Phe His Asn Gly Ile Val Thr Glu Tyr Leu Ala Gly Thr Ser Lys Asn
225                 230                 235                 240
Pro Leu Val Ala Ser Lys Asn Ala Thr Phe His Ser Asp Lys Arg Ile
                245                 250                 255
Phe Asp Asn Asp Lys Ala Thr Met Lys Lys Leu Ser Thr Lys Ala Gly
            260                 265                 270
Phe Asn Ser Met Cys Ala Asp Ile Leu Thr Arg Met Ile Asp Thr Val
        275                 280                 285
Pro Lys Ser Val Gln Leu Thr Pro Val Leu Glu Ala Tyr Asp Val Arg
```

```
    290                 295                 300
Pro Tyr Ile Thr Glu Leu Ser Leu Asn Asn Lys Asn Lys Ile His Phe
305                 310                 315                 320
Thr Gly Ser Val Arg Val Arg Ile Thr Asn Asn Ile Arg Asp Asn Asn
                325                 330                 335
Asp Leu Ala Ile Asn Leu Ile Tyr Val Gly Arg Asp Gly Lys Lys Val
            340                 345                 350
Thr Val Pro Thr Gln Gln Val Thr Phe Gln Gly Gly Thr Ser Phe Gly
        355                 360                 365
Ala Gly Glu Val Phe Ala Asn Phe Glu Phe Asp Thr Thr Met Asp Ala
    370                 375                 380
Lys Asn Gly Ile Thr Lys Phe Phe Ile Gln Glu Val Lys Pro Ser Thr
385                 390                 395                 400
Lys Ala Thr Val Thr His Asp Asn Gln Lys Thr Gly Gly Tyr Lys Val
                405                 410                 415
Asp Asp Thr Val Leu Tyr Gln Leu Gln Gln Ser Cys Ala Val Leu Glu
            420                 425                 430
Lys Leu Pro Asn Ala Pro Leu Val Val Thr Ala Met Val Arg Asp Ala
        435                 440                 445
Arg Ala Lys Asp Ala Leu Thr Leu Arg Val Ala His Lys Lys Pro Val
    450                 455                 460
Lys Gly Ser Ile Val Pro Arg Phe Gln Thr Ala Ile Thr Asn Phe Lys
465                 470                 475                 480
Ala Thr Gly Lys Lys Ser Ser Gly Tyr Thr Gly Phe Gln Ala Lys Thr
                485                 490                 495
Met Phe Glu Glu Gln Ser Thr Tyr Phe Asp Ile Val Leu Gly Gly Ser
            500                 505                 510
Pro Ala Ser Gly Val Gln Phe Leu Thr Ser Gln Ala Met Pro Ser Gln
        515                 520                 525
Cys Ser
    530
```

<210> 8
<211> 358
<212> PRT
<213> Fusarium graminearum

<400> 8

```
Met Ala Ser Ala Thr Arg Gln Phe Ala Arg Ala Ala Thr Arg Ala Thr
 1               5                  10                  15
Arg Asn Gly Phe Ala Ile Ala Pro Arg Gln Val Ile Arg Gln Gln Gly
            20                  25                  30
Arg Arg Tyr Tyr Ser Ser Glu Pro Ala Gln Lys Ser Ser Ser Ala Trp
        35                  40                  45
Ile Trp Leu Thr Gly Ala Ala Val Ala Gly Gly Ala Gly Tyr Tyr Phe
    50                  55                  60
Tyr Gly Asn Ser Ala Ser Ser Ala Thr Ala Lys Val Phe Asn Pro Ser
65                  70                  75                  80
```

```
Lys Glu Asp Tyr Gln Lys Val Tyr Asn Glu Ile Ala Ala Arg Leu Glu
                85                  90                  95
Glu Lys Asp Asp Tyr Asp Asp Gly Ser Tyr Gly Pro Val Leu Val Arg
            100                 105                 110
Leu Ala Trp His Ala Ser Gly Thr Tyr Asp Lys Glu Thr Gly Thr Gly
        115                 120                 125
Gly Ser Asn Gly Ala Thr Met Arg Phe Ala Pro Glu Ser Asp His Gly
    130                 135                 140
Ala Asn Ala Gly Leu Ala Ala Ala Arg Asp Phe Leu Gln Pro Val Lys
145                 150                 155                 160
Glu Lys Phe Pro Trp Ile Thr Tyr Ser Asp Leu Trp Ile Leu Ala Gly
                165                 170                 175
Val Cys Ala Ile Gln Glu Met Leu Gly Pro Ala Ile Pro Tyr Arg Pro
            180                 185                 190
Gly Arg Ser Asp Arg Asp Val Ser Gly Cys Thr Pro Asp Gly Arg Leu
        195                 200                 205
Pro Asp Ala Ser Lys Arg Gln Asp His Leu Arg Gly Ile Phe Gly Arg
    210                 215                 220
Met Gly Phe Asn Asp Gln Glu Ile Val Ala Leu Ser Gly Ala His Ala
225                 230                 235                 240
Leu Gly Arg Cys His Thr Asp Arg Ser Gly Tyr Ser Gly Pro Trp Thr
                245                 250                 255
Phe Ser Pro Thr Val Leu Thr Asn Asp Tyr Phe Arg Leu Leu Val Glu
            260                 265                 270
Glu Lys Trp Gln Trp Lys Lys Trp Asn Gly Pro Ala Gln Tyr Glu Asp
        275                 280                 285
Lys Ser Thr Lys Ser Leu Met Met Leu Pro Ser Asp Ile Ala Leu Ile
    290                 295                 300
Glu Asp Lys Lys Phe Lys Pro Trp Val Glu Lys Tyr Ala Lys Asp Asn
305                 310                 315                 320
Asp Ala Phe Phe Lys Asp Phe Ser Asn Val Val Leu Arg Leu Phe Glu
                325                 330                 335
Leu Gly Val Pro Phe Ala Gln Gly Thr Glu Asn Gln Arg Trp Thr Phe
            340                 345                 350
Lys Pro Thr His Gln Glu
        355
```

<210> 9
<211> 122
<212> PRT
<213> Chlamydomonas eugametos

<400> 9

