

CX2-095W02_ST25.txt
SEQUENCE LISTING

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<110>  Codexis, Inc.
      CHEN, Haibin
      BONG, Yong Koy
      CABIROL, Fabien
      COLLIER, Steven J.
      GOHEL, Anupam
      LI, Tao
      MOORE, Jeffrey C.
      QUINTANAR-AUDELO, Martina
      SMITH, Derek
      YANG, Hong

<120>  BIOCATALYSTS AND METHODS FOR HYDROXYLATION OF CHEMICAL COMPOUNDS

<130>  CX2-095W02

<150>  61/644,135
<151>  2012-05-08

<160>  228

<170>  PatentIn version 3.5

<210>  1
<211>  843
<212>  DNA
<213>  Artificial Sequence

<220>
<223>  Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
      meliloti

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aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
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gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
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acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
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taa
843

<210>  2
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<212>  PRT
<213>  Sinorhizobium meliloti

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Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
          20          25          30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
          35          40          45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
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Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100      105      110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130      135      140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145      150      155      160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165      170      175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225      230      235      240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245      250      255
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260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
275      280

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<210> 3
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
aacgcaccgg ctcttgcaac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
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gcgtgcatta taccacattc agattacctc gagcttgacg agacatttac cagattgcat 360
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cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
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843

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<210> 4
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 <212> PRT
 <213> Sinorhizobium meliloti

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20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg

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CX2-095W02_ST25.txt

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Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
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Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
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260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 5
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

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gagcatgctg tgctacgcaa tcggaccgga atgcaggagg aagatattcgt cgtaagtcac 180
aacgctcctg cactggccac gccgctgagc aagtcgctgc cgtatctgaa cgaacttggt 240
gaaaccactc tcgattgcag cgctgttcgg tatacaagaa ttgtccgtgt atcagaaaac 300
gcatgtataa tccccatag tgattacctt gaactagatg agaccttcac aaggttacac 360
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<210> 6
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 <212> PRT
 <213> Sinorhizobium meliloti

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CX2-095W02_ST25.txt

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

<210> 7
 <211> 843
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 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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 aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
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 ctgctgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
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<210> 8
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 8

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

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<210> 9

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 9

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aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcttga tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac      360
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acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggttc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
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<210> 10
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<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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

<210> 11
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 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
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 ctctgttggg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
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atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
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taa						843

<210> 12
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<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 12

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

<210> 13
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 13

CX2-095W02_ST25.txt

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gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacgctgac	ccggctgcac	360
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aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
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taa						843

<210> 14
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 14

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

<210> 15
 <211> 843

<212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

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<400> 15
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc tatactgagg aagataagat attccacatg      420
ggctctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa                                                    843
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<210> 16
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 16

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

<210> 17
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 17
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
 aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctggtt tctggacagt atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 18
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 18

Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ser Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190

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```

Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 19
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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<400> 19
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aagtcgctga gtttgctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgcg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggcttgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgactct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 20
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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

```

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130	Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145	Lys	Thr	Pro	Arg	Leu	Thr	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
	Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp
	Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
	Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val
	Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser
225	Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
	Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
	Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr								

<210> 21
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 21	atgtctacgc	atcttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
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	gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
	aatgcgcccg	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
	gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagAAC	300
	gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacggttcac	ccggctgcac	360
	ctcgtgttgg	atactaacag	tggttggtgcc	aacactgagg	aagataagat	attccacatg	420
	ggtctgggCG	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
	aaaactccta	gactgacgct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
	ttacgcaatg	tggAACagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
	acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
	cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
	atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
	acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
	taa						843

<210> 22
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 22

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

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65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145
Lys Thr Pro Arg Leu Thr Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260
Glu Arg Gly Glu Val Met Thr Tyr
275      280

```

<210> 23
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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<400> 23
atgtctacgc acttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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<210> 24
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 24

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

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

<210>	25
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	25					
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tctacttttag	aagtcgctga	gttttctggt	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcactt	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaaacagc	tgtaactact	cgcgacattg	tagacctctg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcggg	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210>	26
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 26

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

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<210> 27

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 27

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctactttag aagtcgctga gttttctccg gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780

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acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat
taa

840
843

<210> 28
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 28

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

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<210> 29
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 29

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctactttag aagtcgctga gttttctagt gcatattcgg acttcacttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300

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chr1: 65301201-65301250 (60 bp)						
gacctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgtttg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcattc	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcggt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210>	30
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	30														
Met 1	Ser	Thr	His	Phe 5	Leu	Gly	Lys	Val 10	Lys	Phe	Asp	Glu	Ala	Arg 15	Leu
Ala	Glu	Asp	Leu 20	Ser	Thr	Leu	Glu	Val 25	Ala	Glu	Phe	Ser	Ser 30	Ala	Tyr
Ser	Asp	Phe 35	Thr	Cys	Gly	Lys	Trp 40	Glu	Ala	Cys	Val	Leu 45	Arg	Asn	Arg
Thr	Gly 50	Met	Gln	Glu	Glu	Asp 55	Ile	Val	Val	Ser	His 60	Asn	Ala	Pro	Ala
Leu 65	Ala	Thr	Pro	Leu	Ser 70	Lys	Ser	Leu	Pro	Tyr 75	Leu	Asn	Glu	Leu	Val 80
Glu	Thr	His	Phe	Asp 85	Cys	Ser	Ala	Val	Arg 90	Tyr	Thr	Arg	Ile	Val 95	Arg
Val	Ser	Glu	Asn 100	Ala	Cys	Ile	Ile	Pro 105	His	Ser	Asp	Tyr	Leu 110	Glu	Leu
Asp	Glu	Thr 115	Phe	Thr	Arg	Leu	His 120	Leu	Val	Leu	Asp	Thr 125	Asn	Ser	Gly
Cys	Ala 130	Asn	Thr	Glu	Glu	Asp 135	Lys	Ile	Phe	His	Met 140	Gly	Leu	Gly	Glu
Ile 145	Trp	Phe	Leu	Asp	Ala 150	Met	Leu	Pro	His	Ser 155	Ala	Ala	Cys	Phe	Ser 160
Lys	Thr	Pro	Arg	Leu 165	His	Leu	Met	Ile	Asp 170	Phe	Glu	Ala	Thr	Ala 175	Phe
Pro	Glu	Ser	Phe 180	Leu	Arg	Asn	Val	Glu 185	Gln	Pro	Val	Thr	Thr 190	Arg	Asp
Met	Val	Asp 195	Pro	Arg	Lys	Glu	Leu 200	Thr	Asp	Glu	Val	Ile 205	Glu	Gly	Ile
Leu	Gly 210	Phe	Ser	Ile	Ile	Ile 215	Ser	Glu	Ala	Asn	Tyr 220	Arg	Glu	Ile	Val
Ser 225	Ile	Leu	Ala	Lys	Leu 230	His	Phe	Phe	Tyr	Lys 235	Ala	Asp	Cys	Arg	Ser 240
Met	Tyr	Asp	Trp	Leu 245	Lys	Glu	Ile	Cys	Lys 250	Arg	Arg	Gly	Asp	Pro 255	Ala
Leu	Ile	Glu	Lys 260	Thr	Ala	Ser	Leu	Glu 265	Arg	Phe	Phe	Leu	Gly 270	His	Arg
Glu	Arg	Gly 275	Glu	Val	Met	Thr	Tyr 280								

