

SEQUENCE LISTING

<110> METABOLIC EXPLORER

<120> MICROORGANISMS WITH IMPROVED 1,3-PROPANEDIOL AND BUTYRIC ACID
PRODUCTION

<130> B376540PCT D38115

<150> EP18306099.5

<151> 2018-08-10

<160> 47

<170> PatentIn version 3.5

<210> 1

<211> 498

<212> PRT

<213> Clostridium acetobutylicum

<400> 1

Met Lys Lys Tyr Ile Ile Ala Leu Asp Gln Gly Thr Thr Ser Ser Arg
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Ala Ile Ile Phe Asp His Glu Gln Asn Ile Leu Glu Ile Ser Gln Lys
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Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Ala Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Val Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile
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Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
485 490 495

Glu Glu

<210> 2

<211> 1497

<212> DNA

<213> Clostridium acetobutylicum

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aaaggatggg ttgagcataa tccttagag atatggtcaa gtcaatatgg agttttgcaa 180

gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300
 gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360
 tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420
 ataaagtgga tattagataa thtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480
 ctatttgga cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540
 accgattaca caaatgcac tagaactatg ctttataata taaaggaatt aaaatgggat 600
 gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660
 tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720
 ggcatggcag gagatcaaca atgtgcatta ttgggtcaaa cctgtttga agaaggtagt 780
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 <213> Clostridium acetobutylicum

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Ala Ile Ile Phe Asp His Glu Gln Asn Ile Leu Glu Ile Ser Gln Lys

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25

30

Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Thr Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Val Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile
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Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
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Glu Glu

<210> 4
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<212> DNA
<213> Clostridium acetobutylicum

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aaaggatggg ttgagcataa tcctttagag atatggtcaa gtcaatatgg agttttgcaa 180
gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240
caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300
gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360
tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420
ataaagtgga tattagataa thtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480
ctatttggtg cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540
accgattaca caaatgcac tagaactatg cttataata taaaggaatt aaaatgggat 600
gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660
tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720
ggcatggcag gagatcaaca atgtgcatta ttggtcaaa cctgtttga agaaggtagt 780
gttaaaaata cttatggcac aggatgcttt ttacttatga atacaggaga aaatataatt 840
cagagtaaaa atggactagt aacgacaatt gcaattggat tagaagggaa agttcaatat 900
gcattagaag gttcagtggt ttgtgggggg gcagttattc agtggattag agatgaactt 960
aagttagtta gcgatgctgc ggatacagag tattttgcta aaaaagtga tgacaatggt 1020
ggagtatatg tggaccaac atttactggt ctggagctc catattggga tatgtatgct 1080

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 tgtgaaatta caagaattaa agttgatgga ggagctagta gaaataattt attaatgcag 1260
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<213> Clostridium acetobutylicum

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Ala Ile Ile Phe Asp Tyr Glu Gln Asn Ile Leu Glu Ile Ser Gln Lys
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Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
 35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
 50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
 65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
 85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
 100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
 115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile

130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Ala Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Val Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile
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Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
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Glu Glu

<210> 6

<211> 1497

<212> DNA

<213> Clostridium acetobutylicum

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gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300

gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360
 tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420
 ataaagtgga tattagataa tgtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480
 ctatttgga cagttgatac ttggcttgta tggaaagctaa caaatggcaa agtccatgta 540
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 gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660
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 gccgagaagt ggtctgtgag tgagggtgat actccgaatt tagatgagga tgagaaaata 1440
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<211> 498

<212> PRT

<213> Clostridium acetobutylicum

<400> 7

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	20			25			30								

Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe

245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Ala Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

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

<210> 8
<211> 1494
<212> DNA
<213> Clostridium acetobutylicum

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aaaggatggg ttgagcataa tcctttagag atatggtcaa gtcaatatgg agttttgcaa 180

gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300

gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360

tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420

ataaagtgga tattagataa ttagagagggt gcaagagaaa aagctgaaaa aggtgaattg 480

ctatttggtg cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540

accgattaca caaatgcac tagaactatg ctttataata taaaggaatt aaaatgggat 600

gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660

tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720

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gttaaaaata cttatggcac aggatgcttt ttacttatga atacaggaga aaatataatt 840

cagagtaaaa atggactagt aacgacaatt gcaattggat tagaaggga agttcaatat 900

gcattagaag gttcagtgtt tgttgggggg gcagttattc agtggattag agatgaactt 960

aagttagtta gcatgctgc ggatacagag tattttgcta aaaaagtga tgacaatggt 1020

ggagtatatg tggtagcagc atttactggt cttggagctc catattggga tatgtatgct 1080

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 <400> 9

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Ala Ile Ile Phe Asp Tyr Glu Gln Asn Ile Leu Glu Ile Ser Gln Lys
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Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
 35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
 50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
 65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
 85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
 100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
 115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
 130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
 165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
 180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
 195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
 210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
 245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
 260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
 275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
 290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
 325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Thr Phe Thr Gly Leu Gly
 340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr

355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Val Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile
465 470 475 480

Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
485 490 495

Glu Glu

<210> 10

<211> 1497

<212> DNA

<213> Clostridium acetobutylicum

<400> 10

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gactatgaac aaaatatatt agaaattagt caaaaggaat ttactcaaat ctatccgagt 120

aaaggatggg ttgagcataa tccttagag atatggtcaa gtcaatatgg agttttgcaa 180

gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300

gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360
 tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420
 ataaagtgga tattagataa thtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480
 ctatttgga cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540
 accgattaca caaatgcac tagaactatg ctttataata taaaggaatt aaaatgggat 600
 gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660
 tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720
 ggcatggcag gagatcaaca atgtgcatta ttggtcaaa cctgttttga agaaggtagt 780
 gttaaaaata cttatggcac aggatgcttt ttacttatga atacaggaga aaatataatt 840
 cagagtaaaa atggactagt aacgacaatt gcaattggat tagaaggga agttcaatat 900
 gcattagaag gttcagtgtt tgttgggggg gcagtattc agtggattag agatgaactt 960
 aagttagtta gcgatgctgc ggatacagag tatttgcta aaaaagtga tgacaatggt 1020
 ggagtatatg tggtagcaac atttactggt ctggagctc catattggga tatgtatgct 1080
 agaggagcaa ttttgggtc gacaagaggc gcaataaaa accatataat tagagcggca 1140
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 tgtgaaatta caagaattaa agttgatgga ggagctagta gaaataattt attaatgcag 1260
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 cttggtgcag cttatttagc cggacttgct gtaggctttt ggaagtcaaa agaagaaatt 1380
 gccgagaagt ggtctgtgag tgagggtgat actccgaatt tagatgagga tgagaaaata 1440
 agattatata acggttgga gagagcagtt gaaagagttc agggctggga agaataa 1497