```
Met Ser Leu Phe Ala Lys Leu Gly Gly Arg Glu Ala Val Glu Ala Ala
 1               5                  10                  15
Val Asp Lys Phe Tyr Asn Lys Ile Val Ala Asp Pro Thr Val Ser Thr
            20                  25                  30
Tyr Phe Ser Asn Thr Asp Met Lys Val Gln Arg Ser Lys Gln Phe Ala
```

```
        35                  40                  45
Phe Leu Ala Tyr Ala Leu Gly Gly Ala Ser Glu Trp Lys Gly Lys Asp
    50                  55                  60
Met Arg Thr Ala His Lys Asp Leu Val Pro His Leu Ser Asp Val His
65                  70                  75                  80
Phe Gln Ala Val Ala Arg His Leu Ser Asp Thr Leu Thr Glu Leu Gly
                85                  90                  95
Val Pro Pro Glu Asp Ile Thr Asp Ala Met Ala Val Val Ala Ser Thr
            100                 105                 110
Arg Thr Glu Val Leu Asn Met Pro Gln Gln
        115                 120
```

<210> 10
<211> 121
<212> PRT
<213> Tetrahymena pyriformis

<400> 10

```
Met Asn Lys Pro Gln Thr Ile Tyr Glu Lys Leu Gly Gly Glu Asn Ala
 1               5                  10                  15
Met Lys Ala Ala Val Pro Leu Phe Tyr Lys Lys Val Leu Ala Asp Glu
            20                  25                  30
Arg Val Lys His Phe Phe Lys Asn Thr Asp Met Asp His Gln Thr Lys
        35                  40                  45
Gln Gln Thr Asp Phe Leu Thr Met Leu Leu Gly Gly Pro Asn His Tyr
    50                  55                  60
Lys Gly Lys Asn Met Thr Glu Ala His Lys Gly Met Asn Leu Gln Asn
65                  70                  75                  80
Leu His Phe Asp Ala Ile Ile Glu Asn Leu Ala Ala Thr Leu Lys Glu
                85                  90                  95
Leu Gly Val Thr Asp Ala Val Ile Asn Glu Ala Ala Lys Val Ile Glu
            100                 105                 110
His Thr Arg Lys Asp Met Leu Gly Lys
        115                 120
```

<210> 11
<211> 117
<212> PRT
<213> Paramecium caudatum

<400> 11

```
Met Ser Leu Phe Glu Gln Leu Gly Gly Gln Ala Ala Val Gln Ala Val
 1               5                  10                  15
Thr Ala Gln Phe Tyr Ala Asn Ile Gln Ala Asp Ala Thr Val Ala Thr
            20                  25                  30
Phe Phe Asn Gly Ile Asp Met Pro Asn Gln Thr Asn Lys Thr Ala Ala
        35                  40                  45
```

```
Phe Leu Cys Ala Ala Leu Gly Gly Pro Asn Ala Trp Thr Gly Arg Asn
    50                  55                  60
Leu Lys Glu Val His Ala Asn Met Gly Val Ser Asn Ala Gln Phe Thr
65                  70                  75                  80
Thr Val Ile Gly His Leu Arg Ser Ala Leu Thr Gly Ala Gly Val Ala
                85                  90                  95
Ala Ala Leu Val Glu Gln Thr Val Ala Val Ala Glu Thr Val Arg Gly
            100                 105                 110
Asp Val Val Thr Val
        115
```

<210> 12
<211> 147
<212> PRT
<213> Aspergillus niger

<400> 12

```
Met Pro Leu Thr Pro Glu Gln Ile Lys Ile Ile Lys Ala Thr Val Pro
 1               5                  10                  15
Val Leu Gln Glu Tyr Gly Thr Lys Ile Thr Thr Ala Phe Tyr Met Asn
            20                  25                  30
Met Ser Thr Val His Pro Glu Leu Asn Ala Val Phe Asn Thr Ala Asn
        35                  40                  45
Gln Val Lys Gly His Gln Ala Arg Ala Leu Ala Gly Ala Leu Phe Ala
    50                  55                  60
Tyr Ala Ser His Ile Asp Asp Leu Gly Ala Leu Gly Pro Ala Val Glu
65                  70                  75                  80
Leu Ile Cys Asn Lys His Ala Ser Leu Tyr Ile Gln Ala Asp Glu Tyr
                85                  90                  95
Lys Ile Val Gly Lys Tyr Leu Leu Glu Ala Met Lys Glu Val Leu Gly
            100                 105                 110
Asp Ala Cys Thr Asp Asp Ile Leu Asp Ala Trp Gly Ala Ala Tyr Trp
        115                 120                 125
Ala Leu Ala Asp Ile Met Ile Asn Arg Glu Ala Ala Leu Tyr Lys Gln
    130                 135                 140
Ser Gln Gly
145
```

<210> 13
<211> 165
<212> PRT
<213> Zea mays

<400> 13

```
Met Ala Leu Ala Glu Ala Asp Asp Gly Ala Val Val Phe Gly Glu Glu
 1               5                  10                  15
Gln Glu Ala Leu Val Leu Lys Ser Trp Ala Val Met Lys Lys Asp Ala
```

Figure 4 (Continued)