<210>	31
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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<400> 31
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tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttggtcac 180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcgaatg tggacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

```

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<210> 32
<211> 280
<212> PRT
<213> Artificial Sequence

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<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

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<400> 32
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Gly His Asn Ala Pro Ala
50 55 60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85 90 95
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 33
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

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<400> 33
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctactttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattac ggtttctcac      180
aatgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctgggt tctggacgca atgttacctc actctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa                                                                 843
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<210> 34
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 34

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

<210> 35
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 35
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 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcctgaag aagacattgt ggtttctcac 180
 aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctatatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 36
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 36

Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Pro Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175

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Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Tyr Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 37
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 37
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 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgc tgtttctcac 180
 aatgcgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggtt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
 ctctgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
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 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggtcc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
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 taa 843

<210> 38
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 38
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 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Ala Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110

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Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 39
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gagacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aacatttcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 40
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

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

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50	Leu	Ala	Thr	Pro	Leu	Ser	Leu	Pro	Tyr	60	Leu	Asn	Glu	Leu	Val
65	Glu	Thr	His	Phe	Asp	Cys	Ser	Ala	Val	75	Arg	Tyr	Thr	Arg	Ile
				85	Ala	Cys	Ile	Ile	Pro	90	His	Ser	Asp	Tyr	Leu
				100	Thr	Arg	Leu	His	Leu	105	Val	Leu	Asp	Thr	Asn
				115	Phe	Thr	Arg	Leu	His	120	Val	Leu	Asp	Thr	Asn
				130	Ala	Thr	Glu	Glu	Asp	135	Lys	Ile	Phe	His	Met
				145	Trp	Phe	Leu	Asp	Ala	150	Met	Leu	Pro	His	Ser
				165	Leu	His	Leu	Met	Ile	170	Asp	Phe	Glu	Ala	Thr
				180	Phe	Leu	Arg	Asn	Val	185	Glu	Gln	Pro	Val	Thr
				195	Asp	Pro	Arg	Lys	Glu	200	Thr	Asp	Glu	Val	Ile
				210	Gly	Phe	Ser	Ile	Ile	215	Ser	Glu	Ala	Asn	Tyr
				225	Ser	Ile	Leu	Ala	Lys	230	Leu	His	Phe	Phe	Tyr
				245	Met	Tyr	Asp	Trp	Leu	250	Lys	Arg	Arg	Gly	Asp
				260	Leu	Ile	Glu	Lys	Thr	265	Arg	Phe	Phe	Leu	Gly
				275	Glu	Arg	Gly	Glu	Val	280	Met	Thr	Tyr		

<210> 41
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 41	atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
	tctactttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaaagtgg	120
	gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
	aatgcgcccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
	gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
	gcttgcatta	tccctcatag	tgattatttg	gagacggatg	aaacgttcac	ccggctgcac	360
	ctcgtgttgg	atactaacag	tggttgtgcc	aacactgagg	aagataagat	attccacatg	420
	ggctctggcg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
	aaaactccta	gactgcattc	catgatagat	tttgaagcta	cgcctttccc	ggaatccttc	540
	ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
	acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
	cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
	atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
	acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
	taa						843

<210> 42
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 42

CX2-095W02_ST25.txt

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

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<210> 43
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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<400> 43
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggctctggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta cgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa
843

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<210> 44
 <211> 280

<212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 44

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

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<210> 45
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 45

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctactttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac      660

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CX2-095W02_ST25.txt

cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	aagcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 46
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 46

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

<210> 47
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 47

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctactttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180

CX2-095W02_ST25.txt

aatgcgccccg	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tcctcatag	tgattatttg	gagctcgatg	aagatttcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtcc	aacactgagg	aagataagat	attccacatg	420
ggctctggg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 48
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 48

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

<210> 49
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 49

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
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gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tcctcatag	tgattatttg	gagctcgatg	aaggtttcac	ccggctgcac	360
ttcgtgttgg	atactaacag	tggttggtgcc	aacactgagg	aagataagat	attccacatg	420
ggtctggg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgcgggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 50

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 50

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

<210> 51
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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<400> 51
atgtctacgc atttccttgg caagggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcattc catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg cggcgtgaac gcggagaagt aatgacgtat      840
taa
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<210> 52
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 52

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

<210> 53
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 53
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
 aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggtt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gaggttgatg aaacggtcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 54
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 54

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

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Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

<210> 55
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 55
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaagtttcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 56
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 56

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

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Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Ser Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 57
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 57
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aacgtgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggctttctcac 180
 aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggtt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 843
 taa

<210> 58
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 58

Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30

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

<210> 59
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 59
 atgaagacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
 aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac cgggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta cgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 60
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium*

meliloti

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<400> 60
Met Lys Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85      90      95
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100     105     110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115     120     125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130     135     140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145     150     155     160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165     170     175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180     185     190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195     200     205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210     215     220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225     230     235     240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245     250     255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260     265     270
Glu Arg Gly Glu Val Met Thr Tyr
275     280

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<210> 61
<211> 843
<212> DNA
<213> Artificial Sequence

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<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

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<400> 61
atgactacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctggggc agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggttc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa

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<210> 62
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 62

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

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<210> 63
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 63

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atgtctacgc atttccttgg caaggtcaaa ttgcacactg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggctctggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540

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ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 64
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 64

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

<210> 65
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 65

atgtctacgc	agttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
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tctacttttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaagtg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tcctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgttg	atactaacag	tggttggtcc	aacactgagg	aagataagat	attccacatg	420
ggtctggg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
ttaa						843

<210> 66
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 66

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

<210> 67
 <211> 843
 <212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 67

atgtctacgt	tgttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctacttttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttgtgcc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 68

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 68

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

260
Glu Arg Gly Glu Val Met Thr Tyr
275 280 270

<210> 69
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 69
atgtctacgc atattcttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgctgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 70
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 70
Met Ser Thr His Ile Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85 90 95
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205

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Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 71
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 71
 atgtctacgc atttgcttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctactttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 72
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 72

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

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Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

<210> 73
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 73
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tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctggtggc agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 843
taa

<210> 74
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 74

Met Ser Thr His Met Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
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Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80

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Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 75
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 75
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 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 76
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 76

Met Ser Thr His Phe Leu Gly Lys Ile Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15

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

<210> 77
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 77

atgtctacgg	aattccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctacttttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccg	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaaacagc	tgtaactact	cgcgacatgg	tagaccctcg	ttaaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 78
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 78

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

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<210> 79

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 79

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atgtctacgc tcttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aagcgttcac ccggtgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggttc      720
atgtatgatt ggcttaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840

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taa

<210> 80
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 80
 Met Ser Thr Leu Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Ala Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 81
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 81
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 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gctgcatta tccccatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420

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ggtctggg	cgagatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 82
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 82

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

<210> 83
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

CX2-095W02_ST25.txt

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<400> 83
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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctggatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

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<210> 84
<211> 280
<212> PRT
<213> Artificial Sequence

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<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

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<400> 84
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85 90 95
Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Trp Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 85

<211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 85
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 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
 aatgcgccccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcattc catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tccttatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 86
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 86

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