<210> 11
 <211> 498
 <212> PRT
 <213> Clostridium acetobutylicum

<400> 11

Met Lys Lys Tyr Ile Ile Ala Leu Asp Gln Gly Thr Thr Ser Ser Arg
 1 5 10 15

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

Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Thr Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Met Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile

465 470 475 480

Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
 485 490 495

Glu Glu

<210> 12
<211> 1497
<212> DNA
<213> Clostridium acetobutylicum

<400> 12
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aaaggatggg ttgagcataa tcctttagag atatggtcaa gtcaatatgg agttttgcaa 180

gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300

gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360

tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420

ataaagtgga tattagataa tgtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480

ctatttggtg cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540

accgattaca caaatgcac tagaactatg ctttataata taaaggaatt aaaatgggat 600

gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660

tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720

ggcatggcag gagatcaaca atgtgcatta ttggtcaaa cctgttttga agaaggtagt 780

gttaaaaata cttatggcac aggatgcttt ttacttatga atacaggaga aaatataatt 840

cagagtaaaa atggactagt aacgacaatt gcaattggat tagaaggga agttcaatat 900

gcattagaag gttcagtggt ttgtgggggg gcagttattc agtggattag agatgaactt 960

aagttagtta gcatgctgc ggatacagag tattttgcta aaaaagtga tgacaatggg 1020

ggagtatatg tggtaacca atttactggg ctggagctc catattggga tatgtatgct 1080

agaggagcaa ttttgggtct gacaagaggc gcaataaaaa accatataat tagagcggca 1140

cttgaagcta ttgcatatca gtcaagagat cttatagatg caatgaaaga agattcggga 1200
 tgtgaaatta caagaattaa agttgatgga ggagctagta gaaataattt attaatgcag 1260
 tttcaagcag acattacagg aacagaagtt gtaagaccta taataactga aacaacagca 1320
 cttggtgcag cttatttagc cggacttgct gtaggctttt ggaagtcaaa agaagaaatt 1380
 gccgagaagt ggtctatgag tgagggtgat actccgaatt tagatgagga tgagaaaata 1440
 agattatata acggttggaa gagagcagtt gaaagagttc agggctggga agaataa 1497

<210> 13
 <211> 498
 <212> PRT
 <213> Clostridium acetobutylicum

 <400> 13

Met Lys Lys Tyr Ile Ile Ala Leu Asp Gln Gly Thr Thr Ser Ser Arg
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Ala Ile Ile Phe Asp Tyr Glu Gln Asn Ile Leu Glu Ile Ser Gln Lys
 20 25 30

Glu Phe Thr Gln Ile Tyr Pro Ser Lys Gly Trp Val Glu His Asn Pro
 35 40 45

Leu Glu Ile Trp Ser Ser Gln Tyr Gly Val Leu Gln Glu Val Met Ala
 50 55 60

Lys Ala Asn Ile Thr Gln Glu Asn Ile Ala Ala Ile Gly Ile Thr Asn
 65 70 75 80

Gln Arg Glu Thr Thr Ile Val Trp Asp Lys Asn Thr Gly Glu Pro Val
 85 90 95

Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Asp Ile Val Glu
 100 105 110

Gly Leu Lys Arg Asp Lys Glu Phe Ser Asp Tyr Val Lys Glu Asn Thr
 115 120 125

Gly Leu Ile Leu Asp Ala Tyr Phe Ser Ala Thr Lys Ile Lys Trp Ile
 130 135 140

Leu Asp Asn Val Glu Gly Ala Arg Glu Lys Ala Glu Lys Gly Glu Leu
145 150 155 160

Leu Phe Gly Thr Val Asp Thr Trp Leu Val Trp Lys Leu Thr Asn Gly
165 170 175

Lys Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu Tyr
180 185 190

Asn Ile Lys Glu Leu Lys Trp Asp Glu Arg Ile Leu Arg Lys Leu Asn
195 200 205

Ile Pro Arg Ser Met Leu Pro Glu Val Lys Asn Ser Ser Glu Val Tyr
210 215 220

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

Gly Met Ala Gly Asp Gln Gln Cys Ala Leu Phe Gly Gln Thr Cys Phe
245 250 255

Glu Glu Gly Ser Val Lys Asn Thr Tyr Gly Thr Gly Cys Phe Leu Leu
260 265 270

Met Asn Thr Gly Glu Asn Ile Ile Gln Ser Lys Asn Gly Leu Val Thr
275 280 285

Thr Ile Ala Ile Gly Leu Glu Gly Lys Val Gln Tyr Ala Leu Glu Gly
290 295 300

Ser Val Phe Val Gly Gly Ala Val Ile Gln Trp Ile Arg Asp Glu Leu
305 310 315 320

Lys Leu Val Ser Asp Ala Ala Asp Thr Glu Tyr Phe Ala Lys Lys Val
325 330 335

Asn Asp Asn Gly Gly Val Tyr Val Val Pro Thr Phe Thr Gly Leu Gly
340 345 350

Ala Pro Tyr Trp Asp Met Tyr Ala Arg Gly Ala Ile Phe Gly Leu Thr
355 360 365

Arg Gly Ala Asn Lys Asn His Ile Ile Arg Ala Ala Leu Glu Ala Ile
370 375 380

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

Cys Glu Ile Thr Arg Ile Lys Val Asp Gly Gly Ala Ser Arg Asn Asn
405 410 415

Leu Leu Met Gln Phe Gln Ala Asp Ile Thr Gly Thr Glu Val Val Arg
420 425 430

Pro Ile Ile Thr Glu Thr Thr Ala Leu Gly Ala Ala Tyr Leu Ala Gly
435 440 445

Leu Ala Val Gly Phe Trp Lys Ser Lys Glu Glu Ile Ala Glu Lys Trp
450 455 460

Ser Met Ser Glu Val Tyr Thr Pro Asn Leu Asp Glu Asp Glu Lys Ile
465 470 475 480

Arg Leu Tyr Asn Gly Trp Lys Arg Ala Val Glu Arg Val Gln Gly Trp
485 490 495

Glu Glu

<210> 14

<211> 1497

<212> DNA

<213> Clostridium acetobutylicum

<400> 14

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aaaggatggg ttgagcataa tccttagag atatggtcaa gtcaatatgg agttttgcaa 180