```
            20                  25                  30
Ala Asn Leu Gly Leu Arg Phe Phe Leu Lys Val Phe Glu Ile Ala Pro
        35                  40                  45
Ser Ala Glu Gln Met Phe Ser Phe Leu Arg Asp Ser Asp Val Pro Leu
    50                  55                  60
Glu Lys Asn Pro Lys Leu Lys Thr His Ala Met Ser Val Phe Val Met
65                  70                  75                  80
Thr Cys Glu Ala Ala Ala Gln Leu Arg Lys Ala Gly Lys Val Thr Val
                85                  90                  95
Arg Glu Thr Thr Leu Lys Arg Leu Gly Ala Thr His Leu Arg Tyr Gly
            100                 105                 110
Val Ala Asp Gly His Phe Glu Val Thr Gly Phe Ala Leu Leu Glu Thr
        115                 120                 125
Ile Lys Glu Ala Leu Pro Ala Asp Met Trp Ser Leu Glu Met Lys Lys
    130                 135                 140
Ala Trp Ala Glu Ala Tyr Ser Gln Leu Val Ala Ala Ile Lys Arg Glu
145                 150                 155                 160
Met Lys Pro Asp Ala
                165
```

<210> 14
<211> 169
<212> PRT
<213> Oryza sativa subsp. japonica

<400> 14

```
Met Ala Leu Val Glu Gly Asn Asn Gly Val Ser Gly Gly Ala Val Ser
 1               5                  10                  15
Phe Ser Glu Glu Gln Glu Ala Leu Val Leu Lys Ser Trp Ala Ile Met
            20                  25                  30
Lys Lys Asp Ser Ala Asn Ile Gly Leu Arg Phe Phe Leu Lys Ile Phe
        35                  40                  45
Glu Val Ala Pro Ser Ala Ser Gln Met Phe Ser Phe Leu Arg Asn Ser
    50                  55                  60
Asp Val Pro Leu Glu Lys Asn Pro Lys Leu Lys Thr His Ala Met Ser
65                  70                  75                  80
Val Phe Val Met Thr Cys Glu Ala Ala Ala Gln Leu Arg Lys Ala Gly
                85                  90                  95
Lys Val Thr Val Arg Asp Thr Thr Leu Lys Arg Leu Gly Ala Thr His
            100                 105                 110
Phe Lys Tyr Gly Val Gly Asp Ala His Phe Glu Val Thr Arg Phe Ala
        115                 120                 125
Leu Leu Glu Thr Ile Lys Glu Ala Val Pro Val Asp Met Trp Ser Pro
    130                 135                 140
Ala Met Lys Ser Ala Trp Ser Glu Ala Tyr Asn Gln Leu Val Ala Ala
145                 150                 155                 160
Ile Lys Gln Glu Met Lys Pro Ala Glu
                165
```

<210> 15
<211> 160
<212> PRT
<213> Arabidopsis thaliana

<400> 15
Met Glu Ser Glu Gly Lys Ile Val Phe Thr Glu Glu Gln Glu Ala Leu
1 5 10 15
Val Val Lys Ser Trp Ser Val Met Lys Lys Asn Ser Ala Glu Leu Gly
20 25 30
Leu Lys Leu Phe Ile Lys Ile Phe Glu Ile Ala Pro Thr Thr Lys Lys
35 40 45
Met Phe Ser Phe Leu Arg Asp Ser Pro Ile Pro Ala Glu Gln Asn Pro
50 55 60
Lys Leu Lys Pro His Ala Met Ser Val Phe Val Met Cys Cys Glu Ser
65 70 75 80
Ala Val Gln Leu Arg Lys Thr Gly Lys Val Thr Val Arg Glu Thr Thr
85 90 95
Leu Lys Arg Leu Gly Ala Ser His Ser Lys Tyr Gly Val Val Asp Glu
100 105 110
His Phe Glu Val Ala Lys Tyr Ala Leu Leu Glu Thr Ile Lys Glu Ala
115 120 125
Val Pro Glu Met Trp Ser Pro Glu Met Lys Val Ala Trp Gly Gln Ala
130 135 140
Tyr Asp His Leu Val Ala Ala Ile Lys Ala Glu Met Asn Leu Ser Asn
145 150 155 160

<210> 16
<211> 147
<212> PRT
<213> Pisum sativum

<400> 16
Met Gly Phe Thr Asp Lys Gln Glu Ala Leu Val Asn Ser Ser Trp Glu
1 5 10 15
Ser Phe Lys Gln Asn Leu Ser Gly Asn Ser Ile Leu Phe Tyr Thr Ile
20 25 30
Ile Leu Glu Lys Ala Pro Ala Ala Lys Gly Leu Phe Ser Phe Leu Lys
35 40 45
Asp Thr Ala Gly Val Glu Asp Ser Pro Lys Leu Gln Ala His Ala Glu
50 55 60
Gln Val Phe Gly Leu Val Arg Asp Ser Ala Ala Gln Leu Arg Thr Lys
65 70 75 80
Gly Glu Val Val Leu Gly Asn Ala Thr Leu Gly Ala Ile His Val Gln
85 90 95
Arg Gly Val Thr Asp Pro His Phe Val Val Val Lys Glu Ala Leu Leu

Figure 4 (Continued)

```
            100                 105                 110
Gln Thr Ile Lys Lys Ala Ser Gly Asn Asn Trp Ser Glu Glu Leu Asn
        115                 120                 125
Thr Ala Trp Glu Val Ala Tyr Asp Gly Leu Ala Thr Ala Ile Lys Lys
    130                 135                 140
Ala Met Thr
145
```

<210> 17
<211> 145
<212> PRT
<213> Vigna unguiculata

<400> 17

```
Met Val Ala Phe Ser Asp Lys Gln Glu Ala Leu Val Asn Gly Ala Tyr
 1               5                  10                  15
Glu Ala Phe Lys Ala Asn Ile Pro Lys Tyr Ser Val Val Phe Tyr Thr
            20                  25                  30
Thr Ile Leu Glu Lys Ala Pro Ala Ala Lys Asn Leu Phe Ser Phe Leu
        35                  40                  45
Ala Asn Gly Val Asp Ala Thr Asn Pro Lys Leu Thr Gly His Ala Glu
    50                  55                  60
Lys Leu Phe Gly Leu Val Arg Asp Ser Ala Ala Gln Leu Arg Ala Ser
65                  70                  75                  80
Gly Gly Val Val Ala Asp Ala Ala Leu Gly Ala Val His Ser Gln Lys
                85                  90                  95
Ala Val Asn Asp Ala Gln Phe Val Val Val Lys Glu Ala Leu Val Lys
            100                 105                 110
Thr Leu Lys Glu Ala Val Gly Asp Lys Trp Ser Asp Glu Leu Gly Thr
        115                 120                 125
Ala Val Glu Leu Ala Tyr Asp Glu Leu Ala Ala Ala Ile Lys Lys Ala
    130                 135                 140
Tyr
145
```

<210> 18
<211> 154
<212> PRT
<213> Bos taurus

<400> 18

