

<110> CJ CheilJedang Corporation
 <120> PUTRESCINE-PRODUCING MICROORGANISM AND METHOD FOR PRODUCING PUTRESCINE USING THE SAME
 <130> OPA16290
 <150> KR 10-2016-0030898
 <151> 2016-03-15
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 <170> KopatentIn 2.0
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 <211> 48
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 <213> Artificial Sequence
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 <223> CbFdh primer 1

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 ctacagacca tggctaagat cgttttagtc ttatatgatg ctggtaac 48

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 <223> CbFdh primer 2

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 <223> T7 promoter primer

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 taatacgact cactataggg 20

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 <223> T7 terminator primer

 <400> 4
 gctagttatt gctcagcgg 19

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	ttatatgggtt gtactgaaaa taaattaggt attgctaatt ggttaaaaga tcaagggtcat		120
	gaactaatta ctacttctga taaagaaggt gaaacaagtg aattggataa acatatccca		180
	gatgctgata ttatcatcac cactcctttc catcctgctt atatcactaa ggaaagactt		240

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gacaaggcta agaacttaaa attagtcggt gtcgctgggt ttggttctga tcacattgat 300
 ttagattata ttaatcaaac aggtaagaaa atctcagtc tggaagttac aggttctaata 360
 gttgtctctg ttgctgaaca cggtgtcatg accatgcttg tcttggttag aaatttcgtt 420
 ccagcacatg aacaaattat taaccacgat tgggaggttg ctgctatcgc taaggatgct 480
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 gctcaagctg atatcggttac agttaatgct ccattacacg caggtaacaa aggtttaatt 720
 aataaggaat tattatctaa atttaaaaaa ggtgcttggt tagtcaatac cgcaagaggt 780
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<220>
 <223> CbFdh protein

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 Asn Trp Leu₃₅ Lys Asp Gln Gly₄₀ His Glu Leu Ile Thr₄₅ Thr Ser Asp Lys
 Glu Gly₅₀ Glu Thr Ser Glu Leu₅₅ Asp Lys His Ile Pro₆₀ Asp Ala Asp Ile
 Ile₆₅ Ile Thr Thr Pro₇₀ Phe His Pro Ala Tyr Ile₇₅ Thr Lys Glu Arg Leu₈₀
 Asp Lys Ala Lys₈₅ Asn Leu Lys Leu Val Val₉₀ Val Ala Gly Val Gly₉₅ Ser
 Asp His Ile₁₀₀ Asp Leu Asp Tyr Ile₁₀₅ Asn Gln Thr Gly Lys Lys₁₁₀ Ile Ser
 Val Leu Glu₁₁₅ Val Thr Gly Ser Asn₁₂₀ Val Val Ser Val Ala Glu His Val
 Val₁₃₀ Met Thr Met Leu Val₁₃₅ Leu Val Arg Asn Phe Val₁₄₀ Pro Ala His Glu

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Gln Ile Ile Asn His Asp Trp Glu Val Ala Ala Ile Ala Lys Asp Ala
145 150 155 160

Tyr Asp Ile Glu Gly Lys Thr Ile Ala Thr Ile Gly Ala Gly Arg Ile
165 170 175

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

Leu Tyr Tyr Asp Tyr Gln Ala Leu Pro Lys Glu Ala Glu Glu Lys Val
195 200 205

Gly Ala Arg Arg Val Glu Asn Ile Glu Glu Leu Val Ala Gln Ala Asp
210 215 220

Ile Val Thr Val Asn Ala Pro Leu His Ala Gly Thr Lys Gly Leu Ile
225 230 235 240

Asn Lys Glu Leu Leu Ser Lys Phe Lys Lys Gly Ala Trp Leu Val Asn
245 250 255

Thr Ala Arg Gly Ala Ile Cys Val Ala Glu Asp Val Ala Ala Ala Leu
260 265 270

Glu Ser Gly Gln Leu Arg Gly Tyr Gly Gly Asp Val Trp Phe Pro Gln
275 280 285

Pro Ala Pro Lys Asp His Pro Trp Arg Asp Met Arg Asn Lys Tyr Gly
290 295 300

Ala Gly Asn Ala Met Thr Pro His Tyr Ser Gly Thr Thr Leu Asp Ala
305 310 315 320

Gln Thr Arg Tyr Ala Glu Gly Thr Lys Asn Ile Leu Glu Ser Phe Phe
325 330 335

Thr Gly Lys Phe Asp Tyr Arg Pro Gln Asp Ile Ile Leu Leu Asn Gly
340 345 350

Glu Tyr Val Thr Lys Ala Tyr Gly Lys His Asp Lys Lys
355 360 365

<210> 11
<211> 319
<212> PRT
<213> Artificial Sequence

<220>
<223> Ornithine carbamoyl transferase (argF)

<400> 11
Met Thr Ser Gln Pro Gln Val Arg His Phe Leu Ala Asp Asp Asp Leu
1 5 10 15