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Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 245 250 255
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 87
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 87
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 tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac 300
 gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
 ctgctgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaagtg cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 88
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 88
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp

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      180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
      195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
      210      215      220
Ser Ile Leu Ala Lys Val His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225      230      235
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
      245      250      255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
      260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
      275      280

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<210> 89
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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<400> 89
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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggtgcac      360
ctcgtgttgg atactaacag tggttgtgcc tttactgagg aagataagat attccacatg      420
ggtctggggc agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa

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<210> 90
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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

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Cys Ala Phe Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

<210> 91
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 91
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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtgcgta tcgtgcgtgt ctccgagaac 300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 92
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 92

Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60

CX2-095W02_ST25.txt

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

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<210> 93
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

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<400> 93
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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcatgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac      360
ctcgtgttgg atactaacag tggttggtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcattc catgatagat tttgaagcta cgccttccc ggaatccttc      540
ttacgcaatg tggaaacagg tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg catttttagg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggtcc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa

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<210> 94
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 94

CX2-095W02_ST25.txt

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

<210> 95
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

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gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac														180
aatgcgcccc	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt														240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac														300
gcctgcatta	tccctcatag	tgattatttg	gagctcgatg	aaggcttcac	ccggctgcac														360
ctcgtgttgg	atactaacag	tggttgtgcc	aacactgagg	aagataagat	attccacatg														420
ggtctgggcg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct														480
aaaactccta	gactgcatct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc														540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg														600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac														660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc														720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag														780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat														840
taa																			843

<210> 96
 <211> 280
 <212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 96

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

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<210> 97

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 97

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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcatta tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcatct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg catttttagg ttctccataa tcatcagtga agcgaattac      660
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 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 98
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 98

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

<210> 99
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
 meliloti

<400> 99

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 gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
 aacgcaccgg ctcttgcaac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240

CX2-095W02_ST25.txt

gagacacatt	tcgactgttc	ggctgtccgt	tacacgcgta	ttgtaagagt	gagcgagaac	300
gcgtgcatta	taccacattc	agattacctc	gagcttgacg	agacattttac	cagattgcat	360
ctggtcttgg	ataccaactc	aggttgtgcc	aataccgaag	aggacaagat	attccatatg	420
ggtctcgggtg	aaatatggtt	cttggatgcg	atgctgcctc	atagtgcagc	atgtttttct	480
aagacgccta	gactgcagct	gatgattgac	ttcgaagcta	cagcgtttcc	cgaatcattt	540
ttacggaacg	tcgaacagcc	ggttaccacc	cgtgatatgg	tcgaccctag	aaaagaatta	600
acggacgaag	tgatcgaagg	tatactcggc	ttttctatta	tcatatcgga	ggcgaactac	660
cgtgaaatcg	tgtctatttt	agcgaagctg	cacttctttt	ataaagccga	ttgccggtcg	720
atgtatgatt	ggctgaaaga	aatttgcaag	agacggggag	acccggcgct	tattgaaaag	780
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taa						843

<210> 100
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 100
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 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Ile Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 101
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium*

meliloti

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gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat      180
aacgcaccgg ctcttgcaac cccgctgagt aaatcattgc cttaccttaa tgaattagtt      240
gagacacatt tcgactgttc ggctgtccgt tacacgcgta ttgtaagagt gagcgagAAC      300
gcgtgcctga taccacattc agattacctc gagcttgacg agacatttac cagattgcat      360
ctggctcttg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg      420
ggctctcggt aaatatgggt cttggatgcg atgctgcctc atagtgcagc atgtttttct      480
aagacgccta gactgcatct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt      540
ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tcgaccctag aaaagaatta      600
acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac      660
cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggctc      720
atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag      780
acggcttcat tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac      840
taa

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<210> 102
<211> 280
<212> PRT
<213> Artificial Sequence

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<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

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<400> 102
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85      90      95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100      105      110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130      135      140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145      150      155      160
Lys Thr Pro Arg Leu His Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165      170      175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225      230      235      240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245      250      255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
275      280

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<210> 103
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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<400> 103
atgagtaccc acttttctcgg caaagtgaag ttcgatgaag cacggcttgc agaagacttg      60
tctacgctgg aagtggcgga attttcctcc gcgtatagtg attttgctg cggaaaatgg      120
gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat      180
aacgcaccgg ctcttgcaac cccgctgagt aaatcattgc cttaccttaa tgaattagtt      240
gagacacatt tcgactgttc ggctgtccgt tacacgcgta ttgtaagagt gagcgagaac      300
gcgtgcctga taccacattc agattacctc gagcttgacg agacatttac cagattgcat      360
ctggctcttg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg      420
ggctctcggg aaatatgggt cttggatgcg atgctgcctc atagtgcagc atgtttttct      480
aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt      540
ttacggaacg tcgaacagcc ggttaccacc cgtgatatgg tgcaccctag aaaagaatta      600
acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcggg ggcgaactac      660
cgtgaaatcg tgtctatatt agcgaagctg cacttctttt ataaagccga ttgccggtcg      720
atgtatgatt ggctgaaaga aatttgcaag agacggggag accgggcgct tattgaaaag      780
acggcttcac tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac      840
taa

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<210> 104
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

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<400> 104
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
85      90      95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100      105      110
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130      135      140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145      150      155      160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165      170      175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser

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225					230					235				240
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro
				245					250				255	
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His
			260					265					270	
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr							
		275					280							

<210> 105
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 105
 atgagtaccc actttctcgg caaagtgaag ttcgatgaag cacggcttgc agaagacttg 60
 tctacgctgg aagtggcggg attttcctcc gcgtatagtg attttgctg cggaaaatgg 120
 gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
 aacgcaccgg ctcttgcaac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
 gagacacatt tcgactgttc ggctgtccgt tacacgcgta ttgtaagagt gagcgagaac 300
 gcgtgcctga taccacattc agattacctc gagcttgacg agacatttac cagattgcat 360
 ctggtcttgg ataccaactc aggttgtgcc tataccgaag aggacaagat attccatatg 420
 ggtctcggtg aaatatgggt cttggatgcg atgctgcctc atagtgcagc atgtttttct 480
 aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
 ttacggaacg tcgaacagcc ggttaccacc cgtgatatgg tcgaccctag aaaagaatta 600
 acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaaactac 660
 cgtgaaatcg tgtctatatt agcgaagctg cacttctttt ataaagccga ttgccggctc 720
 atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
 acggcttcat tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
 taa 843

<210> 106
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 106
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Thr Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Tyr Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe

Pro	Glu	Ser	Phe	165 Leu	Arg	Asn	Val	Glu	170 Gln	Pro	Val	Thr	Thr	175 Arg	Asp
Met	Val	Asp	180 Pro	Arg	Lys	Glu	Leu	185 Thr	Asp	Glu	Val	Ile	190 Glu	Gly	Ile
Leu	Gly	Phe	195 Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
Glu	Arg	Gly	260 Glu	Val	Met	Thr	Tyr	265 280							

<210>	107
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	107						
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gaagcatgtg	ttcttagaaa	ccgtacaggt	atgcaagaag	aggatattgt	ggtttcccat		180
aacgcaccgg	cttttgcac	cccgctgagt	aaatcattgc	cttaccttaa	tgaattagtt		240
gagacacatt	tcgactgttc	ggctgtccgt	tacacgcgt	ttgtaagatg	gagcgagaac		300
gcgtgcctga	taccacattc	agattacctc	gagcttgacg	agacatttac	cagattgcat		360
ctggctcttg	ataccaactc	aggttgtgcc	aataccgaag	aggacaagat	attccatatg		420
ggtctcggtg	aaatatggtt	cttggatgcg	atgctgcctc	atagtgacag	atgtttttct		480
aagacgccta	gcattgcagt	gatgattgac	cttgaagcta	cagcgtttcc	cgaatcattt		540
ttacggaacg	tcgaacagcc	ggttaccacc	ctgtatatgg	tcgaccttag	aaaagaatta		600
acggacgaag	tgatcgaagg	tatactcggc	ttttctatta	tcatatcgga	ggcgaactac		660
cgtgaaatcg	tgtctatttt	agcgaagctg	cacttctttt	ataaagccga	ttgccggctg		720
atgtatgatt	ggctgaaaga	aattttgcaag	agacggggag	acccggcgct	tattgaaaag		780
acggcttcat	tggaacgctt	cttttttaggc	cacagagaac	gcgggggaagt	aatgacctac		840
taa							843

<210>	108
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 108															
Met	Ser	Ser	His	Phe	Leu	Gly	Lys	Val	Lys	Phe	Asp	Glu	Ala	Arg	Leu
1				5					10					15	
Ala	Glu	Asp	Leu	Ser	Thr	Leu	Glu	Val	Ala	Glu	Phe	Ser	Ser	Ala	Tyr
			20					25					30		
Ser	Asp	Phe	Ala	Cys	Gly	Lys	Trp	Glu	Ala	Cys	Val	Leu	Arg	Asn	Arg
		35					40					45			
Thr	Gly	Met	Gln	Glu	Glu	Asp	Ile	Val	Val	Ser	His	Asn	Ala	Pro	Ala
	50					55					60				
Leu	Ala	Thr	Pro	Leu	Ser	Lys	Ser	Leu	Pro	Tyr	Leu	Asn	Glu	Leu	Val
65					70					75				80	
Glu	Thr	His	Phe	Asp	Cys	Ser	Ala	Val	Arg	Tyr	Thr	Arg	Ile	Val	Arg
				85					90					95	
Val	Ser	Glu	Asn	Ala	Cys	Leu	Ile	Pro	His	Ser	Asp	Tyr	Leu	Glu	Leu

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

<210>	111
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	111					
atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctacttttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccg	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgcctga	tccctcatag	tgattatttg	gagctcgatg	aaacgttcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctggtt	tctggacgca	atgttacctc	attctgtctg	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaaacagc	tgtaactact	cgcgacatgg	tagacctctg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210>	112
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 112

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

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<210> 113

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 113

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagtcgctga gttttctagt gcatattcgg acttcgcttg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac      180
aatgcgcccc cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgacagcag tgcggttaga tatgtccgta tcgtgcgtgt ctccgagaac      300
gcctgcctga tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggtctgggcg agatctggtt tctggacgca tccttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggttc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcggt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgagg catcgtgaac gcggagaagt aatgacgtat      840
taa

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<210> 114

<211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 114

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

<210> 115
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 115

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gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccg	cattagcgac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatacgcgta	tcgtgcgtgt	ctccgagaac	300
gcctgccaga	tccctcatag	tgattatttg	gagctcgatg	aaacgttaac	ccggctgcat	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggctctggcg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600

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acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tcctgatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggcc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 116
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 116

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

<210> 117
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 117

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctacttttag	aagtcgctga	gttttctagt	gcatattcgg	acttcgcttg	tggaagtg	120

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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggtt 240
gaaacacact tcgactgcag tgcgggttaga tatacgcgta tcgtgctgtg ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggc agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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<210> 118
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 118

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

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<210> 119
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 119

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg      60
tctacttttag aagttgctga gttttcttcc gcatattcgg acttcgcatg tggaaagtgg      120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac      180
aatgcgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt      240
gaaacacact tcgactgcag tgcggttaga tatacgcgta tcgtgcgtgt ctccgagaac      300
gcctgcctga tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac      360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg      420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct      480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc      540
ttacgcaatg tggaaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg      600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac      660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc      720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag      780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat      840
taa

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<210> 120

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 120