```
Met Gly Leu Ser Asp Gly Glu Trp Gln Leu Val Leu Asn Ala Trp Gly
 1               5                  10                  15
Lys Val Glu Ala Asp Val Ala Gly His Gly Gln Glu Val Leu Ile Arg
            20                  25                  30
Leu Phe Thr Gly His Pro Glu Thr Leu Glu Lys Phe Asp Lys Phe Lys
        35                  40                  45
```

```
His Leu Lys Thr Glu Ala Glu Met Lys Ala Ser Glu Asp Leu Lys Lys
    50                  55                  60
His Gly Asn Thr Val Leu Thr Ala Leu Gly Gly Ile Leu Lys Lys Lys
65                  70                  75                  80
Gly His His Glu Ala Glu Val Lys His Leu Ala Glu Ser His Ala Asn
                85                  90                  95
Lys His Lys Ile Pro Val Lys Tyr Leu Glu Phe Ile Ser Asp Ala Ile
            100                 105                 110
Ile His Val Leu His Ala Lys His Pro Ser Asp Phe Gly Ala Asp Ala
        115                 120                 125
Gln Ala Ala Met Ser Lys Ala Leu Glu Leu Phe Arg Asn Asp Met Ala
    130                 135                 140
Ala Gln Tyr Lys Val Leu Gly Phe His Gly
145                 150
```

<210> 19
<211> 154
<212> PRT
<213> Sus scrofa

<400> 19

```
Met Gly Leu Ser Asp Gly Glu Trp Gln Leu Val Leu Asn Val Trp Gly
 1               5                  10                  15
Lys Val Glu Ala Asp Val Ala Gly His Gly Gln Glu Val Leu Ile Arg
            20                  25                  30
Leu Phe Lys Gly His Pro Glu Thr Leu Glu Lys Phe Asp Lys Phe Lys
        35                  40                  45
His Leu Lys Ser Glu Asp Glu Met Lys Ala Ser Glu Asp Leu Lys Lys
    50                  55                  60
His Gly Asn Thr Val Leu Thr Ala Leu Gly Gly Ile Leu Lys Lys Lys
65                  70                  75                  80
Gly His His Glu Ala Glu Leu Thr Pro Leu Ala Gln Ser His Ala Thr
                85                  90                  95
Lys His Lys Ile Pro Val Lys Tyr Leu Glu Phe Ile Ser Glu Ala Ile
            100                 105                 110
Ile Gln Val Leu Gln Ser Lys His Pro Gly Asp Phe Gly Ala Asp Ala
        115                 120                 125
Gln Gly Ala Met Ser Lys Ala Leu Glu Leu Phe Arg Asn Asp Met Ala
    130                 135                 140
Ala Lys Tyr Lys Glu Leu Gly Phe Gln Gly
145                 150
```

<210> 20
<211> 154
<212> PRT
<213> Equus caballus

<400> 20
Met Gly Leu Ser Asp Gly Glu Trp Gln Gln Val Leu Asn Val Trp Gly
1 5 10 15
Lys Val Glu Ala Asp Ile Ala Gly His Gly Gln Glu Val Leu Ile Arg
20 25 30
Leu Phe Thr Gly His Pro Glu Thr Leu Glu Lys Phe Asp Lys Phe Lys
35 40 45
His Leu Lys Thr Glu Ala Glu Met Lys Ala Ser Glu Asp Leu Lys Lys
50 55 60
His Gly Thr Val Val Leu Thr Ala Leu Gly Gly Ile Leu Lys Lys Lys
65 70 75 80
Gly His His Glu Ala Glu Leu Lys Pro Leu Ala Gln Ser His Ala Thr
85 90 95
Lys His Lys Ile Pro Ile Lys Tyr Leu Glu Phe Ile Ser Asp Ala Ile
100 105 110
Ile His Val Leu His Ser Lys His Pro Gly Asp Phe Gly Ala Asp Ala
115 120 125
Gln Gly Ala Met Thr Lys Ala Leu Glu Leu Phe Arg Asn Asp Ile Ala
130 135 140
Ala Lys Tyr Lys Glu Leu Gly Phe Gln Gly
145 150

<210> 21
<211> 152
<212> PRT
<213> Nicotiana benthamiana

<400> 21
Met Ser Ser Phe Thr Glu Glu Gln Glu Ala Leu Val Val Lys Ser Trp
1 5 10 15
Asp Ser Met Lys Lys Asn Ala Gly Glu Trp Gly Leu Lys Leu Phe Leu
20 25 30
Lys Ile Phe Glu Ile Ala Pro Ser Ala Lys Lys Leu Phe Ser Phe Leu
35 40 45
Lys Asp Ser Asn Val Pro Leu Glu Gln Asn Ala Lys Leu Lys Pro His
50 55 60
Ser Lys Ser Val Phe Val Met Thr Cys Glu Ala Ala Val Gln Leu Arg
65 70 75 80
Lys Ala Gly Lys Val Val Val Arg Asp Ser Thr Leu Lys Lys Leu Gly
85 90 95
Ala Thr His Phe Lys Tyr Gly Val Ala Asp Glu His Phe Glu Val Thr
100 105 110
Lys Phe Ala Leu Leu Glu Thr Ile Lys Glu Ala Val Pro Glu Met Trp
115 120 125
Ser Val Asp Met Lys Asn Ala Trp Gly Glu Ala Phe Asp Gln Leu Val
130 135 140
Asn Ala Ile Lys Thr Glu Met Lys
145 150

Figure 4 (Continued)

<210> 22
<211> 132
<212> PRT
<213> Bacillus subtilis

<400> 22
Met Gly Gln Ser Phe Asn Ala Pro Tyr Glu Ala Ile Gly Glu Glu Leu
1 5 10 15
Leu Ser Gln Leu Val Asp Thr Phe Tyr Glu Arg Val Ala Ser His Pro
20 25 30
Leu Leu Lys Pro Ile Phe Pro Ser Asp Leu Thr Glu Thr Ala Arg Lys
35 40 45
Gln Lys Gln Phe Leu Thr Gln Tyr Leu Gly Gly Pro Pro Leu Tyr Thr
50 55 60
Glu Glu His Gly His Pro Met Leu Arg Ala Arg His Leu Pro Phe Pro
65 70 75 80
Ile Thr Asn Glu Arg Ala Asp Ala Trp Leu Ser Cys Met Lys Asp Ala
85 90 95
Met Asp His Val Gly Leu Glu Gly Glu Ile Arg Glu Phe Leu Phe Gly
100 105 110
Arg Leu Glu Leu Thr Ala Arg His Met Val Asn Gln Thr Glu Ala Glu
115 120 125
Asp Arg Ser Ser
130

<210> 23
<211> 131
<212> PRT
<213> Corynebacterium glutamicum

<400> 23
Met Thr Thr Ser Glu Asn Phe Tyr Asp Ser Val Gly Gly Glu Glu Thr
1 5 10 15
Phe Ser Leu Ile Val His Arg Phe Tyr Glu Gln Val Pro Asn Asp Asp
20 25 30
Ile Leu Gly Pro Met Tyr Pro Pro Asp Asp Phe Glu Gly Ala Glu Gln
35 40 45
Arg Leu Lys Met Phe Leu Ser Gln Tyr Trp Gly Gly Pro Lys Asp Tyr
50 55 60
Gln Glu Gln Arg Gly His Pro Arg Leu Arg Met Arg His Val Asn Tyr
65 70 75 80
Pro Ile Gly Val Thr Ala Ala Glu Arg Trp Leu Gln Leu Met Ser Asn
85 90 95
Ala Leu Asp Gly Val Asp Leu Thr Ala Glu Gln Arg Glu Ala Ile Trp
100 105 110
Glu His Met Val Arg Ala Ala Asp Met Leu Ile Asn Ser Asn Pro Asp