gaagtaatgg caaaagctaa tataactcaa gaaaatattg cagcaatagg aattactaat 240

caaagagaaa caacaattgt ttgggacaaa aatactggag aacctgtgta taatgctatt 300

gtatggcagt gtagaagaac agcagatata gtggaaggac ttaagagaga taaagagttt 360

tcagattatg taaaagaaaa tacaggatta atattagatg catatttttc agcaacaaaa 420
 ataaagtgga tattagataa thtagagggt gcaagagaaa aagctgaaaa aggtgaattg 480
 ctatttggtg cagttgatac ttggcttgta tggaagctaa caaatggcaa agtccatgta 540
 accgattaca caaatgcac tagaactatg ctttataata taaaggaatt aaaatgggat 600
 gaaagaattt taagaaaact taatattcca agatcaatgc taccagaagt taaaaattca 660
 tccgaagttt atggatatac aaaccttgga ggtaaagggt gtattagagt accaatagca 720
 ggcatggcag gagatcaaca atgtgcatta ttgggtcaaa cctgttttga agaaggtagt 780
 gttaaaaata cttatggcac aggatgcttt ttacttatga atacaggaga aaatataatt 840
 cagagtaaaa atggactagt aacgacaatt gcaattggat tagaaggga agttcaatat 900
 gcattagaag gttcagtggt ttgtgggggg gcagttatc agtggattag agatgaactt 960
 aagttagtta gcatgctgc ggatacagag tattttgcta aaaaagtga tgacaatggt 1020
 ggagtatatg tggtagcaac atttactggt ctggagctc catattggga tatgtatgct 1080
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 tgtgaaatta caagaattaa agttgatgga ggagctagta gaaataattt attaatgcag 1260
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 cttggtgcag cttatttagc cggacttgct gtaggctttt ggaagtcaaa agaagaaatt 1380
 gccgagaagt ggtctatgag tgagggtgat actccgaatt tagatgagga tgagaaaata 1440
 agattatata acggttgga gagagcagtt gaaagagttc agggctggga agaataa 1497