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

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275

<210> 121
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 121
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aagtcgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgta tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagctcgatg aaacgttcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 122
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 122

Met	Ser	Thr	His	Phe	Leu	Gly	Lys	Val	Lys	Phe	Asp	Glu	Ala	Arg	Leu
1				5					10					15	
Ala	Glu	Asp	Leu	Ser	Thr	Leu	Glu	Val	Ala	Glu	Phe	Ser	Ser	Ala	Tyr
			20					25					30		
Ser	Asp	Phe	Ala	Cys	Gly	Lys	Trp	Glu	Ala	Cys	Val	Leu	Arg	Asn	Arg
		35					40					45			
Thr	Gly	Met	Gln	Glu	Glu	Asp	Ile	Val	Val	Ser	His	Asn	Ala	Pro	Ala
	50					55					60				
Leu	Gln	Thr	Pro	Leu	Ser	Lys	Ser	Leu	Pro	Tyr	Leu	Asn	Glu	Leu	Val
65					70					75				80	
Glu	Thr	His	Phe	Asp	Cys	Ser	Ala	Val	Arg	Tyr	Val	Arg	Ile	Val	Arg
				85					90					95	
Val	Ser	Glu	Asn	Ala	Cys	Leu	Ile	Pro	His	Ser	Asp	Tyr	Leu	Glu	Leu
			100					105					110		
Asp	Glu	Thr	Phe	Thr	Arg	Leu	His	Leu	Val	Leu	Asp	Thr	Asn	Ser	Gly
		115					120					125			
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu
	130					135					140				
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145					150					155				160	
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
			165						170					175	
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp
			180					185					190		
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
		195					200					205			
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val

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210	215	220
Ser Ile Leu Ala Lys	Leu His Phe Phe Tyr Lys	Ala Asp Cys Arg Ser
225	230	235
Met Tyr Asp Trp Leu	Lys Glu Ile Cys Lys	Arg Arg Gly Asp Pro Ala
245	250	255
Leu Ile Glu Lys Thr	Ala Ser Leu Glu	Arg Phe Phe Leu Gly His Arg
260	265	270
Glu Arg Gly Glu Val	Met Thr Tyr	
275	280	

<210> 123
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 123	
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tctactttag aagttgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg	120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac	180
aatgcgcccg cattagcgac ccctttatct aaatcactgc cgtacttgaa tgagcttggt	240
gaaacacact tcgactgcag tgcggttaga tatgtacgta tcgtgcgtgt ctccgagaac	300
gcctgcctga tccctcatag tgattatttg gagctcgatg aaacggtcac ccggctgcac	360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg	420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct	480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc	540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg	600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac	660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc	720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag	780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat	840
taa	843

<210> 124
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 124	
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu	
1 5 10 15	
Ala Glu Asp Leu Ser Thr Leu Glu Val Ala Glu Phe Ser Ser Ala Tyr	
20 25 30	
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg	
35 40 45	
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala	
50 55 60	
Leu Ala Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val	
65 70 75 80	
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg	
85 90 95	
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu	
100 105 110	
Asp Glu Thr Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly	
115 120 125	
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu	
130 135 140	
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser	

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145	Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
					165					170					175	
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp	
			180					185						190		
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile	
		195					200					205				
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val	
	210					215					220					
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser	
	225				230					235					240	
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala	
				245					250					255		
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg	
			260					265					270			
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr									
		275					280									

<210>	125
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	125						
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gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac		180
aatgcgcccc	cattacagac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt		240
gaaacacact	tcgactgcag	tgcggttaga	tatgtacgta	tcgtgctgtg	ctccgagaac		300
gcctgcctga	tccctcatag	tgattatttg	gagttggagg	aatcattcac	ccggctgcac		360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attcccatg		420
ggtctgggcg	agatctggtt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct		480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc		540
ttacgcaatg	tggaaacagc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg		600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac		660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcggtcc		720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag		780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat		840
taa							843

<210>	126
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 126

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

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Val	Ser	Glu	Asn	Ala	Cys	Leu	Ile	Pro	His	Ser	Asp	Tyr	Leu	Glu	Leu
			100					105					110		
Glu	Glu	Ser	Phe	Thr	Arg	Leu	His	Leu	Val	Leu	Asp	Thr	Asn	Ser	Gly
		115					120					125			
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu
	130					135					140				
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145					150					155					160
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
				165					170					175	
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp
			180					185					190		
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
		195					200					205			
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val
	210					215					220				
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser
225					230					235					240
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
				245					250					255	
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
			260					265					270		
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr								
		275					280								

<210>	127
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	127					
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tctacttttag	aacgtgctga	gttttcttcc	gcatattcg	acttcgcttg	tggaaagtgg	120
gaagcatgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccg	cattaccagac	ccctttatct	aatcacctgc	cgtacctgaa	tgagcttgtt	240
gaaacacact	tcgactgcag	tgcggttaga	tatgtacgga	tcgtgcgtgt	tccggagaac	300
gcctgcctga	tccctcatag	tgattatttg	gagttggatg	aagaattcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctggtt	tctggacgca	atgttacctc	attctgtctg	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttaacgcaatg	tggaaacagc	tgtaaactact	cgcgacatgg	tagacctctg	taaagaattg	600
acggacgaag	ttatagaagg	catttttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcggg	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcggt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210>	128
<211>	280
<212>	PRT
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from Sinorhizobium
meliloti

<400> 128

Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr

Ser	Asp	Phe	20 Ala	Cys	Gly	Lys	Trp	25 Glu	Ala	Cys	Val	Leu	30 Arg	Asn	Arg
Thr	Gly	35 Met	Gln	Glu	Glu	Asp	40 Ile	Val	Val	Ser	His	45 Asn	Ala	Pro	Ala
Leu	Gln	Thr	Pro	Leu	Ser	Lys	Ser	Leu	Pro	Tyr	Leu	Asn	Glu	Leu	Val
65 Glu	Thr	His	Phe	85 Asp	Cys	Ser	Ala	Val	Arg	90 Tyr	Val	Arg	Ile	Val	Arg
Val	Ser	Glu	100 Asn	Ala	Cys	Leu	Ile	Pro	105 His	Ser	Asp	Tyr	Leu	Glu	Leu
Asp	Glu	Glu	115 Phe	Thr	Arg	Leu	His	Leu	Val	Leu	Asp	Thr	Asn	Ser	Gly
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	125 Gly	Leu	Gly	Glu
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	140 Ala	Ala	Cys	Phe	Ser
145 Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
Pro	Glu	Ser	165 Phe	Leu	Arg	Asn	Val	Glu	170 Gln	Pro	Val	Thr	Thr	Arg	Asp
Met	Val	Asp	180 Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	205 Arg	Glu	Ile	Val
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	220 Ala	Asp	Cys	Arg	Ser
225 Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
Leu	Ile	Glu	245 Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
Glu	Arg	Gly	260 Glu	Val	Met	Thr	Tyr	265 280							

<210>	129
<211>	843
<212>	DNA
<213>	Artificial Sequence

<220>
<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400>	129						
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aacgcaccgg	ctcttcagac	cccgctgagt	aaatcattgc	cttaccttaa	tgaattagtt		240
gagacacatt	tcgactgttc	ggctgtccgt	tacgttcgta	ttgtaagagt	gagcgagaac		300
gcgtgcctga	taccacattc	agattacctc	gagcttgacg	agacatttac	cagattgcat		360
ctggctcttg	ataccaactc	aggttgtgcc	aataccgaag	aggacaagat	attccatatg		420
ggtctcggtg	aaatatggtt	cttggatgcg	atgctgcctc	atagtgacag	atgtttttct		480
aagacgccta	tactgcagct	gatgattgac	ctcgaagcta	cagcgtttcc	cgaatcattt		540
ttacggaacg	tcgaacagcc	ggttaccacc	ctgtatatgg	tcgaccctag	aaaagaatta		600
acggacgaag	tgatcgaagg	tatactcggc	ttttctatta	tcatatcgga	ggcgaactac		660
cgtgaaatcg	tgtctatttt	agcgaagctg	cacttctttt	ataaagccga	ttgccggctg		720
atgtatgatt	ggctgaaaga	aattttgcaag	agacggggag	acccggcgct	tattgaaaag		780
acggcttcat	tggaacgctt	cttttttaggc	cacagagaac	gcggggaagt	aatgacctac		840
taa							843

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<210> 130
<211> 280
<212> PRT
<213> Artificial Sequence
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 $\langle 220 \rangle$

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 130

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

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<210> 131

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 131

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tctacgctgg aacgtgcgga attttctctc gcgtatagtg attttgcctg cggaaaatgg      120
gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat      180
aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt      240
gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gagcgagaac      300
gcgtgcctga taccacattc agattacctc gagcttgacg aggagtttac cagattgcat      360
ctggctcttg ataccaactc aggttggtgc aataccgaag aggacaagat attccatatg      420
ggctctcggt aaatatggtt ctggatgcg atgctgcctc atagtgcagc atgtttttct      480
aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt      540
ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tgcaccctag aaaagaatta      600
acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac      660
cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggtcg      720
atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag      780
acggcttcac tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac      840
taa

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<210> 132
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 132

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

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<210> 133
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from *Sinorhizobium meliloti*

<400> 133

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atgagtagcc acttttctcgg caaagtgaag ttcgatgaag cacggccttg agaagacttg      60
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gaagcatgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat      180
aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt      240
gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gagcgagaac      300
gcgtgcctga taccacattc agattacctc gagcttgacg agacatttac cagattgcat      360
ctggtcttgg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg      420
ggtctcggtg aaatatgggt cttggatgcg atgctgcctc atagtgcagc atgtttttct      480

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acggacgaag	tgatcgaagg	tatactcggc	ttttctatta	tcatatcgga	ggcgaactac	660
cggtgaaatcg	tgtctatttt	agcgaagctg	cacttctttt	ataaagccga	ttgccggtcg	720
atgtatgatt	ggctgaaaga	aatttgcaag	agacggggag	acccggcgct	tattgaaaag	780
acggcttcat	tggaacgctt	ctttttaggc	cacagagaac	gcggggaagt	aatgacctac	840
taa						843

<210> 134
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Engineered variant of proline 4-hydroxylase from Sinorhizobium meliloti

<400> 134

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

<210> 135
 <211> 843
 <212> DNA
 <213> Sinorhizobium meliloti

<400> 135															
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gaggcatg	tgctacgcaa	tcggaccgga	atgcaggagg	aagatatcgt	cgtaagtcac	180									
aacgctcctg	cactggccac	gccgctgagc	aagtcgctgc	cgtatctgaa	cgaacttggt	240									

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ctggtgttag	acactaattc	aggatgcgct	aatactgagg	aagataaaat	atttcatatg	420
ggactgggag	agatttggtt	ccttgacgct	atgttaccgc	atagcgctgc	ttgtttttcc	480
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ctgcgaaatg	tcgaacaacc	agtgacaaca	cgagacatgg	ttgatcctcg	gaaggaacta	600
accgatgagg	ttatcgaagg	tattctgggg	ttttcaataa	ttattagcga	agccaattac	660
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accgcctcgc	tcgagcgatt	ttttctaggg	caccgtgaac	gtggcgaggt	gatgacatac	840
taa						843

<210> 136
 <211> 280
 <212> PRT
 <213> Sinorhizobium meliloti

<400> 136

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

<210> 137
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 137
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cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
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taa

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<210> 138
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

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<400> 138
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Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85      90      95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100     105     110
Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115     120     125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130     135     140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145     150     155     160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165     170     175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180     185     190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195     200     205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210     215     220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225     230     235     240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245     250     255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260     265     270
Glu Arg Gly Glu Val Met Thr Tyr
275     280

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<210> 139
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 139

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gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacttg 420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 140

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 140

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

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<210> 141
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 141
 atgtctacgc atttcctcgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgctgt cactgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa

<210> 142
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 142
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser

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225					230					235				240
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro
				245					250				255	
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His
			260					265					270	
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr							
		275					280							

<210> 143

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 143

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctacttttag	aacgtgctga	gttttcttcc	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaactttgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgcccc	cattacagac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tcggttaga	tatgtacgga	tcgtgcgtgt	ctccgagaac	300
gcctgcctga	tccctcatag	tgattatttg	gagttggatg	aagaattcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttgtgcc	aacactgagg	aagataagat	attccacatg	420
ggtctgggcg	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 144

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 144

Met	Ser	Thr	His	Phe	Leu	Gly	Lys	Val	Lys	Phe	Asp	Glu	Ala	Arg	Leu
1				5					10					15	
Ala	Glu	Asp	Leu	Ser	Thr	Leu	Glu	Arg	Ala	Glu	Phe	Ser	Ser	Ala	Tyr
			20					25					30		
Ser	Asp	Phe	Ala	Cys	Gly	Lys	Trp	Glu	Leu	Cys	Val	Leu	Arg	Asn	Arg
		35				40					45				
Thr	Gly	Met	Gln	Glu	Glu	Asp	Ile	Val	Val	Ser	His	Asn	Ala	Pro	Ala
	50					55				60					
Leu	Gln	Thr	Pro	Leu	Ser	Lys	Ser	Leu	Pro	Tyr	Leu	Asn	Glu	Leu	Val
65				70					75					80	
Glu	Thr	His	Phe	Asp	Cys	Ser	Ala	Val	Arg	Tyr	Val	Arg	Ile	Val	Arg
			85					90					95		
Val	Ser	Glu	Asn	Ala	Cys	Leu	Ile	Pro	His	Ser	Asp	Tyr	Leu	Glu	Leu
			100					105					110		
Asp	Glu	Glu	Phe	Thr	Arg	Leu	His	Leu	Val	Leu	Asp	Thr	Asn	Ser	Gly
		115				120					125				
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu
	130					135				140					
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145				150					155					160	
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
			165					170					175		

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Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 145

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 145

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagt cgaagatctg 60
tctacttttag aacgttggga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