```
        115                 120                 125
Pro His Ala
    130


<210> 24
<211> 124
<212> PRT
<213> Synechocystis sp.

<400> 24
Met Ser Thr Leu Tyr Glu Lys Leu Gly Gly Thr Thr Ala Val Asp Leu
 1               5                  10                  15
Ala Val Asp Lys Phe Tyr Glu Arg Val Leu Gln Asp Asp Arg Ile Lys
            20                  25                  30
His Phe Phe Ala Asp Val Asp Met Ala Lys Gln Arg Ala His Gln Lys
        35                  40                  45
Ala Phe Leu Thr Tyr Ala Phe Gly Gly Thr Asp Lys Tyr Asp Gly Arg
    50                  55                  60
Tyr Met Arg Glu Ala His Lys Glu Leu Val Glu Asn His Gly Leu Asn
65                  70                  75                  80
Gly Glu His Phe Asp Ala Val Ala Glu Asp Leu Leu Ala Thr Leu Lys
                85                  90                  95
Glu Met Gly Val Pro Glu Asp Leu Ile Ala Glu Val Ala Ala Val Ala
            100                 105                 110
Gly Ala Pro Ala His Lys Arg Asp Val Leu Asn Gln
        115                 120


<210> 25
<211> 183
<212> PRT
<213> Synechococcus sp.

<400> 25
Met Asp Val Ala Leu Leu Glu Lys Ser Phe Glu Gln Ile Ser Pro Arg
 1               5                  10                  15
Ala Ile Glu Phe Ser Ala Ser Phe Tyr Gln Asn Leu Phe His His His
            20                  25                  30
Pro Glu Leu Lys Pro Leu Phe Ala Glu Thr Ser Gln Thr Ile Gln Glu
        35                  40                  45
Lys Lys Leu Ile Phe Ser Leu Ala Ala Ile Ile Glu Asn Leu Arg Asn
    50                  55                  60
Pro Asp Ile Leu Gln Pro Ala Leu Lys Ser Leu Gly Ala Arg His Ala
65                  70                  75                  80
Glu Val Gly Thr Ile Lys Ser His Tyr Pro Leu Val Gly Gln Ala Leu
                85                  90                  95
Ile Glu Thr Phe Ala Glu Tyr Leu Ala Ala Asp Trp Thr Glu Gln Leu
            100                 105                 110
```

Figure 4 (Continued)

```
Ala Thr Ala Trp Val Glu Ala Tyr Asp Val Ile Ala Ser Thr Met Ile
        115                 120                 125
Glu Gly Ala Asp Asn Pro Ala Ala Tyr Leu Glu Pro Glu Leu Thr Phe
    130                 135                 140
Tyr Glu Trp Leu Asp Leu Tyr Gly Glu Glu Ser Pro Lys Val Arg Asn
145                 150                 155                 160
Ala Ile Ala Thr Leu Thr His Phe His Tyr Gly Glu Asp Pro Gln Asp
                165                 170                 175
Val Gln Arg Asp Ser Arg Gly
            180
```

<210> 26
<211> 118
<212> PRT
<213> Nostoc commune

<400> 26

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Met Ser Thr Leu Tyr Asp Asn Ile Gly Gly Gln Pro Ala Ile Glu Gln
 1               5                  10                  15
Val Val Asp Glu Leu His Lys Arg Ile Ala Thr Asp Ser Leu Leu Ala
            20                  25                  30
Pro Val Phe Ala Gly Thr Asp Met Val Lys Gln Arg Asn His Leu Val
        35                  40                  45
Ala Phe Leu Ala Gln Ile Phe Glu Gly Pro Lys Gln Tyr Gly Gly Arg
    50                  55                  60
Pro Met Asp Lys Thr His Ala Gly Leu Asn Leu Gln Gln Pro His Phe
65                  70                  75                  80
Asp Ala Ile Ala Lys His Leu Gly Glu Arg Met Ala Val Arg Gly Val
                85                  90                  95
Ser Ala Glu Asn Thr Lys Ala Ala Leu Asp Arg Val Thr Asn Met Lys
            100                 105                 110
Gly Ala Ile Leu Asn Lys
        115
```