Thr Pro Ala Glu Gln Ala Glu Val Leu Thr Leu Ala Ala Lys Leu Lys
20 25 30

Ala Ala Pro Phe Ser Glu Arg Pro Leu Glu Gly Pro Lys Ser Val Ala
35 40 45

Val Leu Phe Asp Lys Thr Ser Thr Arg Thr Arg Phe Ser Phe Asp Ala
50 55 60

Gly Ile Ala His Leu Gly Gly His Ala Ile Val Val Asp Ser Gly Ser
65 70 75 80

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Ser Gln Met Gly Lys₈₅ Gly Glu Ser Leu Gln₉₀ Asp Thr Ala Ala Val₉₅ Leu
 Ser Arg Tyr Val₁₀₀ Glu Ala Ile Val Trp₁₀₅ Arg Thr Tyr Ala His₁₁₀ Ser Asn
 Phe His Ala₁₁₅ Met Ala Glu Thr Ser₁₂₀ Thr Val Pro Leu Val₁₂₅ Asn Ser Leu
 Ser Asp₁₃₀ Asp Leu His Pro Cys₁₃₅ Gln Ile Leu Ala Asp₁₄₀ Leu Gln Thr Ile
 Val₁₄₅ Glu Asn Leu Ser Pro₁₅₀ Glu Glu Gly Pro Ala₁₅₅ Gly Leu Lys Gly₁₆₀ Lys
 Lys Ala Val Tyr₁₆₅ Leu Gly Asp Gly Asp Asn₁₇₀ Asn Met Ala Asn Ser Tyr₁₇₅
 Met Ile Gly Phe₁₈₀ Ala Thr Ala Gly Met₁₈₅ Asp Ile Ser Ile Ile₁₉₀ Ala Pro
 Glu Gly Phe₁₉₅ Gln Pro Arg Ala Glu₂₀₀ Phe Val Glu Arg Ala₂₀₅ Glu Lys Arg
 Gly Gln Glu Thr Gly Ala Lys₂₁₅ Val Val Val Thr Asp₂₂₀ Ser Leu Asp Glu
 Val₂₂₅ Ala Gly Ala Asp Val₂₃₀ Val Ile Thr Asp Thr₂₃₅ Trp Val Ser Met Gly₂₄₀
 Met Glu Asn Asp Gly₂₄₅ Ile Asp Arg Thr Thr₂₅₀ Pro Phe Val Pro Tyr₂₅₅ Gln
 Val Asn Asp Glu₂₆₀ Val Met Ala Lys Ala₂₆₅ Asn Asp Gly Ala Ile₂₇₀ Phe Leu
 His Cys₂₇₅ Leu Pro Ala Tyr Arg Gly₂₈₀ Lys Glu Val Ala Ala₂₈₅ Ser Val Ile
 Asp Gly₂₉₀ Pro Ala Ser Lys Val₂₉₅ Phe Asp Glu Ala Glu₃₀₀ Asn Arg Leu His
 Ala Gln Lys Ala Leu Leu₃₁₀ Val Trp Leu Leu Ala₃₁₅ Asn Gln Pro Arg
 305

<210> 12
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 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Glutamate exporter

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 Trp Ile Val Asp₂₀ Thr Gly Phe Asp Val₂₅ Ala Ile Ile Leu Val₃₀ Leu Ala
 Phe Leu Ile₃₅ Pro Arg Ile Gly Arg₄₀ Leu Ala Met Arg Ile₄₅ Ile Lys Arg
 Arg Val₅₀ Glu Ser Ala Ala Asp₅₅ Ala Asp Thr Thr Lys₆₀ Asn Gln Leu Ala

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Phe	Ala	Gly	Val	Gly	Val	Tyr	Ile	Ala	Gln	Ile	Val	Ala	Phe	Phe	Met
65					70					75					80
Leu	Ala	Val	Ser	Ala	Met	Gln	Ala	Phe	Gly	Phe	Ser	Leu	Ala	Gly	Ala
				85					90					95	
Ala	Ile	Pro	Ala	Thr	Ile	Ala	Ser	Ala	Ala	Ile	Gly	Leu	Gly	Ala	Gln
			100					105					110		
Ser	Ile	Val	Ala	Asp	Phe	Leu	Ala	Gly	Phe	Phe	Ile	Leu	Thr	Glu	Lys
		115					120					125			
Gln	Phe	Gly	Val	Gly	Asp	Trp	Val	Arg	Phe	Glu	Gly	Asn	Gly	Ile	Val
	130					135					140				
Val	Glu	Gly	Thr	Val	Ile	Glu	Ile	Thr	Met	Arg	Ala	Thr	Lys	Ile	Arg
145					150					155					160
Thr	Ile	Ala	Gln	Glu	Thr	Val	Ile	Ile	Pro	Asn	Ser	Thr	Ala	Lys	Val
				165					170					175	
Cys	Ile	Asn	Asn	Ser	Asn	Asn	Trp	Ser	Arg	Ala	Val	Val	Val	Ile	Pro
			180					185						190	
Ile	Pro	Met	Leu	Gly	Ser	Glu	Asn	Ile	Thr	Asp	Val	Ile	Ala	Arg	Ser
		195					200					205			
Glu	Ala	Ala	Thr	Arg	Arg	Ala	Leu	Gly	Gln	Glu	Lys	Ile	Ala	Pro	Glu
	210					215					220				
Ile	Leu	Gly	Glu	Leu	Asp	Val	His	Pro	Ala	Thr	Glu	Val	Thr	Pro	Pro
225					230					235					240
Thr	Val	Val	Gly	Met	Pro	Trp	Met	Val	Thr	Met	Arg	Phe	Leu	Val	Gln
				245					250					255	
Val	Thr	Ala	Gly	Asn	Gln	Trp	Leu	Val	Glu	Arg	Ala	Ile	Arg	Thr	Glu
			260					265					270		
Ile	Ile	Ser	Glu	Phe	Trp	Glu	Glu	Tyr	Gly	Ser	Ala	Thr	Thr	Thr	Ser
		275					280					285			
Gly	Thr	Leu	Ile	Asp	Ser	Leu	His	Val	Glu	His	Glu	Glu	Pro	Lys	Thr
	290					295					300				
Ser	Leu	Ile	Asp	Ala	Ser	Pro	Gln	Ala	Leu	Lys	Glu	Pro	Lys	Pro	Glu
305					310					315					320
Ala	Ala	Ala	Thr	Val	Ala	Ser	Leu	Ala	Ala	Ser	Ser	Asn	Asp	Asp	Ala
				325					330					335	
Asp	Asn	Ala	Asp	Ala	Ser	Val	Ile	Asn	Ala	Gly	Asn	Pro	Glu	Lys	Glu
			340					345					350		
Leu	Asp	Ser	Asp	Val	Leu	Glu	Gln	Glu	Leu	Ser	Ser	Glu	Glu	Pro	Glu
		355					360					365			
Glu	Thr	Ala	Lys	Pro	Asp	His	Ser	Leu	Arg	Gly	Phe	Phe	Arg	Thr	Asp
	370					375					380				
Tyr	Tyr	Pro	Asn	Arg	Trp	Gln	Lys	Ile	Leu	Ser	Phe	Gly	Gly	Arg	Val
385					390					395					400
Arg	Met	Ser	Thr	Ser	Leu	Leu	Leu	Gly	Ala	Leu	Leu	Leu	Leu	Ser	Leu
				405					410					415	
Phe	Lys	Val	Met	Thr	Val	Glu	Pro	Ser	Glu	Asn	Trp	Gln	Asn	Ser	Ser
			420					425					430		