<210> 15
 <211> 582
 <212> PRT
 <213> Clostridium acetobutylicum

<400> 15

Met Lys Thr Ile Ile Leu Asn Gly Asn Glu Val His Thr Asp Lys Asp
 1 5 10 15

Ile Thr Ile Leu Glu Leu Ala Arg Glu Asn Asn Val Asp Ile Pro Thr
 20 25 30

Leu Cys Phe Leu Lys Asp Cys Gly Asn Phe Gly Lys Cys Gly Val Cys
35 40 45

Met Val Glu Val Glu Gly Lys Gly Phe Arg Ala Ala Cys Val Ala Lys
50 55 60

Val Glu Asp Gly Met Val Ile Asn Thr Glu Ser Asp Glu Val Lys Glu
65 70 75 80

Arg Ile Lys Lys Arg Val Ser Met Leu Leu Asp Lys His Glu Phe Lys
85 90 95

Cys Gly Gln Cys Ser Arg Arg Glu Asn Cys Glu Phe Leu Lys Leu Val
100 105 110

Ile Lys Thr Lys Ala Lys Ala Ser Lys Pro Phe Leu Pro Glu Asp Lys
115 120 125

Asp Ala Leu Val Asp Asn Arg Ser Lys Ala Ile Val Ile Asp Arg Ser
130 135 140

Lys Cys Val Leu Cys Gly Arg Cys Val Ala Ala Cys Lys Gln His Thr
145 150 155 160

Ser Thr Cys Ser Ile Gln Phe Ile Lys Lys Asp Gly Gln Arg Ala Val
165 170 175

Gly Thr Val Asp Asp Val Cys Leu Asp Asp Ser Thr Cys Leu Leu Cys
180 185 190

Gly Gln Cys Val Ile Ala Cys Pro Val Ala Ala Leu Lys Glu Lys Ser
195 200 205

His Ile Glu Lys Val Gln Glu Ala Leu Asn Asp Pro Lys Lys His Val
210 215 220

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

Lys Met Gly Tyr Gly Lys Asp Val Thr Gly Lys Leu Tyr Thr Ala Leu
245 250 255

Arg Met Leu Gly Phe Asp Lys Val Phe Asp Ile Asn Phe Gly Ala Asp
260 265 270

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

Asn Gly Pro Phe Pro Met Phe Thr Ser Cys Cys Pro Ala Trp Val Arg
290 295 300

Leu Ala Gln Asn Tyr His Pro Glu Leu Leu Asp Asn Leu Ser Ser Ala
305 310 315 320

Lys Ser Pro Gln Gln Ile Phe Gly Thr Ala Ser Lys Thr Tyr Tyr Pro
325 330 335

Ser Ile Ser Gly Ile Ala Pro Glu Asp Val Tyr Thr Val Thr Ile Met
340 345 350

Pro Cys Asn Asp Lys Lys Tyr Glu Ala Asp Ile Pro Phe Met Glu Thr
355 360 365

Asn Ser Leu Arg Asp Ile Asp Ala Ser Leu Thr Thr Arg Glu Leu Ala
370 375 380

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

Glu Val Asp Pro Ala Met Gly Thr Tyr Ser Gly Ala Gly Ala Ile Phe
405 410 415

Gly Ala Thr Gly Gly Val Met Glu Ala Ala Ile Arg Ser Ala Lys Asp
420 425 430

Phe Ala Glu Asn Lys Glu Leu Glu Asn Val Asp Tyr Thr Glu Val Arg
435 440 445

Gly Phe Lys Gly Ile Lys Glu Ala Glu Val Glu Ile Ala Gly Asn Lys
450 455 460

Leu Asn Val Ala Val Ile Asn Gly Ala Ser Asn Phe Phe Glu Phe Met
465 470 475 480

Lys Ser Gly Lys Met Asn Glu Lys Gln Tyr His Phe Ile Glu Val Met
485 490 495

Ala Cys Pro Gly Gly Cys Ile Asn Gly Gly Gly Gln Pro His Val Asn
500 505 510

Ala Leu Asp Arg Glu Asn Val Asp Tyr Arg Lys Leu Arg Ala Ser Val
515 520 525

Leu Tyr Asn Gln Asp Lys Asn Val Leu Ser Lys Arg Lys Ser His Asp
530 535 540

Asn Pro Ala Ile Ile Lys Met Tyr Asp Ser Tyr Phe Gly Lys Pro Gly
545 550 555 560

Glu Gly Leu Ala His Lys Leu Leu His Val Lys Tyr Thr Lys Asp Lys
565 570 575

Asn Val Ser Lys His Glu
580

<210> 16
<211> 1749
<212> DNA
<213> Clostridium acetobutylicum

<400> 16
atgaaaacaa taatcttaaa tggcaatgaa gtgcatacag ataaagatat tactatcctt 60
gagctagcaa gagaaaataa ttagatatac ccaacactct gctttttaa ggattgtggc 120
aatTTTggaa aatgcggagt ctgtatggta gaggtagaag gcaagggctt tagagctgct 180
tgtgttgcca aagttgaaga tggaatggta ataaacacag aatccgatga agtaaaagaa 240
cgaatcaaaa aaagagtttc aatgcttctt gataagcatg aatttaaag tggacaatgt 300
tctagaagag aaaattgtga attccttaaa cttgtaataa agacaaaagc aaaagcttca 360
aaaccatttt taccagaaga taaggatgct ctagttgata atagaagtaa ggctattgta 420
attgacagat caaaatgtgt actatgcggt agatgcgtag ctgcatgtaa acagcacaca 480
agcacttgct caattcaatt tattaataaaa gatggacaaa gggctgttgg aactgttgat 540
gatgtttgtc ttgatgactc aacatgctta ttatgcggtc agtgtgtaat cgcttgcct 600

gttgctgctt taaaagaaaa atcccatata gaaaaagttc aagaagctct taatgaccct 660
 aaaaaacatg tcattgttgc aatggctcca tcagtaagaa ctgctatggg cgaattattc 720
 aaaatgggat atggaaaaga tgtaacagga aaactatata ctgcacttag aatgttaggc 780
 ttgataaag tatttgatat aaactttggt gcagatatga ctataatgga agaagctact 840
 gaacttttag gcagagttaa aaataatggc ccattcccta tgtttacatc ttgctgtcct 900
 gcatgggtaa gattagctca aaattatcat cctgaattat tagataatct ttcacagca 960
 aaatcaccac acaaatatt tggtagctga tcaaaaactt actatccttc aatttcagga 1020
 atagctccag aagatgttta tacagttact atcatgcctt gtaatgataa aaaatatgaa 1080
 gcagatattc ctttcatgga aactaacagc ttaagagata ttgatgcac ctaactaca 1140
 agagagcttg caaaaatgat taaagatgca aaaattaaat ttgcagatct tgaagatggt 1200
 gaagttgatc ctgctatggg tacttacagt ggtgctggag ctatctttgg tgcaaccggt 1260
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 ggatgtataa atgggtggagg tcaacctcac gtaaatgctc ttgatagaga aaatgttgat 1560
 tacagaaaac taagagcatc agtattatac aaccaagata aaaatgttct tcaaagaga 1620
 aagtcacatg ataatccagc tattattaaa atgtatgata gctactttgg aaaaccaggt 1680
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 catgaataa 1749

<210> 17
 <211> 209
 <212> PRT
 <213> Clostridium acetobutylicum

<400> 17

Met Lys Thr Ile Ile Leu Asn Gly Asn Glu Val His Thr Asp Lys Asp
 1 5 10 15

Ile Thr Ile Leu Glu Leu Ala Arg Glu Asn Asn Val Asp Ile Pro Thr
 20 25 30

Leu Cys Phe Leu Lys Asp Cys Gly Asn Phe Gly Lys Cys Gly Val Cys
35 40 45

Met Val Glu Val Glu Gly Lys Gly Phe Arg Ala Ala Cys Val Ala Lys
50 55 60

Val Glu Asp Gly Met Val Ile Asn Thr Glu Ser Asp Glu Val Lys Glu
65 70 75 80

Arg Ile Lys Lys Arg Val Ser Met Leu Leu Asp Lys His Glu Phe Lys
85 90 95

Cys Gly Gln Cys Ser Arg Arg Glu Asn Cys Glu Phe Leu Lys Leu Val
100 105 110

Ile Lys Thr Lys Ala Lys Ala Ser Lys Pro Phe Leu Pro Glu Asp Lys
115 120 125

Asp Ala Leu Val Asp Asn Arg Ser Lys Ala Ile Val Ile Asp Arg Ser
130 135 140

Lys Cys Val Leu Cys Gly Arg Cys Val Ala Ala Cys Lys Gln His Thr
145 150 155 160

Ser Thr Cys Ser Ile Gln Phe Ile Lys Lys Asp Gly Gln Arg Ala Val
165 170 175

Gly Thr Val Asp Asp Val Cys Leu Asp Asp Ser Thr Cys Leu Leu Cys
180 185 190

Gly Gln Cys Val Ile Ala Cys Pro Val Ala Ala Leu Lys Lys Asn Pro
195 200 205

Ile

<210> 18

<211> 630

<212> DNA

<213> Clostridium acetobutylicum

<400> 18
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 aattttggaa aatgcggagt ctgtatggta gaggtagaag gcaagggctt tagagctgct 180
 tgtgttgcca aagttgaaga tggaatggta ataaacacag aatccgatga agtaaaagaa 240
 cgaatcaaaa aaagagtttc aatgcttctt gataagcatg aatttaaag tggacaatgt 300
 tctagaagag aaaattgtga attccttaaa cttgtaataa agacaaaagc aaaagcttca 360
 aaaccatttt taccagaaga taaggatgct ctagttgata atagaagtaa ggctattgta 420
 attgacagat caaaatgtgt actatgcggt agatgcgtag ctgcatgtaa acagcacaca 480
 agcacttgct caattcaatt tattaataaaa gatggacaaa gggctgttgg aactgttgat 540
 gatgttgc ttgatgactc aacatgctta ttatgcggtc agtgtgtaat cgcttgcct 600
 gttgctgctt taaaaaaaaa tcccatatag 630