<210> 27
<211> 136
<212> PRT
<213> Bacillus megaterium

<400> 27

```
Met Arg Glu Lys Ile His Ser Pro Tyr Glu Leu Leu Gly Gly Glu His
 1               5                  10                  15
Thr Ile Ser Lys Leu Val Asp Ala Phe Tyr Thr Arg Val Gly Gln His
            20                  25                  30
Pro Glu Leu Ala Pro Ile Phe Pro Asp Asn Leu Thr Glu Thr Ala Arg
        35                  40                  45
Lys Gln Lys Gln Phe Leu Thr Gln Tyr Leu Gly Gly Pro Ser Leu Tyr
```

```
    50                  55                  60
Thr Glu Glu His Gly His Pro Met Leu Arg Ala Arg His Leu Pro Phe
65                  70                  75                  80
Glu Ile Thr Pro Ser Arg Ala Lys Ala Trp Leu Thr Cys Met His Glu
                85                  90                  95
Ala Met Asp Glu Ile Asn Leu Glu Gly Pro Glu Arg Asp Glu Leu Tyr
            100                 105                 110
His Arg Leu Ile Leu Thr Ala Gln His Met Ile Asn Ser Pro Glu Gln
        115                 120                 125
Thr Asp Glu Lys Gly Phe Ser His
    130                 135
```

Figure 4 (Continued)

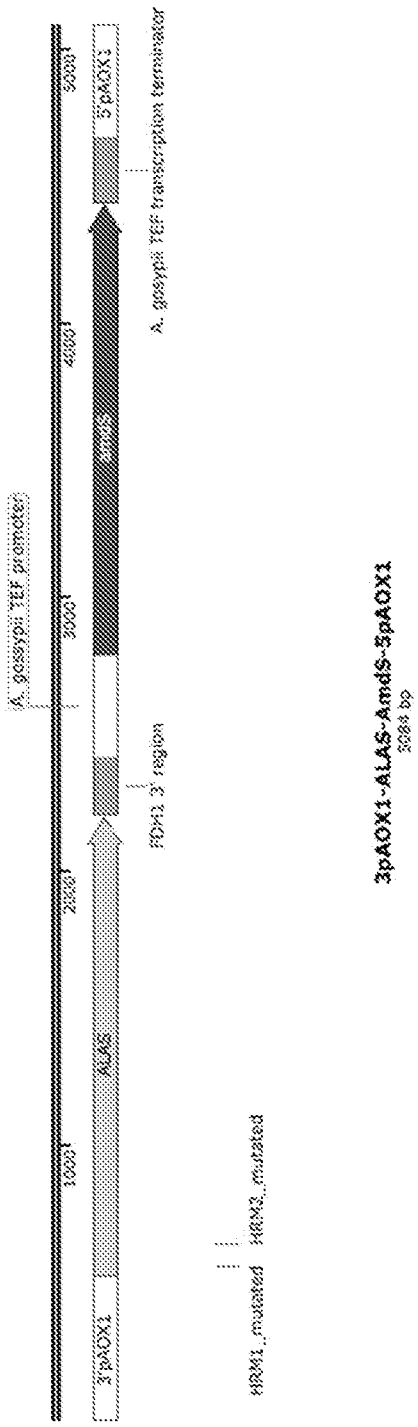
3'pAOX1
ALAS
amdS
5'pAOX1
1000
2000
3000
4000
5000
A. gossypii TEF promoter
A. gossypii TEF transcription terminator
FDH1 3' region
HRM1_mutated
HRM3_mutated
3pAOX1-ALAS-AmdS-5pAOX1

Figure 5

Figure 6

SEQ ID NO: 28

```
atggagtttg tcgcccgtca gtccatgaat gcctgtccct ttgtcaggtc aacttctacc      60
caccatttga agaagttggc agcaaacagt tctctagctg ctactgctag tcattgtccc     120
gtggttggcc ctgctctcca acagcagaga tactactctc aaccttccaa gccagcccaa     180
gcccaaacct ccgacattgc tactgggatc aagaaggatg tttctccgat ccgtatggac     240
tctaatgaaa ccgcctttga ttacaatgga atgtatgagt ctgatcttgc gaataaacgt     300
aaagataact cgtatcgtta tttcaataac atcaaccgtc tagccaagga gtttcccaag     360
gcacatcgcc agaccgaaga tgacaaggtg accgtctggt gctctaacga ctacttagga     420
atgggtaggc atcctgagat tatcaaaacc atgaaggcta ccatggacaa gtacggttcc     480
ggagcaggag gaactaggaa cattgcaggt cataaccacg ccgctatcaa tttggaaagc     540
gagttggctt gcttgaacaa gaaggaagcg gctctggtgt tttcatcatg tttcatagct     600
aacgatgcaa tcatctcgtt gttgggacaa aaaatcaaaa atttggtcat tttctctgac     660
cagtcgaatc atgcttccat gatattgggt gtgcgtaact ccaaagcgaa gaagcacatc     720
ttcaagcaca acaatttgaa ggatctggag tcgcagttag ctcagtaccc caagtcgact     780
cctaaactga tcgccttcga gtcagtttac tctatgtgtg gatctgtggc tcccattgag     840
aagatttgcg atttggctaa aaggtacggt gccctcacct tcttggatga agttcatgct     900
gttggaatgt atggtcctca tggacagggt gtagctgagc atttggactt tgatctgcat     960
ttacagtctg gaatcgccag tcctagcgtg gtggacaaac gcaccatatt ggatcgtgtc    1020
gacatgatta ctggtacttg cggaaagtca tttggtactg ttggaggtta cgttgctggt    1080
agtgccaacc taattgattg gttaagatcc tatgcgccag gtttcatttt cactaccaca    1140
cttcctcctg ctatcatggc tggtacagcc acttctgttc gtattgttag ggccgacatt    1200
gaggcccgta tcaagcaaca gcttaatact cgctacgtca aagactcatt tgaaaacctt    1260
ggtattccag tcattccaaa cccaagtcac attgttcctg ttctagttgg aaatgctgca    1320
gatgccaaga aggcatccga tatgttaatg aacaaacacc gtatttatgt tcaagctatt    1380
aactacccta ctgtgcctgt cggtgaagaa cgactaagga ttactcctac tccaggtcat    1440
ggaaaggaga tttgtgacca gctgatcagc gctgtcgacg atgtttttac tgagcttaat    1500
ttaccaagaa tcaacaaatg gcagtcccaa ggtggtcatt gcggtgttgg tgatgctaat    1560
tacgtaccag aacccaatct gtggactcag gaccagctca gcttgacaaa ccaagacttg    1620
cactccaatg tgcacaaccc agtgattgag cagatcgaaa cctcatcagg agtcagattg    1680
tag                                                                  1683
```