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Gly Trp Leu Ser Pro Ser Thr Ala Thr Ser Thr Ala Val Thr Thr Ser
435 440 445
Glu Thr Ser Ala Pro Val Ser Thr Pro Ser Met Thr Val Pro Thr Thr
450 455 460
Val Glu Glu Thr Pro Thr Met Glu Ser Asn Val Glu Thr Gln Gln Glu
465 470 475 480
Thr Ser Thr Pro Ala Thr Ala Thr Pro Gln Arg Ala Asp Thr Ile Glu
485 490 495
Pro Thr Glu Glu Ala Thr Ser Gln Glu Glu Thr Thr Ala Ser Gln Thr
500 505 510
Gln Ser Pro Ala Val Glu Ala Pro Thr Ala Val Gln Glu Thr Val Ala
515 520 525
Pro Thr Ser Thr Pro
530

<210> 13
<211> 711
<212> PRT
<213> Artificial Sequence

<220>
<223> ornithine decarboxylase (ODC)

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

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Ala Ala Asn Lys Val Val Thr Asn Ala Leu Leu Thr Arg Gly Asp Leu
 195 200 205
 Val Leu Phe Asp Arg Asn Asn His Lys Ser Asn His His Gly Ala Leu
 210 215 220
 Ile Gln Ala Gly Ala Thr Pro Val Tyr Leu Glu Ala Ser Arg Asn Pro
 225 230 235 240
 Phe Gly Phe Ile Gly Gly Ile Asp Ala His Cys Phe Asn Glu Glu Tyr
 245 250 255
 Leu Arg Gln Gln Ile Arg Asp Val Ala Pro Glu Lys Ala Asp Leu Pro
 260 265 270
 Arg Pro Tyr Arg Leu Ala Ile Ile Gln Leu Gly Thr Tyr Asp Gly Thr
 275 280 285
 Val Tyr Asn Ala Arg Gln Val Ile Asp Thr Val Gly His Leu Cys Asp
 290 295 300
 Tyr Ile Leu Phe Asp Ser Ala Trp Val Gly Tyr Glu Gln Phe Ile Pro
 305 310 315 320
 Met Met Ala Asp Ser Ser Pro Leu Leu Leu Glu Leu Asn Glu Asn Asp
 325 330 335
 Pro Gly Ile Phe Val Thr Gln Ser Val His Lys Gln Gln Ala Gly Phe
 340 345 350
 Ser Gln Thr Ser Gln Ile His Lys Lys Asp Asn His Ile Arg Gly Gln
 355 360 365
 Ala Arg Phe Cys Pro His Lys Arg Leu Asn Asn Ala Phe Met Leu His
 370 375 380
 Ala Ser Thr Ser Pro Phe Tyr Pro Leu Phe Ala Ala Leu Asp Val Asn
 385 390 395 400
 Ala Lys Ile His Glu Gly Glu Ser Gly Arg Arg Leu Trp Ala Glu Cys
 405 410 415
 Val Glu Ile Gly Ile Glu Ala Arg Lys Ala Ile Leu Ala Arg Cys Lys
 420 425 430
 Leu Phe Arg Pro Phe Ile Pro Pro Val Val Asp Gly Lys Leu Trp Gln
 435 440 445
 Asp Tyr Pro Thr Ser Val Leu Ala Ser Asp Arg Arg Phe Phe Ser Phe
 450 455 460
 Glu Pro Gly Ala Lys Trp His Gly Phe Glu Gly Tyr Ala Ala Asp Gln
 465 470 475 480
 Tyr Phe Val Asp Pro Cys Lys Leu Leu Leu Thr Thr Pro Gly Ile Asp
 485 490 495
 Ala Glu Thr Gly Glu Tyr Ser Asp Phe Gly Val Pro Ala Thr Ile Leu
 500 505 510
 Ala His Tyr Leu Arg Glu Asn Gly Ile Val Pro Glu Lys Cys Asp Leu
 515 520 525
 Asn Ser Ile Leu Phe Leu Leu Thr Pro Ala Glu Ser His Glu Lys Leu
 530 535 540
 Ala Gln Leu Val Ala Met Leu Ala Gln Phe Glu Gln His Ile Glu Asp