<210> 19
 <211> 242
 <212> PRT
 <213> Clostridium acetobutylicum

<400> 19

Met His Tyr Ser Leu Ala Val Lys Leu Val Cys Glu Met Leu Gly Thr
 1 5 10 15

Ala Ile Leu Val Leu Phe Gly Asn Gly Ala Val Ala Asn Val Glu Leu
 20 25 30

Lys Gly Thr Lys Gly Tyr Arg Asn Gly Trp Ile Ile Ile Ala Ile Gly
 35 40 45

Tyr Gly Val Gly Val Met Leu Pro Ala Leu Met Phe Asn Lys Ile Ser
 50 55 60

Gly Ser Gln Thr Asn Pro Ala Met Thr Ile Gly Leu Ala Val Asn Gly
 65 70 75 80

Leu Phe Pro Trp Ser Glu Val Ile Pro Tyr Ile Leu Ala Gln Phe Val
 85 90 95

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

<210> 20
 <211> 729
 <212> DNA
 <213> Clostridium acetobutylicum

<400> 20
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 ggctggatta ttattgcat tgggtatggg gttgggtgaa tgcttcagc ttaatgttt 180
 aataaaatta gtggtagtca gacaaatcca gctatgacaa taggattagc agtaaatggg 240
 cttttccgt ggtctgaggt tataccatat atattggctc agttttagg tgctataata 300

ggtcaagtta ttctttactt tatatacctt ccgttttata aacaaacaga ggatactaaa 360
 agcattcttg gtacatgttc tactatatca gcatcaggaa gtcataataa tggatttgc 420
 acagaatttt ttggcacatt cttattgggt ttaggtgcaa tgtttattct taattcaact 480
 ggagtaaaaa gtacacctgc agtaggttat gttggtcttg gatttctgt atgctcatta 540
 gttgcatctt taggtgtcc aactggctct ggattaaatc cagctagaga tttgggcct 600
 cgtatagtagc attcactttt gccacttaaa aataaaggca attctgaatg gacatatgcc 660
 tggattcctg ttttggcacc aatgtttgga agtattattg ctatattctt gttaataaaa 720
 atatattaa 729

<210> 21
 <211> 242
 <212> PRT
 <213> Clostridium acetobutylicum
 <400> 21

Met His Tyr Ser Leu Ala Val Lys Leu Val Cys Glu Ile Leu Gly Thr
 1 5 10 15

Ala Ile Leu Val Leu Phe Gly Asn Gly Ala Val Ala Asn Val Glu Leu
 20 25 30

Lys Gly Thr Lys Gly Tyr Arg Asn Gly Trp Ile Ile Ile Ala Ile Gly
 35 40 45

Tyr Gly Val Gly Val Met Leu Pro Ala Leu Met Phe Asn Lys Ile Ser
 50 55 60

Gly Ser Gln Thr Asn Pro Ala Met Thr Ile Gly Leu Ala Val Asn Gly
 65 70 75 80

Leu Phe Pro Trp Ser Glu Val Ile Pro Tyr Ile Leu Ala Gln Phe Val
 85 90 95

Gly Ala Ile Ile Gly Gln Val Ile Leu Tyr Phe Ile Tyr Leu Pro Phe
 100 105 110

Tyr Lys Gln Thr Glu Asp Thr Lys Ser Ile Leu Gly Thr Cys Ser Thr
 115 120 125

Ile Ser Ala Ser Gly Ser His Ile Asn Gly Phe Val Thr Glu Phe Phe
130 135 140

Gly Thr Phe Leu Leu Val Leu Gly Ala Met Phe Ile Leu Asn Ser Thr
145 150 155 160

Gly Val Lys Ser Thr Pro Ala Val Gly Tyr Val Gly Leu Gly Phe Leu
165 170 175

Val Cys Ser Leu Val Ala Ser Leu Gly Gly Pro Thr Gly Pro Gly Leu
180 185 190

Asn Pro Ala Arg Asp Leu Gly Pro Arg Ile Val His Ser Leu Leu Pro
195 200 205

Leu Lys Asn Lys Gly Asn Ser Glu Trp Thr Tyr Ala Trp Ile Pro Val
210 215 220

Leu Ala Pro Met Phe Gly Ser Ile Ile Ala Ile Phe Leu Phe Asn Lys
225 230 235 240

Ile Tyr

<210> 22

<211> 729

<212> DNA

<213> Clostridium acetobutylicum

<400> 22

atgcattata gtttagctgt aaagttagtt tgcgaaatac ttggtacagc aattttagta 60

ctatttggtgta acgggtgcagt tgctaagtga gaattaaaag gaactaaagg gtatcgcaat 120

ggctgggatta ttattgccat tggttatggt gttggtgtaa tgcttcagc tttaatgttt 180

aataaaatta gtggtagtca gacaaatcca gctatgacaa taggattagc agtaaattggg 240

ctttttccgt ggtctgaggt tataccatat atattggctc agttttagg tgctataata 300

ggccaagtta ttctttactt tatatacctt ccgtttata aacaaacaga ggatactaaa 360

agcattcttg gtacatgttc tactatatca gcatcaggaa gcatataaa tggatttgtc 420

acagaatttt ttggcacatt cttattgggt ttaggtgcaa tgttattct taattcaact 480

ggagtaaaaa gtacacctgc agtaggttat gttggtcttg gatttcttgt atgctcatta 540
 gttgcacatt taggtgggcc aactggctct ggattaaatc cagctagaga tttgggccct 600
 cgtatagtag attcactttt gccacttaaa aataaaggca attctgaatg gacatatgcc 660
 tggattcctg ttttggcacc aatgtttgga agtattattg ctatattctt gttaataaaa 720
 atatattaa 729