```

<210> 146

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 146

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

```


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```

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

```

<210> 149
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 149
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtaggga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttagg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

```

<210> 150
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 150
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu

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

<210> 151
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 151
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca gcgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa

<210> 152
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 152

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

```

<210> 153

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 153

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840

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taa

843

<210> 154
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 154
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 155
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 155
 atgtctacgc atttccttgg taaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcttgctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420

CX2-095W02_ST25.txt

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ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacacagc tgggactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg ctttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 156
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 156

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

<210> 157
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 157

CX2-095W02_ST25.txt

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctactttac gtcgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacagacc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 158

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 158

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

```

<210> 159

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 159

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttaa gtcgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaacagc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 160

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 160

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

```

Glu Arg Gly Glu Val Met Thr Tyr
275 280

<210> 161
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 161
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaagcatgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctttgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
```

<210> 162
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

```
<400> 162
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Ala Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85 90 95
Val Phe Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
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210	215	220
Ser Ile Leu Ala Lys	Leu His Phe Phe Tyr Lys	Ala Asp Cys Arg Ser
225	230	235
Met Tyr Asp Trp Leu	Lys Glu Ile Cys Lys	Arg Arg Gly Asp Pro Ala
245	250	255
Leu Ile Glu Lys Thr	Ala Ser Leu Glu	Arg Phe Phe Leu Gly His Arg
260	265	270
Glu Arg Gly Glu Val	Met Thr Tyr	
275	280	

<210> 163
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 163
 atgagtagcc acttttctcgg caaagtgaag ttcgatgaag cacggcttgc agaagacttg 60
 tctacgctgg aacgtgcgga attttcctcc gcgtatagtg attttgcctg cggaaaatgg 120
 gaactgtgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
 aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
 gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gagcgagaac 300
 gcgtgcctga taccacattc agattacctc gagcttgacg aggagtttac cagattgcat 360
 ctggctcttg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg 420
 ggtctcggtg aaatatggtt ctgggatgcg atgctgcctc atagtgcagc atgtttttct 480
 aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
 ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tcgaccctag aaaagaatta 600
 acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac 660
 cgtagaatcg tgtctatatt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
 atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
 acggcttcat tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
 taa 843

<210> 164
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 164
 Met Ser Ser His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160

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Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