545 550 4541512_1 555 560
 Asp Ser Pro Leu Val₅₆₅ Glu Val Leu Pro Ser₅₇₀ Val Tyr Asn Lys Tyr₅₇₅ Pro
 Val Arg Tyr Arg₅₈₀ Asp Tyr Thr Leu Arg₅₈₅ Gln Leu Cys Gln Glu₅₉₀ Met His
 Asp Leu Tyr₅₉₅ Val Ser Phe Asp Val₆₀₀ Lys Asp Leu Gln Lys₆₀₅ Ala Met Phe
 Arg Gln₆₁₀ Gln Ser Phe Pro Ser₆₁₅ Val Val Met Asn Pro₆₂₀ Gln Asp Ala His
 Ser₆₂₅ Ala Tyr Ile Arg Gly₆₃₀ Asp Val Glu Leu Val₆₃₅ Arg Ile Arg Asp Ala₆₄₀
 Glu Gly Arg Ile Ala₆₄₅ Ala Glu Gly Ala Leu₆₅₀ Pro Tyr Pro Pro Gly₆₅₅ Val
 Leu Cys Val Val₆₆₀ Pro Gly Glu Val Trp₆₆₅ Gly Gly Ala Val Gln₆₇₀ Arg Tyr
 Phe Leu Ala₆₇₅ Leu Glu Glu Gly Val₆₈₀ Asn Leu Leu Pro Gly₆₈₅ Phe Ser Pro
 Glu Leu₆₉₀ Gln Gly Val Tyr Ser₆₉₅ Glu Thr Asp Ala Asp₇₀₀ Gly Val Lys Arg
 Leu Tyr Gly Tyr Val Leu₇₀₅ Lys₇₁₀

<210> 14
 <211> 388
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Acetyl glutamate synthase or Ornithine acetyl transferase (ArgJ)

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 Thr Thr Ala Gly₂₀ Ile Lys Ala Ser Gly₂₅ Asn Pro Asp Met Ala₃₀ Leu Val
 Val Asn Gln₃₅ Gly Pro Glu Phe Ser₄₀ Ala Ala Ala Val Phe Thr Arg Asn
 Arg Val₅₀ Phe Ala Ala Pro Val₅₅ Lys Val Ser Arg Glu₆₀ Asn Val Ala Asp
 Gly₆₅ Gln Ile Arg Ala Val₇₀ Leu Tyr Asn Ala Gly₇₅ Asn Ala Asn Ala Cys₈₀
 Asn Gly Leu Gln₈₅ Gly Glu Lys Asp Ala Arg₉₀ Glu Ser Val Ser His₉₅ Leu
 Ala Gln Asn Leu₁₀₀ Gly Leu Glu Asp Ser₁₀₅ Asp Ile Gly Val Cys₁₁₀ Ser Thr
 Gly Leu Ile₁₁₅ Gly Glu Leu Leu Pro₁₂₀ Met Asp Lys Leu Asn₁₂₅ Ala Gly Ile
 Asp Gln Leu Thr Ala Glu Gly Ala Leu Gly Asp Asn Gly Ala Ala Ala

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140

130 135 140
Ala Lys Ala Ile Met Thr Thr Asp Thr Val Asp Lys Glu Thr Val Val
145 150 155 160
Phe Ala Asp Gly Trp Thr Val Gly Gly Met Gly Lys Gly Val Gly Met
165 170 175
Met Ala Pro Ser Leu Ala Thr Met Leu Val Cys Leu Thr Thr Asp Ala
180 185 190
Ser Val Thr Gln Glu Met Ala Gln Ile Ala Leu Ala Asn Ala Thr Ala
195 200 205
Val Thr Phe Asp Thr Leu Asp Ile Asp Gly Ser Thr Ser Thr Asn Asp
210 215 220
Thr Val Phe Leu Leu Ala Ser Gly Ala Ser Gly Ile Thr Pro Thr Gln
225 230 235 240
Asp Glu Leu Asn Asp Ala Val Tyr Ala Ala Cys Ser Asp Ile Ala Ala
245 250 255
Lys Leu Gln Ala Asp Ala Glu Gly Val Thr Lys Arg Val Ala Val Thr
260 265 270
Val Val Gly Thr Thr Asn Asn Glu Gln Ala Ile Asn Ala Ala Arg Thr
275 280 285
Val Ala Arg Asp Asn Leu Phe Lys Cys Ala Met Phe Gly Ser Asp Pro
290 295 300
Asn Trp Gly Arg Val Leu Ala Ala Val Gly Met Ala Asp Ala Asp Met
305 310 315 320
Glu Pro Glu Lys Ile Ser Val Phe Phe Asn Gly Gln Ala Val Cys Leu
325 330 335
Asp Ser Thr Gly Ala Pro Gly Ala Arg Glu Val Asp Leu Ser Gly Ala
340 345 350
Asp Ile Asp Val Arg Ile Asp Leu Gly Thr Ser Gly Glu Gly Gln Ala
355 360 365
Thr Val Arg Thr Thr Asp Leu Ser Phe Ser Tyr Val Glu Ile Asn Ser
370 375 380
Ala Tyr Ser Ser
385

<210> 15
<211> 317
<212> PRT
<213> Artificial Sequence

<220>
<223> Acetyl glutamate kinase (ArgB)