<210> 23
 <211> 336
 <212> PRT
 <213> Clostridium acetobutylicum
 <400> 23

Met Asn Lys Ala Asp Tyr Lys Gly Val Trp Val Phe Ala Glu Gln Arg
 1 5 10 15

Asp Gly Glu Leu Gln Lys Val Ser Leu Glu Leu Leu Gly Lys Gly Lys
 20 25 30

Glu Met Ala Glu Lys Leu Gly Val Glu Leu Thr Ala Val Leu Leu Gly
 35 40 45

His Asn Thr Glu Lys Met Ser Lys Asp Leu Leu Ser His Gly Ala Asp
 50 55 60

Lys Val Leu Ala Ala Asp Asn Glu Leu Leu Ala His Phe Ser Thr Asp
 65 70 75 80

Gly Tyr Ala Lys Val Ile Cys Asp Leu Val Asn Glu Arg Lys Pro Glu
 85 90 95

Ile Leu Phe Ile Gly Ala Thr Phe Ile Gly Arg Asp Leu Gly Pro Arg
 100 105 110

Ile Ala Ala Arg Leu Ser Thr Gly Leu Thr Ala Asp Cys Thr Ser Leu
 115 120 125

Asp Ile Asp Val Glu Asn Arg Asp Leu Leu Ala Thr Arg Pro Ala Phe
 130 135 140

Gly Gly Asn Leu Ile Ala Thr Ile Val Cys Ser Asp His Arg Pro Gln
145 150 155 160

Met Ala Thr Val Arg Pro Gly Val Phe Glu Lys Leu Pro Val Asn Asp
165 170 175

Ala Asn Val Ser Asp Asp Lys Ile Glu Lys Val Ala Ile Lys Leu Thr
180 185 190

Ala Ser Asp Ile Arg Thr Lys Val Ser Lys Val Val Lys Leu Ala Lys
195 200 205

Asp Ile Ala Asp Ile Gly Glu Ala Lys Val Leu Val Ala Gly Gly Arg
210 215 220

Gly Val Gly Ser Lys Glu Asn Phe Glu Lys Leu Glu Glu Leu Ala Ser
225 230 235 240

Leu Leu Gly Gly Thr Ile Ala Ala Ser Arg Ala Ala Ile Glu Lys Glu
245 250 255

Trp Val Asp Lys Asp Leu Gln Val Gly Gln Thr Gly Lys Thr Val Arg
260 265 270

Pro Thr Leu Tyr Ile Ala Cys Gly Ile Ser Gly Ala Ile Gln His Leu
275 280 285

Ala Gly Met Gln Asp Ser Asp Tyr Ile Ile Ala Ile Asn Lys Asp Val
290 295 300

Glu Ala Pro Ile Met Lys Val Ala Asp Leu Ala Ile Val Gly Asp Val
305 310 315 320

Asn Lys Val Val Pro Glu Leu Ile Ala Gln Val Lys Ala Ala Asn Asn
325 330 335

<210> 24

<211> 1011

<212> DNA

<213> Clostridium acetobutylicum

<400> 24

atgaataaag cagattacaa gggcgtatgg gtgtttgctg aacaaagaga cggagaatta 60

caaaaggtat cattggaatt attaggtaaa ggtaaggaaa tggctgagaa attaggcgtt 120
 gaattaacag ctgttttact tggacataat actgaaaaaa tgtcaaagga tttattatct 180
 catggagcag ataaggtttt agcagcagat aatgaacttt tagcacattt ttcaacagat 240
 ggatatgcta aagttatatg tgatttagtt aatgaaagaa agccagaaat attattcata 300
 ggagctactt tcataggaag agatttagga ccaagaatag cagcaagact ttctactggt 360
 ttaactgctg attgtacatc acttgacata gatgtagaaa atagagattt attggctaca 420
 agaccagcgt ttggtggaaa ttgatagct acaatagttt gttcagacca cagaccacaa 480
 atggctacag taagacctgg tgtgtttgaa aaattacctg ttaatgatgc aaatgtttct 540
 gatgataaaa tagaaaaagt tgcaatataa ttaacagcat cagacataag aacaaaagtt 600
 tcaaaagttg ttaagcttgc taaagatatt gcagatatcg gagaagctaa ggtattagtt 660
 gctggtggta gaggagtgg aagcaaagaa aactttgaaa aacttgaaga gtttagcaagt 720
 ttacttggtg gaacaatagc cgcttcaaga gcagcaatag aaaaagaatg ggttgataag 780
 gaccttcaag taggtcaaac tggtaaaact gtaagaccaa ctctttatat tgcattgtgt 840
 atatcaggag ctatccagca tttagcaggt atgcaagatt cagattacat aattgctata 900
 aataaagatg tagaagcccc aataatgaag gtagcagatt tggctatagt tggatgata 960
 aataaagttg taccagaatt aatagctcaa gttaaagctg ctaataatta a 1011