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<210> 165
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 165
atgagtagcc actttctcgg caaagtgaag ttcgatgaag cacggcttgc agaagacttg 60
tctacgctgg aacgtgcgga attttcctcc gcgtatagtg attttgcttg cggaaaatgg 120
gaactgtgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gaccgagaac 300
gcgtgcctga taccacattc agattacctc gagcttgacg aggagtttac cagattgcat 360
ctggtcttgg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg 420
ggtctcgggtg aaatatggtt cttggatgcg atgctgcctc atagtgcagc atgtttttct 480
aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tcgaccctag aaaagaatta 600
acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaaactac 660
cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
acggcttcat tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
taa 843

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<210> 166
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

```

<400> 166
Met Ser Ser His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85 90 95
Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu

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Asp	Glu	Glu	100	Phe	Thr	Arg	Leu	His	105	Leu	Val	Leu	Asp	Thr	110	Asn	Ser	Gly
		115						120						125				
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu			
	130					135					140							
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser			
145				150						155					160			
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe			
			165						170					175				
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp			
			180					185						190				
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile			
		195					200					205						
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val			
	210					215					220							
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser			
225				230						235					240			
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala			
			245					250						255				
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg			
			260					265					270					
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr											
		275					280											

<210> 167
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 167
 atgagtagcc acttttctcgg caaagtgaaa ttcgatgaag cacggcttgc agaagacttg 60
 tctacgttgg aacgtgacga attttctctc gcgtatagtg attttgctg cggaaaatgg 120
 gaactgtgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
 aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
 gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gaccgagaac 300
 gcgtgcctga taccacattc agattacctc gagcttgacg aggagtttac cagattgcat 360
 ctggtcttgg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg 420
 ggctctcggg aaatatgggt ctggtatgac atgctgcctc atagtgcagc atgtttttct 480
 aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
 ttacggaacg tcgaacagcc gggcaccacc cgtgatattg tcgaccctag aaaagaatta 600
 acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac 660
 cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
 atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
 acggcttcac tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
 taa 843

<210> 168
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 168
 Met Ser Ser His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45

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

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<210> 169
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

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<400> 169
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttaa gtcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggtgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgggtactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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<210> 170
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

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<400> 170
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
20     25     30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35     40     45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50     55     60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65     70     75     80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85     90     95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100    105    110
Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115    120    125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130    135    140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145    150    155    160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165    170    175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Gly Thr Thr Arg Asp
180    185    190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195    200    205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210    215    220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225    230    235    240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245    250    255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260    265    270
Glu Arg Gly Glu Val Met Thr Tyr
275    280

```

```

<210> 171
<211> 843
<212> DNA
<213> Artificial Sequence

```

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<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
meliloti

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<400> 171
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctactttta gtcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt cacggagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata acgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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```

<210> 172
<211> 280

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<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 172

```

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

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<210> 173

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 173

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttta gtcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tcggttaga tatgtacgga tcgtgcgtgt cacggagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata acgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttagg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggttc 720

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atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcggt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 174
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
meliloti

<400> 174
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85 90 95
Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225 230 235 240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245 250 255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260 265 270
Glu Arg Gly Glu Val Met Thr Tyr
275 280

<210> 175
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
meliloti

<400> 175
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttaa gtcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300

CX2-095W02_ST25.txt

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gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac cgggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
```

<210> 176
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 176
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85      90      95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100     105     110
Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115     120     125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130     135     140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145     150     155     160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165     170     175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180     185     190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195     200     205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210     215     220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225     230     235     240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245     250     255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260     265     270
Glu Arg Gly Glu Val Met Thr Tyr
275     280
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<210> 177
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 177

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacagcc tgggtactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 178

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 178

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

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<210> 179

<211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 179
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 tctactttaa gtcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 180
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 180
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255

Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 181
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 181
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttaa gtcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt cacggagaat 300
 gcctgcctga tccctcatag tgattatttg gagttggata acgaattcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
 ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tggactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 182
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 182
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Gly Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile

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      195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
    210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
    225      230      235      240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
    245      250      255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
    260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
    275      280

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<210> 183
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 183
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tctactttaa gtcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata acgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggctctggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

```

<210> 184
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 184
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
    20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
    35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala
    50      55      60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
    65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
    85      90      95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
    100      105      110
Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
    115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
    130      135      140

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Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145					150					155					160
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
				165					170					175	
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp
			180					185					190		
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
		195					200					205			
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val
	210					215					220				
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser
225					230					235					240
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
				245					250					255	
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
			260					265					270		
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr								
	275						280								

<210> 185
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 185
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttaa gtcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggata acgaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgaagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 186
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 186
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg

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				85				90					95				
Val	Ser	Glu	Asn	Ala	Cys	Leu	Ile	Pro	His	Ser	Asp	Tyr	Leu	Glu	Leu		
			100					105					110				
Asp	Asn	Glu	Phe	Thr	Arg	Leu	His	Leu	Val	Leu	Asp	Thr	Asn	Ser	Gly		
		115					120					125					
Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu		
	130					135					140						
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser		
145				150						155					160		
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe		
			165					170						175			
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp		
			180					185					190				
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile		
		195					200					205					
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val		
	210					215					220						
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser		
225				230						235					240		
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala		
			245					250						255			
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg		
			260					265					270				
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr										
		275					280										

<210> 187

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 187

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
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gaactttgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatgcgccc	cattacagac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatgtacgga	tcgtgcgtgt	ctccgagaac	300
gcctgcctga	tccctcatag	tgattatttg	gagttggatg	aagaattcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttggtgc	aacactgagg	aagataagat	attccacctg	420
ggtctggggc	agatctgggt	tctggacgca	atgttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcgaat	tggaaacagc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 188

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 188

Met	Ser	Thr	His	Phe	Leu	Gly	Lys	Val	Lys	Phe	Asp	Glu	Ala	Arg	Leu
1				5					10					15	
Ala	Glu	Asp	Leu	Ser	Thr	Leu	Ser	Arg	Ala	Glu	Phe	Ser	Ser	Ala	Tyr
			20					25					30		

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

<210> 189

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 189

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 tctactttat ctctgtcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt cacggagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac cgggctgcac 360
 ctctgtgttg atactaacag tggttgcgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta cgccttccc ggaatccttc 540
 ttacgcaatg tggacaacc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 190

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium

meliloti

<400> 190

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

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<210> 191

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 191

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctggggc agatctgggt tctggacgca catttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacaacc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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<210> 192
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 192
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
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 Ala Glu Asp Leu Ser Thr Leu Glu Arg Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala His Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 193
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 193
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 tctactttat ctctgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt cacggagAAC 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctctgtgttg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
 ggtctgggCG agatctgggt tctggacgca catttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600

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acggacgaag ttatagaagg ctttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843
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<210> 194
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 194
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala His Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 195
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 195
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttag aacgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180

CX2-095W02_ST25.txt

```

aatgcgccccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggctctgggag agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg catttttagg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 196
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

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<400> 196
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Glu Arg Ala Glu Phe Ser Ser Ala Tyr
20     25     30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35     40     45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50     55     60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65     70     75     80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85     90     95
Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100    105    110
Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115    120    125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130    135    140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145    150    155    160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165    170    175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180    185    190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195    200    205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210    215    220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225    230    235    240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245    250    255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260    265    270
Glu Arg Gly Glu Val Met Thr Tyr
275    280

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<210> 197
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 197

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctacttttag aacgtgctga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggtctgggcg agatctgggt tctggacgca catttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttgtagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 198

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 198

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

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<210> 199
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 199
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagatttagc cgaagatctg 60
 tctactttat ctctgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac ccggctgcac 360
 ctctgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctggtt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcggt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 200
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 200
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240

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Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 201
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

<400> 201
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctactttat ctgcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggag agatctgggt tctggacgca catttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgaagc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 202
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

<400> 202
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala His Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp

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Cys	Ala	Asn	Thr	Glu	Glu	Asp	Lys	Ile	Phe	His	Met	Gly	Leu	Gly	Glu
130	130					135					140				
Ile	Trp	Phe	Leu	Asp	Ala	Met	Leu	Pro	His	Ser	Ala	Ala	Cys	Phe	Ser
145				150						155					160
Lys	Thr	Pro	Arg	Leu	Gln	Leu	Met	Ile	Asp	Phe	Glu	Ala	Thr	Ala	Phe
				165					170					175	
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp
			180					185					190		
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile
		195					200					205			
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val
	210				215						220				
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser
225					230					235					240
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala
				245					250					255	
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg
			260					265					270		
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr								
		275					280								