<400> 15
Met Asn Asp Leu Ile Lys Asp Leu Gly Ser Glu Val Arg Ala Asn Val
1 5 10 15
Leu Ala Glu Ala Leu Pro Trp Leu Gln His Phe Arg Asp Lys Ile Val
20 25 30
Val Val Lys Tyr Gly Gly Asn Ala Met Val Asp Asp Asp Leu Lys Ala
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35 40 45
 Ala Phe Ala Ala Asp Met Val Phe Leu Arg Thr Val Gly Ala Lys Pro
 50 55 60
 Val Val Val His Gly Gly Gly Pro Gln Ile Ser Glu Met Leu Asn Arg
 65 70 75 80
 Val Gly Leu Gln Gly Glu Phe Lys Gly Gly Phe Arg Val Thr Thr Pro
 85 90 95
 Glu Val Met Asp Ile Val Arg Met Val Leu Phe Gly Gln Val Gly Arg
 100 105 110
 Asp Leu Val Gly Leu Ile Asn Ser His Gly Pro Tyr Ala Val Gly Thr
 115 120 125
 Ser Gly Glu Asp Ala Gly Leu Phe Thr Ala Gln Lys Arg Met Val Asn
 130 135 140
 Ile Asp Gly Val Pro Thr Asp Ile Gly Leu Val Gly Asp Ile Ile Asn
 145 150 155 160
 Val Asp Ala Ser Ser Leu Met Asp Ile Ile Glu Ala Gly Arg Ile Pro
 165 170 175
 Val Val Ser Thr Ile Ala Pro Gly Glu Asp Gly Gln Ile Tyr Asn Ile
 180 185 190
 Asn Ala Asp Thr Ala Ala Gly Ala Leu Ala Ala Ala Ile Gly Ala Glu
 195 200 205
 Arg Leu Leu Val Leu Thr Asn Val Glu Gly Leu Tyr Thr Asp Trp Pro
 210 215 220
 Asp Lys Ser Ser Leu Val Ser Lys Ile Lys Ala Thr Glu Leu Glu Ala
 225 230 235 240
 Ile Leu Pro Gly Leu Asp Ser Gly Met Ile Pro Lys Met Glu Ser Cys
 245 250 255
 Leu Asn Ala Val Arg Gly Gly Val Ser Ala Ala His Val Ile Asp Gly
 260 265 270
 Arg Ile Ala His Ser Val Leu Leu Glu Leu Leu Thr Met Gly Gly Ile
 275 280 285
 Gly Thr Met Val Leu Pro Asp Val Phe Asp Arg Glu Asn Tyr Pro Glu
 290 295 300
 Gly Thr Val Phe Arg Lys Asp Asp Lys Asp Gly Glu Leu
 305 310 315

<210> 16
 <211> 357
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Acetyl gamma glutamyl phosphate reductase (ArgC)

<400> 16
 Met Ile Met His Asn Val Tyr Gly Val Thr Met Thr Ile Lys Val Ala
 1 5 10 15

Ile Ala Gly Ala Ser Gly Tyr Ala Gly Gly Glu Ile Leu Arg Leu Leu
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20 25 30
 Leu Gly His₃₅ Pro Ala Tyr Ala Ser₄₀ Gly Glu Leu Glu Ile₄₅ Gly Ala Leu
 Thr Ala₅₀ Ala Ser Thr Ala Gly₅₅ Ser Thr Leu Gly Glu₆₀ Leu Met Pro His
 Ile₆₅ Pro Gln Leu Ala Asp₇₀ Arg Val Ile Gln Asp₇₅ Thr Thr Ala Glu Thr₈₀
 Leu Ala Gly His Asp₈₅ Val Val Phe Leu Gly₉₀ Leu Pro His Gly Phe₉₅ Ser
 Ala Glu Ile Ala₁₀₀ Leu Gln Leu Gly Pro₁₀₅ Asp Val Thr Val Ile₁₁₀ Asp Cys
 Ala Ala Asp₁₁₅ Phe Arg Leu Gln Asn₁₂₀ Ala Ala Asp Trp Glu₁₂₅ Lys Phe Tyr
 Gly Ser₁₃₀ Glu His Gln Gly Thr₁₃₅ Trp Pro Tyr Gly Ile₁₄₀ Pro Glu Met Pro
 Gly₁₄₅ His Arg Glu Ala Leu₁₅₀ Arg Gly Ala Lys Arg₁₅₅ Val Ala Val Pro Gly₁₆₀
 Cys Phe Pro Thr Gly₁₆₅ Ala Thr Leu Ala Leu₁₇₀ Leu Pro Ala Val Gln Ala₁₇₅
 Gly Leu Ile Glu₁₈₀ Pro Asp Val Ser Val₁₈₅ Val Ser Ile Thr Gly₁₉₀ Val Ser
 Gly Ala Gly₁₉₅ Lys Lys Ala Ser Val₂₀₀ Ala Leu Leu Gly Ser₂₀₅ Glu Thr Met
 Gly Ser₂₁₀ Leu Lys Ala Tyr Asn₂₁₅ Thr Ser Gly Lys His₂₂₀ Arg His Thr Pro
 Glu Ile Ala Gln Asn₂₃₀ Leu Gly Glu Val Ser Asp₂₃₅ Lys Pro Val Lys Val₂₄₀
 Ser Phe Thr Pro Val₂₄₅ Leu Ala Pro Leu Pro₂₅₀ Arg Gly Ile Leu Thr₂₅₅ Thr
 Ala Thr Ala Pro₂₆₀ Leu Lys Glu Gly Val₂₆₅ Thr Ala Glu Gln Ala₂₇₀ Arg Ala
 Val Tyr Glu₂₇₅ Glu Phe Tyr Ala Gln₂₈₀ Glu Thr Phe Val His₂₈₅ Val Leu Pro
 Glu Gly₂₉₀ Ala Gln Pro Gln Thr₂₉₅ Gln Ala Val Leu Gly₃₀₀ Ser Asn Met Cys
 His Val Gln Val Glu Ile₃₁₀ Asp Glu Glu Ala Gly₃₁₅ Lys Val Leu Val Thr₃₂₀
 Ser Ala Ile Asp Asn₃₂₅ Leu Thr Lys Gly Thr₃₃₀ Ala Gly Ala Ala Val₃₃₅ Gln
 Cys Met Asn₃₄₀ Leu Ser Val Gly Phe Asp₃₄₅ Glu Ala Ala Gly Leu₃₅₀ Pro Gln
 Val Gly Val₃₅₅ Ala Pro