<210> 25

<211> 336

<212> PRT

<213> Clostridium acetobutylicum

<400> 25

Met Asn Lys Ala Asp Tyr Lys Gly Val Trp Val Phe Ala Glu Gln Arg
 1 5 10 15

Asp Gly Glu Leu Gln Lys Val Ser Leu Glu Leu Leu Gly Lys Gly Lys
 20 25 30

Glu Met Ala Glu Lys Leu Gly Val Glu Leu Thr Ala Val Leu Leu Gly
 35 40 45

His Asn Thr Glu Lys Met Ser Lys Asp Leu Leu Ser His Gly Ala Asp
 50 55 60

Lys Val Leu Ala Ala Asp Asn Glu Leu Leu Ala His Phe Ser Thr Asp
65 70 75 80

Gly Tyr Ala Lys Val Ile Cys Asp Leu Val Asn Glu Arg Lys Pro Glu
85 90 95

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

Ile Ala Ala Arg Leu Ser Thr Gly Leu Thr Ala Asp Cys Thr Ser Leu
115 120 125

Asp Ile Asp Val Glu Asn Arg Asp Leu Leu Ala Thr Arg Pro Ala Phe
130 135 140

Gly Gly Asn Leu Ile Ala Thr Ile Val Cys Ser Asp His Arg Pro Gln
145 150 155 160

Met Ala Thr Val Arg Pro Gly Val Phe Glu Lys Leu Pro Val Asn Asp
165 170 175

Ala Asn Val Ser Asp Asp Lys Ile Glu Lys Val Ala Ile Lys Leu Thr
180 185 190

Ala Ser Asp Ile Arg Thr Lys Val Ser Lys Val Val Lys Leu Ala Lys
195 200 205

Asp Ile Ala Asp Ile Gly Glu Ala Lys Val Leu Val Ala Gly Gly Arg
210 215 220

Gly Val Gly Ser Lys Glu Asn Phe Glu Lys Leu Glu Glu Leu Ala Ser
225 230 235 240

Leu Leu Gly Gly Thr Ile Ala Ala Ser Arg Ala Ala Ile Glu Lys Glu
245 250 255

Trp Val Asp Lys Asp Leu Gln Val Gly Gln Thr Gly Lys Thr Val Arg
260 265 270

Pro Thr Leu Tyr Ile Ala Cys Gly Ile Ser Gly Ala Ile Gln His Leu

275

280

285

Ala Gly Met Gln Asp Ser Asp Tyr Ile Ile Ala Ile Asn Lys Asp Val
 290 295 300

Glu Ala Pro Ile Met Lys Val Ala Asp Leu Ala Ile Val Gly Asp Val
 305 310 315 320

Asn Lys Val Val Pro Glu Leu Ile Ala Gln Val Lys Ala Ala Asn Asn
 325 330 335

<210> 26

<211> 1011

<212> DNA

<213> Clostridium acetobutylicum

<400> 26

atgaataaag cagattacaa gggcgtatgg gtgtttgctg aacaaagaga cggagaatta 60

caaaaggat cattggaatt attaggtaaa ggtaaggaaa tggctgagaa attaggcgtt 120

gaattaacag ctgttttact tggacataat actgaaaaaa tgtcaaagga tttattatct 180

catggagcag ataagggttt agcagcagat aatgaacttt tagcacattt ttcaacagat 240

ggatatgcta aagtatatg tgatttagtt aatgaaagaa agccagaaat attattcata 300

ggagctactt tcgtaggaag agatttagga ccaagaatag cagcaagact ttctactggt 360

ttaactgctg attgtacatc acttgacata gatgtagaaa atagagattt attggctaca 420

agaccagcgt ttggtggaaa ttgatagct acaatagttt gttcagacca cagaccacaa 480

atggctacag taagacctgg tgtgtttgaa aaattacctg ttaatgatgc aaatgtttct 540

gatgataaaa tagaaaaagt tgcaattaa ttaacagcat cagacataag aacaaaagtt 600

tcaaaagttg ttaagcttgc taaagatatt gcagatatcg gagaagctaa ggtattagtt 660

gctggtggtg gaggagttgg aagcaaagaa aactttgaaa aacttgaaga gtttagcaagt 720

ttacttggtg gaacaatagc cgcttcaaga gcagcaatag aaaaagaatg gggtgataag 780

gaccttcaag taggtcaaac tggtaaaact gtaagaccaa ctctttatat tgcattgtgt 840

atatcaggag ctatccagca tttagcaggt atgcaagatt cagattacat aattgctata 900

aataaagatg tagaagcccc aataatgaag gtagcagatt tggctatagt tggtagtgta 960

aataaagttg taccagaatt aatagctcaa gttaaagctg ctaataatta a 1011

<210> 27
<211> 2364
<212> DNA
<213> Clostridium butyricum

<400> 27

atgataagta aaggatttag tacccaaca gaaagaataa atattttaa ggctcaaata 60
ttaaagtcta aaccatgtgt tgaatcagaa agagcaatat taataacaga atcatttaa 120
caaacagaag gccagccagc aattttaaga agagcattgg cattgaaaca catacttgaa 180
aatatcccta taacaattag agatcaagaa cttatagtgg gaagttaac taaagaacca 240
aggcttcac aagtatttcc tgagtcttct aataagtggt tacaagatga attggataga 300
ttaataaga gaactggaga tgattccaa attcagaag aaagtaaaga aaaattaaaa 360
gatgtcttg agtattggaa tggaaagaca acaagttagt tagcaactc atatagaca 420
gaggaaacaa gagaggcagt aaattgtgat gtatttactg taggaaacta ctattataat 480
ggcgtaggac atgtatctgt agattatgga aaagtattaa gggttggatt taatgggatt 540
ataaatgagg ctaaggaaca attagaaaaa aacaggagta tagatcctga tttataaag 600
aaagaaaaat tcctaaatag tggtattatc tcatgcaag ctgcaataac atatgtaaat 660
agatatgcta aaaaggctaa agagattgca gataatacaa gtgatgcaa aagaaaagct 720
gaattaaatg aaatagcaaa aattgttca aaagttcag gagagggagc taaatcttc 780
tatgaagcat gtcaattatt ttggttatt catgcaataa taaatataga atctaattga 840
cattctatt ctccagctag attgatcaa tacatgtatc catattatga aaatgataaa 900
aatataacag ataagttgc tcaagaatta atagattgta tctggattaa attaatgat 960
attaataaag taagagatga gatttcaact aaacatttg gtggttacc aatgatcaa 1020
aacttaattg ttgggggtca aaattcagaa ggaaaagatg caactaataa agtatcatat 1080
atggcattag aagcagctgt ccatgtaaag ttgcctcagc catcttctg agtaagaata 1140
tggaataaga ctccagatga attttgctt agagcagcag aattaactag agaagggtta 1200
ggacttctg ctattataa tgatgaagtt attattccag cattagtct tagaggtctt 1260
acattagaag atgcaagaga ctacgaata attggatgtg tgaaccaca aaagccagga 1320
aaaacagaag gatggcatga ttcagcattc ttaattctg caagaatagt agagttaact 1380
ataaattctg gatttgataa aaataaacag attggaccta aaactcaaaa tttgaagaa 1440

atgaaatcct ttgatgaatt catgaaagct tataaagctc aaatggagta ttttgtaaaa 1500
 catatgtgct gtgctgataa ttgcatagat attgcacatg cagaaagagc tccattacct 1560
 ttcttgcacat caatgggtga taattgtatc ggaaaaggaa agagccttca agatgggtgt 1620
 gcagaatata acttcagtg accacaaggt gttggagtag ctaatattgg agattcatta 1680
 gttgcagtta aaaaaattgt gtttgatgaa aataagatta ctccttcaga attaaagaaa 1740
 acattaaata atgattttaa aaattcagaa gaaatacaag ccttactaaa aaatgctcct 1800
 aagtttgaa atgatattga tgaagttgat aatttagcta gagagggtgc attagtatac 1860
 tgtagagaag ttaataaata tacaaatcca aggggaggaa attttcaacc aggattatat 1920
 ccatcttcaa ttaatgtata ttttgaagc ttaacaggtg ctactccaga tggaaggaaa 1980
 tccggacaac cattagctga tggggtttct ccatcaagag gctgtgatgt atctggacct 2040
 actgcagctt gtaactcagt tagtaatta gatcatttta tagcttcaa tggaacttta 2100
 tttaatcaaa aattccatcc gtcagcatta aaagtgata atggattaat gaatttatca 2160
 tcattaataa gaagttattt tgatcaaaag ggatttcattg ttcaatttaa tgtaatagat 2220
 aaaaaaatat tacttgcagc acaaaaaaat cctgaaaaat atcaagattt aattgttaga 2280
 gttgcaggat atagtgaca gttcatttct ttagataaat ctattcaaaa tgatattatt 2340
 gcaagaactg aacatgttat gtaa 2364