<210> 205

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 205

atgtctacgc	atttccttgg	caaggtcaaa	ttcgacgagg	ccagattagc	cgaagatctg	60
tctactttat	ctcgtcgtga	gttttcttcc	gcatattcgg	acttcgcttg	tggaaagtgg	120
gaactttgtg	ttttacgcaa	cagaacaggc	atgcaagaag	aagacattgt	ggtttctcac	180
aatcagcccc	cattacagac	ccctttatct	aaatcactgc	cgtacttgaa	tgagcttggt	240
gaaacacact	tcgactgcag	tgcggttaga	tatgtacgga	tcgtgcgtgt	ctccgagaac	300
gcctgcctga	tccctcatag	tgattatttg	gagttggatg	aagaattcac	ccggctgcac	360
ctcgtgttgg	atactaacag	tggttgtgcc	aacactgagg	aagataagat	attccacctg	420
ggctctggcg	agatctgggt	tctggacgca	catttacctc	attctgctgc	ctgcttttct	480
aaaactccta	gactgcagct	catgatagat	tttgaagcta	ccgccttccc	ggaatccttc	540
ttacgcaatg	tggaacagcc	tgtaactact	cgcgacatgg	tagaccctcg	taaagaattg	600
acggacgaag	ttatagaagg	cattttaggg	ttctccataa	tcatcagtga	agcgaattac	660
cgcgagatcg	tctctatcct	ggccaaatta	cacttctttt	ataaagcgga	ctgtcgggtc	720
atgtatgatt	ggcttaaaga	aatatgtaaa	cgccggggag	atcccgcgtt	gattgagaag	780
acagcgagtc	tcgaacgttt	ctttttgggg	catcgtgaac	gcggagaagt	aatgacgtat	840
taa						843

<210> 206

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 206

Met	Ser	Thr	His	Phe	Leu	Gly	Lys	Val	Lys	Phe	Asp	Glu	Ala	Arg	Leu
1			5						10					15	
Ala	Glu	Asp	Leu	Ser	Thr	Leu	Ser	Arg	Arg	Glu	Phe	Ser	Ser	Ala	Tyr
			20					25					30		
Ser	Asp	Phe	Ala	Cys	Gly	Lys	Trp	Glu	Leu	Cys	Val	Leu	Arg	Asn	Arg
		35				40					45				
Thr	Gly	Met	Gln	Glu	Glu	Asp	Ile	Val	Val	Ser	His	Asn	Gln	Pro	Ala
	50				55					60					
Leu	Gln	Thr	Pro	Leu	Ser	Lys	Ser	Leu	Pro	Tyr	Leu	Asn	Glu	Leu	Val

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

<210> 207
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 207
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctactttat ctcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggttttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
 ttacgcaatg tggaaggctc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 208
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 208
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15

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

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<210> 209

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 209

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctactttat ctcgttggga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggctctggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 210

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 210

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

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<210> 211

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 211

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atgtctacgc atttccttgg caaggtcaaa ttgcagcagg ccagattagc cgaagatctg 60
tctactttat ctgcgtcgta gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact ttgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata atgaattcac ccggtgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggctctggcg agatctggtt tctggatgca catttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaaggtcc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa
843

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<210> 212
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 212
 Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Arg Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Ser Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala His Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
 165 170 175
 Pro Glu Ser Phe Leu Arg Asn Val Glu Gly Pro Val Thr Thr Arg Asp
 180 185 190
 Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
 195 200 205
 Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
 210 215 220
 Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 213
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from *Sinorhizobium meliloti*

<400> 213
 atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
 tctacttttaa gtcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctttgagaac 300
 gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctctgtttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480

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aaaactccta gactgcagct catgatagat tttgaagcta cgcctttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgggtactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg ctttttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