<210> 17
 <211> 391

<212> PRT
 <213> Artificial Sequence

<220>
 <223> Acetyl ornithine aminotransferase (ArgD)

<400> 17
 Met Ser Thr Leu Glu Thr Trp Pro Gln Val Ile Ile Asn Thr Tyr Gly
 1 5 10 15
 Thr Pro Pro Val Glu Leu Val Ser Gly Lys Gly Ala Thr Val Thr Asp
 20 25 30
 Asp Gln Gly Asn Val Tyr Ile Asp Leu Leu Ala Gly Ile Ala Val Asn
 35 40 45
 Ala Leu Gly His Ala His Pro Ala Ile Ile Glu Ala Val Thr Asn Gln
 50 55 60
 Ile Gly Gln Leu Gly His Val Ser Asn Leu Phe Ala Ser Arg Pro Val
 65 70 75 80
 Val Glu Val Ala Glu Glu Leu Ile Lys Arg Phe Ser Leu Asp Asp Ala
 85 90 95
 Thr Leu Ala Ala Gln Thr Arg Val Phe Phe Cys Asn Ser Gly Ala Glu
 100 105 110
 Ala Asn Glu Ala Ala Phe Lys Ile Ala Arg Leu Thr Gly Arg Ser Arg
 115 120 125
 Ile Leu Ala Ala Val His Gly Phe His Gly Arg Thr Met Gly Ser Leu
 130 135 140
 Ala Leu Thr Gly Gln Pro Asp Lys Arg Glu Ala Phe Leu Pro Met Pro
 145 150 155 160
 Ser Gly Val Glu Phe Tyr Pro Tyr Gly Asp Thr Asp Tyr Leu Arg Lys
 165 170 175
 Met Val Glu Thr Asn Pro Thr Asp Val Ala Ala Ile Phe Leu Glu Pro
 180 185 190
 Ile Gln Gly Glu Thr Gly Val Val Pro Ala Pro Glu Gly Phe Leu Lys
 195 200 205
 Ala Val Arg Glu Leu Cys Asp Glu Tyr Gly Ile Leu Met Ile Thr Asp
 210 215 220
 Glu Val Gln Thr Gly Val Gly Arg Thr Gly Asp Phe Phe Ala His Gln
 225 230 235 240
 His Asp Gly Val Val Pro Asp Val Val Thr Met Ala Lys Gly Leu Gly
 245 250 255
 Gly Gly Leu Pro Ile Gly Ala Cys Leu Ala Thr Gly Arg Ala Ala Glu
 260 265 270
 Leu Met Thr Pro Gly Lys His Gly Thr Thr Phe Gly Gly Asn Pro Val
 275 280 285
 Ala Cys Ala Ala Ala Lys Ala Val Leu Ser Val Val Asp Asp Ala Phe
 290 295 300
 Cys Ala Glu Val Ala Arg Lys Gly Glu Leu Phe Lys Glu Leu Leu Ala
 305 310 315 320

Lys Val Asp Gly Val Val Asp Val Arg Gly Arg Gly Leu Met Leu Gly
 325 330 335
 Val Val Leu Glu Arg Asp Val Ala Lys Gln Ala Val Leu Asp Gly Phe
 340 345 350
 Lys His Gly Val Ile Leu Asn Ala Pro Ala Asp Asn Ile Ile Arg Leu
 355 360 365
 Thr Pro Pro Leu Val Ile Thr Asp Glu Glu Ile Ala Asp Ala Val Lys
 370 375 380
 Ala Ile Ala Glu Thr Ile Ala
 385 390

<210> 18
 <211> 203
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> putrescine acetyltransferase