SEQ ID NO: 29

```
        10          20          30          40          50
MEFVARQSMN ACPFVRSTST HHLKKLAANS SLAATASHCP VVGPALQQQR
        60          70          80          90         100
YYSQPSKPAQ AQTSDIATGI KKDVSPIRMD SNETAFDYNG MYESDLANKR
       110         120         130         140         150
KDNSYRYFNN INRLAKEFPK AHRQTEDDKV TVWCSNDYLG MGRHPEIIKT
       160         170         180         190         200
MKATMDKYGS GAGGTRNIAG HNHAAINLES ELACLNKKEA ALVFSSCFIA
       210         220         230         240         250
NDAIISLLGQ KIKNLVIFSD QSNHASMILG VRNSKAKKHI FKHNNLKDLE
       260         270         280         290         300
SQLAQYPKST PKLIAFESVY SMCGSVAPIE KICDLAKRYG ALTFLDEVHA
       310         320         330         340         350
VGMYGPHGQG VAEHLDFDLH LQSGIASPSV VDKRTILDRV DMITGTCGKS
       360         370         380         390         400
FGTVGGYVAG SANLIDWLRS YAPGFIFTTT LPPAIMAGTA TSVRIVRADI
       410         420         430         440         450
```

```
EARIKQQLNT RYVKDSFENL GIPVIPNPSH IVPVLVGNAA DAKKASDMLM
       460         470         480         490         500
NKHRIYVQAI NYPTVPVGEE RLRITPTPGH GKEICDQLIS AVDDVFTELN
       510         520         530         540         550
LPRINKWQSQ GGHCGVGDAN YVPEPNLWTQ DQLSLTNQDL HSNVHNPVIE
       560
QIETSSGVRL
```

Figure 6 (Continued)

Figure 7

Sequence of an exemplary mutant ALAS gene and protein

Gene sequence (SEQ ID NO: 30):

ATGGAGTTTGTCGCCCGTCAGTCCATGAATGCC**TCT**CCCTTTGTCAGGTCAACTTCTACCCACC
ATTTGAAGAAGTTGGCAGCAAACAGTTCTCTAGCTGCTACTGCTAGTCAT**TCT**CCCGTGGTTGG
CCCTGCTCTCCAACAGCAGAGATACTACTCTCAACCTTCCAAGCCAGCCCAAGCCCAAACCTCC
GACATTGCTACTGGGATCAAGAAGGATGTTTCTCCGATCCGTATGGACTCTAATGAAACCGCCT
TTGATTACAATGGAATGTATGAGTCTGATCTTGCGAATAAACGTAAAGATAACTCGTATCGTTA
TTTCAATAACATCAACCGTCTAGCCAAGGAGTTTCCCAAGGCACATCGCCAGACCGAAGATGAC
AAGGTGACCGTCTGGTGCTCTAACGACTACTTAGGAATGGGTAGGCATCCTGAGATTATCAAAA
CCATGAAGGCTACCATGGACAAGTACGGTTCCGGAGCAGGAGGAACTAGGAACATTGCAGGTCA
TAACCACGCCGCTATCAATTTGGAAAGCGAGTTGGCTTGCTTGAACAAGAAGGAAGCGGCTCTG
GTGTTTTCATCATGTTTCATAGCTAACGATGCAATCATCTCGTTGTTGGGACAAAAAATCAAAA
ATTTGGTCATTTTCTCTGACCAGTCGAATCATGCTTCCATGATATTGGGTGTGCGTAACTCCAA
AGCGAAGAAGCACATCTTCAAGCACAACAATTTGAAGGATCTGGAGTCGCAGTTAGCTCAGTAC
CCCAAGTCGACTCCTAAACTGATCGCCTTCGAGTCAGTTTACTCTATGTGTGGATCTGTGGCTC
CCATTGAGAAGATTTGCGATTTGGCTAAAAGGTACGGTGCCCTCACCTTCTTGGATGAAGTTCA
TGCTGTTGGAATGTATGGTCCTCATGGACAGGGTGTAGCTGAGCATTTGGACTTTGATCTGCAT
TTACAGTCTGGAATCGCCAGTCCTAGCGTGGTGGACAAACGCACCATATTGGATCGTGTCGACA
TGATTACTGGTACTTGCGGAAAGTCATTTGGTACTGTTGGAGGTTACGTTGCTGGTAGTGCCAA
CCTAATTGATTGGTTAAGATCCTATGCGCCAGGTTTCATTTTCACTACCACACTTCCTCCTGCT
ATCATGGCTGGTACAGCCACTTCTGTTCGTATTGTTAGGGCCGACATTGAGGCCCGTATCAAGC
AACAGCTTAATACTCGCTACGTCAAAGACTCATTTGAAAACCTTGGTATTCCAGTCATTCCAAA
CCCAAGTCACATTGTTCCTGTTCTAGTTGGAAATGCTGCAGATGCCAAGAAGGCATCCGATATG
TTAATGAACAAACACCGTATTTATGTTCAAGCTATTAACTACCCTACTGTGCCTGTCGGTGAAG
AACGACTAAGGATTACTCCTACTCCAGGTCATGGAAAGGAGATTTGTGACCAGCTGATCAGCGC
TGTCGACGATGTTTTTACTGAGCTTAATTTACCAAGAATCAACAAATGGCAGTCCCAAGGTGGT
CATTGCGGTGTTGGTGATGCTAATTACGTACCAGAACCCAATCTGTGGACTCAGGACCAGCTCA
GCTTGACAAACCAAGACTTGCACTCCAATGTGCACAACCCAGTGATTGAGCAGATCGAAACCTC
ATCAGGAGTCAGATTGTAG