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<210> 214
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 214
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50      55      60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85      90      95
Val Phe Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100      105      110
Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
130      135      140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145      150      155      160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165      170      175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Gly Thr Thr Arg Asp
180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225      230      235      240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245      250      255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
275      280

```

<210> 215
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 215
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60

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tctacttttat ctcgtcgtga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatcagcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctttgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggata gtgaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggtctgggcg agatctggtt tctggacgca catttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacaacc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtcc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843
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<210> 216
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 216
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Arg Glu Phe Ser Ser Ala Tyr
20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala
50      55      60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65      70      75      80
Glu Thr His Phe Asp Cys Ser Arg Val Arg Tyr Val Arg Ile Val Arg
85      90      95
Val Phe Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100     105     110
Asp Ser Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115     120     125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
130     135     140
Ile Trp Phe Leu Asp Ala His Leu Pro His Ser Ala Ala Cys Phe Ser
145     150     155     160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165     170     175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180     185     190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195     200     205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210     215     220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
225     230     235     240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
245     250     255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
260     265     270
Glu Arg Gly Glu Val Met Thr Tyr
275     280
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<210> 217
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 217

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atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
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gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctttgagaac 300
gcctgtctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
ggctctggcg agatctggtt tctggatgca catttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat tttgaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggaacagcc tgaactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa

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<210> 218

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 218

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

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275

<210> 219
<211> 843
<212> DNA
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 219
atgtctacgc atttccttgg caaggtcaaa ttcgacgagg ccagattagc cgaagatctg 60
tctactttat ctcgtgcaga gttttcttcc gcatattcgg acttcgcttg tggaaagtgg 120
gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
aatgcgcccg cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
gaaacacact tcgactgcag tgcggttaga tatgtacgga tcgtgcgtgt ctttgagaac 300
gcctgcctga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacatg 420
ggtctggggc agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
aaaactccta gactgcagct catgatagat ttggaagcta ccgccttccc ggaatccttc 540
ttacgcaatg tggacaacc tgtgactact cgcgacatgg tagaccctcg taaagaattg 600
acggacgaag ttatagaagg cattttaggg ttctccataa tcatcagtga agcgaattac 660
cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcggg ctgtcgggtc 720
atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
acagcgagtc tcgaacgttt ctttttgggg catcgtgaac gcggagaagt aatgacgtat 840
taa 843

<210> 220
<211> 280
<212> PRT
<213> Artificial Sequence

<220>
<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 220
Met Ser Thr His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1 5 10 15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
20 25 30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
35 40 45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
50 55 60
Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
65 70 75 80
Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
85 90 95
Val Phe Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
100 105 110
Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
115 120 125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
130 135 140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
145 150 155 160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
165 170 175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
180 185 190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
195 200 205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
210 215 220

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Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
 225 230 235 240
 Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
 245 250 255
 Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
 260 265 270
 Glu Arg Gly Glu Val Met Thr Tyr
 275 280

<210> 221
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

<400> 221
 atgagtagcc acttttctcg caaagtgaag ttcgatgaag cacggcttgc agaagacttg 60
 tctacgctga gtcgtgcaga attttcctcc gcgtatagtg attttgctg cggaatatgg 120
 gaactgtgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
 aacgcaccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
 gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gaccgagaac 300
 gcgtgcctga taccacattc agattacctc gagcttgaca acgagtttac cagattgcat 360
 ctggtcttgg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatatg 420
 ggtctcggtg aaatatgggt cttggatgcg atgctgcctc atagtgcagc atgtttttct 480
 aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
 ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tcgaccctag aaaagaatta 600
 acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac 660
 cgtgaaatcg tgtctatttt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
 atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
 acggcttcat tggaacgctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
 taa 843

<210> 222
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium
 meliloti

<400> 222
 Met Ser Ser His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
 1 5 10 15
 Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
 20 25 30
 Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
 35 40 45
 Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Ala Pro Ala
 50 55 60
 Leu Gln Thr Pro Leu Ser Lys Ser Leu Pro Tyr Leu Asn Glu Leu Val
 65 70 75 80
 Glu Thr His Phe Asp Cys Ser Ala Val Arg Tyr Val Arg Ile Val Arg
 85 90 95
 Val Thr Glu Asn Ala Cys Leu Ile Pro His Ser Asp Tyr Leu Glu Leu
 100 105 110
 Asp Asn Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
 115 120 125
 Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Met Gly Leu Gly Glu
 130 135 140
 Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
 145 150 155 160
 Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe

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				165				170					175				
Pro	Glu	Ser	Phe	Leu	Arg	Asn	Val	Glu	Gln	Pro	Val	Thr	Thr	Arg	Asp		
			180					185					190				
Met	Val	Asp	Pro	Arg	Lys	Glu	Leu	Thr	Asp	Glu	Val	Ile	Glu	Gly	Ile		
		195					200					205					
Leu	Gly	Phe	Ser	Ile	Ile	Ile	Ser	Glu	Ala	Asn	Tyr	Arg	Glu	Ile	Val		
	210					215					220						
Ser	Ile	Leu	Ala	Lys	Leu	His	Phe	Phe	Tyr	Lys	Ala	Asp	Cys	Arg	Ser		
225					230					235					240		
Met	Tyr	Asp	Trp	Leu	Lys	Glu	Ile	Cys	Lys	Arg	Arg	Gly	Asp	Pro	Ala		
				245					250					255			
Leu	Ile	Glu	Lys	Thr	Ala	Ser	Leu	Glu	Arg	Phe	Phe	Leu	Gly	His	Arg		
			260					265					270				
Glu	Arg	Gly	Glu	Val	Met	Thr	Tyr										
	275						280										

<210> 223

<211> 843

<212> DNA

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 223

atgagtagcc	acttttctcg	caaagtga	ttcgatga	cacggcttgc	agaagacttg	60
tctacgctga	gtcgtcgtga	attttcctcc	gcgtatagtg	attttgcctg	cggaaaatgg	120
gaactgtgtg	ttcttagaaa	ccgtacaggt	atgcaagaag	aggatattgt	ggtttcccat	180
aacgcaccgg	ctcttcagac	cccgtgagt	aatcattgc	cttaccttaa	tgaattagtt	240
gagacacatt	tcgactgttc	gcgtgtccgt	tacgttcgta	ttgtaagagt	gagcgagaac	300
gcgtgcctga	taccacattc	agattacctc	gagcttgacg	aggagtttac	cagattgcat	360
ctggctcttg	ataccaactc	aggttgtgcc	aataccgaag	aggacaagat	attccatctg	420
ggtctcggtg	aaatatggtt	cttgatgctg	atgctgcctc	atagtgcagc	atgtttttct	480
aagacgccta	gactgcagct	gatgattgac	ttcgaagcta	cagcgtttcc	cgaatcattt	540
ttacggaacg	tcgaacagcc	ggttaccacc	cgtgatattg	tcgaccctag	aaaagaatta	600
acggacgaag	tgatcgaagg	tatactcggc	ttttctatta	tcatatcgga	ggcgaactac	660
cgtgaaatcg	tgtctatttt	agcgaagctg	cacttctttt	ataaagccga	ttgccggtcg	720
atgtatgatt	ggctgaaaga	aatttgcaag	agacggggag	acccggcgct	tattgaaaag	780
acggcttcat	tggaacgctt	ctttttaggc	cacagagaac	gcggggaagt	aatgacctac	840
taa						843

<210> 224

<211> 280

<212> PRT

<213> Artificial Sequence

<220>

<223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 224

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

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Asp Glu Glu Phe Thr Arg Leu His Leu Val Leu Asp Thr Asn Ser Gly
      115      120      125
Cys Ala Asn Thr Glu Glu Asp Lys Ile Phe His Leu Gly Leu Gly Glu
      130      135      140
Ile Trp Phe Leu Asp Ala Met Leu Pro His Ser Ala Ala Cys Phe Ser
      145      150      155      160
Lys Thr Pro Arg Leu Gln Leu Met Ile Asp Phe Glu Ala Thr Ala Phe
      165      170      175
Pro Glu Ser Phe Leu Arg Asn Val Glu Gln Pro Val Thr Thr Arg Asp
      180      185      190
Met Val Asp Pro Arg Lys Glu Leu Thr Asp Glu Val Ile Glu Gly Ile
      195      200      205
Leu Gly Phe Ser Ile Ile Ile Ser Glu Ala Asn Tyr Arg Glu Ile Val
      210      215      220
Ser Ile Leu Ala Lys Leu His Phe Phe Tyr Lys Ala Asp Cys Arg Ser
      225      230      235      240
Met Tyr Asp Trp Leu Lys Glu Ile Cys Lys Arg Arg Gly Asp Pro Ala
      245      250      255
Leu Ile Glu Lys Thr Ala Ser Leu Glu Arg Phe Phe Leu Gly His Arg
      260      265      270
Glu Arg Gly Glu Val Met Thr Tyr
      275      280

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<210> 225
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 225
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tctacgctga gtcgtgcaga attttcctcc gcgtatagtg attttgctg cggaaaatgg 120
gaactgtgtg ttcttagaaa ccgtacaggt atgcaagaag aggatattgt ggtttcccat 180
aaccagccgg ctcttcagac cccgctgagt aaatcattgc cttaccttaa tgaattagtt 240
gagacacatt tcgactgttc ggctgtccgt tacgttcgta ttgtaagagt gagcgagaac 300
gcgtgcctga taccacattc agattacctc gagcttgaca acgagtttac cagattgcat 360
ctggctcttg ataccaactc aggttgtgcc aataccgaag aggacaagat attccatctg 420
ggtctcggtg aaatatggtt cttggatgcg atgctgcctc atagtgcagc atgtttttct 480
aagacgccta gactgcagct gatgattgac ttcgaagcta cagcgtttcc cgaatcattt 540
ttacggaacg tcgaacagcc ggttaccacc cgtgatattg tgcaccctag aaaagaatta 600
acggacgaag tgatcgaagg tatactcggc ttttctatta tcatatcgga ggcgaactac 660
cgtgaaatcg tgtctatatt agcgaagctg cacttctttt ataaagccga ttgccggtcg 720
atgtatgatt ggctgaaaga aatttgcaag agacggggag acccggcgct tattgaaaag 780
acggcttcac tgaacgcctt ctttttaggc cacagagaac gcggggaagt aatgacctac 840
taa

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<210> 226
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

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<400> 226
Met Ser Ser His Phe Leu Gly Lys Val Lys Phe Asp Glu Ala Arg Leu
1      5      10      15
Ala Glu Asp Leu Ser Thr Leu Ser Arg Ala Glu Phe Ser Ser Ala Tyr
      20      25      30
Ser Asp Phe Ala Cys Gly Lys Trp Glu Leu Cys Val Leu Arg Asn Arg
      35      40      45
Thr Gly Met Gln Glu Glu Asp Ile Val Val Ser His Asn Gln Pro Ala

```

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50	Leu	Gln	Thr	Pro	Leu	Ser	Leu	Pro	Tyr	60	Leu	Asn	Glu	Leu	Val
65	Glu	Thr	His	Phe	Asp	Cys	Ser	Ala	Val	75	Arg	Tyr	Val	Arg	Ile
				85	Ala	Cys	Leu	Ile	Pro	90	His	Ser	Asp	Tyr	Leu
				100					105						110
				115	Asp	Asn	Glu	Phe	Thr	Arg	Leu	His	Leu	Val	Leu
									120						125
									135						140
									150						155
									165						170
									185						190
									200						205
									215						220
									230						235
									245						250
									265						270
									280						

<210> 227
 <211> 843
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 227
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 gaactttgtg ttttacgcaa cagaacaggc atgcaagaag aagacattgt ggtttctcac 180
 aatgcgcccc cattacagac ccctttatct aaatcactgc cgtacttgaa tgagcttggt 240
 gaaacacact tcgactgcag tcgtgttaga tatgtacgga tcgtgcgtgt ctccgagaac 300
 gcttgcttga tccctcatag tgattatttg gagttggatg aagaattcac ccggctgcac 360
 ctcgtgttgg atactaacag tggttgtgcc aacactgagg aagataagat attccacctg 420
 ggtctgggcg agatctgggt tctggacgca atgttacctc attctgctgc ctgcttttct 480
 aaaactccta gactgcagct catgatagat tttgaagcta cgccttccc ggaatccttc 540
 ttacgcaatg tggaacagcc tgtaactact cgcgacatgg tagaccctcg taaagaattg 600
 acggacgaag ttatagaagg catttttaggg ttctccataa tcatcagtga agcgaattac 660
 cgcgagatcg tctctatcct ggccaaatta cacttctttt ataaagcgga ctgtcgggtc 720
 atgtatgatt ggcttaaaga aatatgtaaa cgccggggag atcccgcgtt gattgagaag 780
 acagcagatc tcgaacgttt ctttttgagg catcgtgaac gcggagaagt aatgacgtat 840
 taa 843

<210> 228
 <211> 280
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Codon-optimized proline 4-hydroxylase gene from Sinorhizobium meliloti

<400> 228

CX2-095W02_ST25.txt

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