<400> 18
 Met Ser Pro Thr Val Leu Pro Ala Thr Gln Ala Asp Phe Pro Lys Ile
 1 5 10 15
 Val Asp Val Leu Val Glu Ala Phe Ala Asn Asp Pro Ala Phe Leu Arg
 20 25 30
 Trp Ile Pro Gln Pro Asp Pro Gly Ser Ala Lys Leu Arg Ala Leu Phe
 35 40 45
 Glu Leu Gln Ile Glu Lys Gln Tyr Ala Val Ala Gly Asn Ile Asp Val
 50 55 60
 Ala Arg Asp Ser Glu Gly Glu Ile Val Gly Val Ala Leu Trp Asp Arg
 65 70 75 80
 Pro Asp Gly Asn His Ser Ala Lys Asp Gln Ala Ala Met Leu Pro Arg
 85 90 95
 Leu Val Ser Ile Phe Gly Ile Lys Ala Ala Gln Val Ala Trp Thr Asp
 100 105 110
 Leu Ser Ser Ala Arg Phe His Pro Lys Phe Pro His Trp Tyr Leu Tyr
 115 120 125
 Thr Val Ala Thr Ser Ser Ser Ala Arg Gly Thr Gly Val Gly Ser Ala
 130 135 140
 Leu Leu Asn His Gly Ile Ala Arg Ala Gly Asp Glu Ala Ile Tyr Leu
 145 150 155 160
 Glu Ala Thr Ser Thr Arg Ala Ala Gln Leu Tyr Asn Arg Leu Gly Phe
 165 170 175
 Val Pro Leu Gly Tyr Ile Pro Ser Asp Asp Asp Gly Thr Pro Glu Leu
 180 185 190
 Ala Met Trp Lys Pro Pro Ala Met Pro Thr Val
 195 200

<210> 19
 <211> 203

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<212> PRT
 <213> Artificial Sequence

<220>
 <223> putrescine acetyltransferase

<400> 19
 Met Ser Pro Thr Val Leu Pro Ala Thr Gln Ala Asp Phe Pro Lys Ile
 1 5 10 15
 Val Asp Val Leu Val Glu Ala Phe Ala Asn Asp Pro Ala Phe Leu Arg
 20 25 30
 Trp Ile Pro Gln Pro Asp Pro Gly Ser Ala Lys Leu Arg Ala Leu Phe
 35 40 45
 Glu Leu Gln Ile Glu Lys Gln Tyr Ala Val Ala Gly Asn Ile Asp Val
 50 55 60
 Ala Arg Asp Ser Glu Gly Glu Ile Val Gly Val Ala Leu Trp Asp Arg
 65 70 75 80
 Pro Asp Gly Asn His Ser Ala Lys Asp Gln Ala Ala Ile Leu Pro Arg
 85 90 95
 Leu Val Ser Ile Phe Gly Ile Lys Ala Ala Gln Val Ala Trp Thr Asp
 100 105 110
 Leu Ser Ser Ala Arg Phe His Pro Lys Phe Pro His Trp Tyr Leu Tyr
 115 120 125
 Thr Val Ala Thr Ser Ser Ser Ala Arg Gly Thr Gly Val Gly Ser Ala
 130 135 140
 Leu Leu Asn His Gly Ile Ala Arg Ala Gly Asp Glu Ala Ile Tyr Leu
 145 150 155 160
 Glu Ala Thr Ser Thr Arg Ala Ala Gln Leu Tyr Asn Arg Leu Gly Phe
 165 170 175
 Val Pro Leu Gly Tyr Ile Pro Ser Asp Asp Asp Gly Thr Pro Glu Leu
 180 185 190
 Ala Met Trp Lys Pro Pro Ala Met Pro Thr Val
 195 200

<210> 20
 <211> 494
 <212> PRT
 <213> putrescine exporting protein

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

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Gly His Arg Arg Met Phe Leu Met Gly Leu Ser Ile Phe Gly Ile Ala
 85 90
 Ser Leu Gly Ala Ala Phe Ala Pro Thr Ala Trp Ala Leu Val Ala Ala
 100 105 110
 Arg Ala Phe Leu Gly Ile Gly Ala Ala Thr Met Met Pro Ala Thr Leu
 115 120 125
 Ala Leu Ile Arg Ile Thr Phe Glu Asp Glu Arg Glu Arg Asn Thr Ala
 130 135 140
 Ile Gly Ile Trp Gly Ser Val Ala Ile Leu Gly Ala Ala Ala Gly Pro
 145 150 155 160
 Ile Ile Gly Gly Ala Leu Leu Glu Phe Phe Trp Trp Gly Ser Val Phe
 165 170 175
 Leu Ile Asn Val Pro Val Ala Val Ile Ala Leu Ile Ala Thr Leu Phe
 180 185 190
 Val Ala Pro Ala Asn Ile Ala Asn Pro Ser Lys His Trp Asp Phe Leu
 195 200 205
 Ser Ser Phe Tyr Ala Leu Leu Thr Leu Ala Gly Leu Ile Ile Thr Ile
 210 215 220
 Lys Glu Ser Val Asn Thr Ala Arg His Met Pro Leu Leu Leu Gly Ala
 225 230 235 240
 Val Ile Met Leu Ile Ile Gly Ala Val Leu Phe Ser Ser Arg Gln Lys
 245 250 255
 Lys Ile Glu Glu Pro Leu Leu Asp Leu Ser Leu Phe Arg Asn Arg Leu
 260 265 270
 Phe Leu Gly Gly Val Val Ala Ala Gly Met Ala Met Phe Thr Val Ser
 275 280 285
 Gly Leu Glu Met Thr Thr Ser Gln Arg Phe Gln Leu Ser Val Gly Phe
 290 295 300
 Thr Pro Leu Glu Ala Gly Leu Leu Met Ile Pro Ala Ala Leu Gly Ser
 305 310 315 320
 Phe Pro Met Ser Ile Ile Gly Gly Ala Asn Leu His Arg Trp Gly Phe
 325 330 335
 Lys Pro Leu Ile Ser Gly Gly Phe Ala Ala Thr Ala Val Gly Ile Ala
 340 345 350
 Leu Cys Ile Trp Gly Ala Thr His Thr Asp Gly Leu Pro Phe Phe Ile
 355 360 365
 Ala Gly Leu Phe Phe Met Gly Ala Gly Ala Gly Ser Val Met Ser Val
 370 375 380
 Ser Ser Thr Ala Ile Ile Gly Ser Ala Pro Val Arg Lys Ala Gly Met
 385 390 395 400
 Ala Ser Ser Ile Glu Glu Val Ser Tyr Glu Phe Gly Thr Leu Leu Ser
 405 410 415
 Val Ala Ile Leu Gly Ser Leu Phe Pro Phe Phe Tyr Ser Leu His Ala
 420 425 430
 Pro Ala Glu Val Ala Asp Asn Phe Ser Ala Gly Val His His Ala Ile