Mutated codons (TGT in wild-type to TCT in mutant) are indicated in bold and double underlined.

Protein sequence (SEQ ID NO: 31):

MEFVARQSMNA**S**PFVRSTSTHHLKKLAANSSLAATASH**S**PVVGPALQQQRYYSQPSKPAQAQTS
DIATGIKKDVSPIRMDSNETAFDYNGMYESDLANKRKDNSYRYFNNINRLAKEFPKAHRQTEDD
KVTVWCSNDYLGMGRHPEIIKTMKATMDKYGSGAGGTRNIAGHNHAAINLESELACLNKKEAAL
VFSSCFIANDAIISLLGQKIKNLVIFSDQSNHASMILGVRNSKAKKHIFKHNNLKDLESQLAQY
PKSTPKLIAFESVYSMCGSVAPIEKICDLAKRYGALTFLDEVHAVGMYGPHGQGVAEHLDFDLH
LQSGIASPSVVDKRTILDRVDMITGTCGKSFGTVGGYVAGSANLIDWLRSYAPGFIFTTTLPPA
IMAGTATSVRIVRADIEARIKQQLNTRYVKDSFENLGIPVIPNPSHIVPVLVGNAADAKKASDM
LMNKHRIYVQAINYPTVPVGEERLRITPTPGHGKEICDQLISAVDDVFTELNLPRINKWQSQGG
HCGVGDANYVPEPNLWTQDQLSLTNQDLHSNVHNPVIEQIETSSGVRL

Length: 560 aa
Mol wt: 61.5 kDa

Two cysteine residues present in wtALAS were mutated to serine (bold and double underlined): C12S and C39S.

Figure 7 (Continued)

Figure 8

SEQ ID NO: 32
R/L/N/A/C/S/H/I/G/Q-C-P-L/V/I/F/C-L/M/P/V

SEQ ID NO: 33
A-C-P-F-V

SEQ ID NO: 34
H-C-P-V-V

SEQ ID NO: 35
I-C-P-F-M

SEQ ID NO: 36
G-C-P-V-V

SEQ ID NO: 37
CGTCAGTCCATGAATGCCTCTCCCTTTGTCAGGTCAACTTC

SEQ ID NO: 38
GAAGTTGACCTGACAAAGGGAGAGGCATTCATGGACTGACG

SEQ ID NO: 39
GCTGCTACTGCTAGTCATTCTCCCGTGGTTGGCCCTG

SEQ ID NO: 40
CAGGGCCAACCACGGGAGAATGACTAGCAGTAGCAGC

SEQ ID NO: 41
AAACGCTGTCTTGGAACCTAATATGAC

SEQ ID NO: 42
GACGGGCGACAAACTCCATCGTTTCGAATAATTAGTTG

SEQ ID NO: 43
CAACTAATTATTCGAAACGATGGAGTTTGTCGCCCGTCAG

SEQ ID NO: 44
AATTAAATACATTTCAACTACAATCTGACTCCTGATGAGGTTTCG

SEQ ID NO: 45
CCTCATCAGGAGTCAGATTGTAGTTGAAATGTATTTAATTTG

SEQ ID NO: 46
AAACTGTCAGTTTTGGGCCATTTG

SEQ ID NO: 47
GCTCTCCAACAGCAGAGATAC

SEQ ID NO: 48
GTCCATACGGATCGGAGAAAC

SEQ ID NO: 49
AGCAACATCCCTGATTCCG

SEQ ID NO: 50
ATGCGTACCTTCAATCCTGG

SEQ ID NO: 51
6-FAM/AAGCCCAAA/Zen/CCTCCGA CATTGCTA/3IABkFQ

SEQ ID NO: 52
HEX/TCGCCGTAA/Zen/GTTCTTGGTT TAGACGTTC/3IABkFQ

SEQ ID NO: 53
TAGCGCAGTCTCTCTATCGCTTC

SEQ ID NO: 54
CACTGGGTTGTGCACATTGG

SEQ ID NO: 55
ACAATATTCTTCTCTGCCGC

SEQ ID NO: 56
TTGATCTCGTCAAGAATGCG

SEQ ID NO: 57
TAGGTGCCACAACTTTTGGTTTC

SEQ ID NO: 58
GATCCAATGCGATGACATTCTTGT

SEQ ID NO: 59
ACCTGCAATAACTCCTCTTCTCTG

SEQ ID NO: 60
CCACTGAGGGTAGCCGAATC

SEQ ID NO: 61
GGGCTCTGAAAAACTCTTTTGG

Figure 8 (Continued)

SEQ ID NO: 62
GCATGTCTCAATAACAGATCTCGACGG

SEQ ID NO: 63
AAGCCTCTTGTTTTTCTGTAAATGCAC

SEQ ID NO: 64
TGATGGCGTCCGAGATGAACTC

SEQ ID NO: 65
ATGGAGTTTGTCGCCCGTCAG

SEQ ID NO: 66
CTACAATCTGACTCCTGATGAGGTTTC

Figure 8 (Continued)