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435 440 445
 Asp Gly Asp Ala Ala Arg Ala Ser Leu Asp Thr Ala Tyr Ile Asn Val
 450 455 460
 Leu Ile Ile Ala Leu Val Cys Ala Val Ala Ala Ala Leu Ile Ser Ser
 465 470 475 480
 Tyr Leu Phe Arg Gly Asn Pro Lys Gly Ala Asn Asn Ala His
 485 490

<210> 21
 <211> 494
 <212> PRT
 <213> putrescine exporting protein

<400> 21
 Met Ile Ser Glu Thr Leu Gln Ala Gln Ala Pro Thr Lys Thr Gln Arg
 1 5 10 15
 Trp Ala Phe Leu Ala Val Ile Ser Gly Gly Leu Phe Leu Ile Gly Val
 20 25 30
 Asp Asn Ser Ile Leu Tyr Thr Ala Leu Pro Leu Leu Arg Glu Gln Leu
 35 40 45
 Ala Ala Thr Glu Thr Gln Ala Leu Trp Ile Ile Asn Ala Tyr Pro Leu
 50 55 60
 Leu Met Ala Gly Leu Leu Leu Gly Thr Gly Thr Leu Gly Asp Lys Ile
 65 70 75 80
 Gly His Arg Arg Met Phe Leu Met Gly Leu Ser Ile Phe Gly Ile Ala
 85 90 95
 Ser Leu Gly Ala Ala Phe Ala Pro Thr Ala Trp Ala Leu Val Ala Ala
 100 105 110
 Arg Ala Phe Leu Gly Ile Gly Ala Ala Thr Met Met Pro Ala Thr Leu
 115 120 125
 Ala Leu Ile Arg Ile Thr Phe Glu Asp Glu Arg Glu Arg Asn Thr Ala
 130 135 140
 Ile Gly Ile Trp Gly Ser Val Ala Ile Leu Gly Ala Ala Ala Gly Pro
 145 150 155 160
 Ile Ile Gly Gly Ala Leu Leu Glu Phe Phe Trp Trp Gly Ser Val Phe
 165 170 175
 Leu Ile Asn Val Pro Val Ala Val Ile Ala Leu Ile Ala Thr Leu Phe
 180 185 190
 Val Ala Pro Ala Asn Ile Ala Asn Pro Ser Lys His Trp Asp Phe Leu
 195 200 205
 Ser Ser Phe Tyr Ala Leu Leu Thr Leu Ala Gly Leu Ile Val Thr Ile
 210 215 220
 Lys Glu Ser Val Asn Thr Ala Arg His Leu Pro Leu Leu Val Gly Ala
 225 230 235 240
 Ile Ile Leu Leu Ile Ile Gly Ala Val Leu Phe Ser Ser Arg Gln Lys
 245 250 255
 Lys Ile Glu Glu Pro Leu Leu Asp Leu Ser Leu Phe Arg Asn Arg Leu
 260 265 270

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Phe Leu Gly Gly Val Val Ala Ala Gly Met Ala Met Phe Thr Val Ser
 275 280 285
 Gly Leu Glu Met Thr Thr Ser Gln Arg Phe Gln Leu Ser Val Gly Phe
 290 295 300
 Thr Pro Leu Glu Ala Gly Leu Leu Met Ile Pro Ala Ala Leu Gly Ser
 305 310 315 320
 Phe Pro Met Ser Ile Ile Gly Gly Ala Asn Leu His Arg Trp Gly Phe
 325 330 335
 Lys Pro Leu Ile Ser Gly Gly Phe Leu Ala Thr Ala Val Gly Ile Ala
 340 345 350
 Leu Cys Ile Trp Gly Ala Thr His Thr Asp Gly Leu Pro Phe Phe Ile
 355 360 365
 Ala Gly Leu Phe Phe Met Gly Ala Gly Ala Gly Ser Val Met Ser Val
 370 375 380
 Ser Ser Thr Ala Ile Ile Gly Ser Ala Pro Val Arg Lys Ala Gly Met
 385 390 395 400
 Ala Ser Ser Ile Glu Glu Val Ser Tyr Glu Phe Gly Thr Leu Leu Ser
 405 410 415
 Val Ala Ile Leu Gly Ser Leu Phe Pro Phe Phe Tyr Ser Leu His Ala
 420 425 430
 Pro Ala Glu Val Ala Asp Asn Phe Ser Ala Gly Val His His Ala Ile
 435 440 445
 Tyr Gly Asp Ala Ala Arg Ala Ser Leu Asp Thr Ala Tyr Ile Asn Val
 450 455 460
 Leu Ile Ile Ala Leu Val Cys Ala Val Ala Ala Leu Ile Ser Ser
 465 470 475 480
 Tyr Leu Phe Arg Gly Asn Pro Lys Gly Ala Asn Asn Ala His
 485 490