<210> 28
 <211> 915
 <212> DNA
 <213> Clostridium butyricum

<400> 28
 atgagtaagg agataaaagg cgttttattt aacatacaaa aattttcggt acatgatggg 60
 cctggaataa gaactatagt atttttaag ggatgttcaa tgcgtgctt atgggtgcagt 120
 aatccagaat cccaagatat taaacctcaa gtaatgttta ataaaaattt atgtacaaaa 180
 tgtggaagat gtaaatctca atgtaaaagt gcagctattg atatgaattc agaatatagg 240
 atagataaaa gcaaatgtac agagtgtaca aaatgtgttg ataattgctt aagcggggca 300
 ctgtttattg aaggaaggaa ttacagtgtt gaagacgtta taaaggaatt gaaaaagat 360
 agtgttcaat atagaagatc aaacggtgga attacactat ctggagggga agtattactt 420
 caaccagatt ttgcagtgga gcttttaaaa gagtgtaaat catatggctg gcacactgcc 480

attgaaacag caatgtatgt taatagtga tctgtaaaa aagtaattcc atatatagat 540
ctggctatga ttgatataaa aagtatgaat gatgaaatcc ataggaaatt tacaggagtg 600
agtaacgaaa taatattaca aaacattaaa ttaagtgatg aattagctaa agaaataata 660
atcagaattc ctgtaataga aggatttaat gcagatttac aaagtatagg agcaatagct 720
caattttcaa aatcattaac aaatcttaa agaatagatc ttctccata ccataattat 780
ggagaaaata agtatcaagc aattggaaga gagtattctt tgaaagaact aaaatcacct 840
agtaaagaca aaatggaaag attaaaagct ttagtgtgaa tcatgggaat accgtgcaca 900
attggagctg agtaa 915

<210> 29
<211> 1158
<212> DNA
<213> Clostridium butyricum

<400> 29
atgagaatgt atgattattt agtaccaagt gtaaacttta tgggagcaaa ttcagtatca 60
gtagtaggtg aaagatgcaa aatattaggt ggaaaaaaag cattgatagt tacagataag 120
tttctaaaag atatggaagg tggagctgtt gaattaacag ttaaattttt aaaagaagct 180
ggattagatg ttgtatatta tgacggagtt gaaccaaac caaagatgt taatgttata 240
gaaggattaa aaatatthaa agaagaaaat tgtgacatga tagtaactgt aggtggagga 300
agttcgcatg attgcggtaa gggaatagga attgctgcaa cacatgaagg agatctttat 360
gattatgcag gaatagaaac acttgtaac ccattgccac caatagtagc tgtaaatact 420
actgcaggaa ctgctagtga attaacctgt cattgtgtat tgactaatc aaaaaagaaa 480
ataaaatttg ttatagttag ctggagaaat tgcctctag tatctataaa tgatccaatg 540
cttatggta aaaaacctgc agattaaca gcagctacag gaatggatgc tttacacat 600
gcaatagaag catatgtatc aaaagatgca aatccagtaa cagatgcttc agcaatacaa 660
gctattaaat taatttcaca aaatttaaga caagctgtag ctttaggaga aaatcttgaa 720
gcaagagaaa atatggctta tgcattatta ctacgggaa tggcatttaa taatgctaatt 780
ttaggatatg tacatgcaat ggctcatcaa ttggggggac tgtatgatat gcctcatgga 840
gttgctaatt ctatgctatt accacatgtt gaacgttata atatgctatc aaatcctaag 900
aagtttgcatg atatagcaga atttatggga gaaaatatat ctggactttc tgtaatggaa 960

gcagcagaga aagccataaa tgcaatgttc aggctttcag aggatgttgg aattccgaaa 1020
 agtctaaagg agatgggagt gaaacaagaa gattttgagc atatggcaga actagctctt 1080
 ttagatggaa atgccttttag caatccaaga aaaggaaatg caaaagatat tataaatatt 1140
 tttaaggctg cttattaa 1158

<210> 30
 <211> 24
 <212> DNA
 <213> artificial

<220>
 <223> glpK oligo for PCR reaction and for Sanger sequencing

<400> 30
 ggagcaacat gtgtatcaac aacc 24

<210> 31
 <211> 21
 <212> DNA
 <213> artificial

<220>
 <223> glpK oligo for PCR reaction and for Sanger sequencing

<400> 31
 gcatccaata acacctgctc c 21

<210> 32
 <211> 19
 <212> DNA
 <213> artificial

<220>
 <223> glpK oligo for Sanger sequencing

<400> 32
 ggcaaagtcc atgtaaccg 19

<210> 33
 <211> 33
 <212> DNA
 <213> artificial

<220>
 <223> hydA oligo for PCR reaction and for Sanger sequencing

<400> 33
 catgttctat tgttactatg gaagaggtag tag 33

<210> 34
 <211> 29
 <212> DNA
 <213> artificial

 <220>
 <223> hydA oligo for PCR reaction and for Sanger sequencing

 <400> 34
 gcagttatta taaatgctgc tactagagc 29

<210> 35
 <211> 31
 <212> DNA
 <213> artificial

 <220>
 <223> hydA oligo for Sanger sequencing

 <400> 35
 cgtgaggttg acctccacca ttatacatc c 31

<210> 36
 <211> 21
 <212> DNA
 <213> artificial

 <220>
 <223> hydA oligo for Sanger sequencing

 <400> 36
 gtggacaatg ttctagaaga g 21

<210> 37
 <211> 19
 <212> DNA
 <213> artificial

 <220>
 <223> glpF oligo for PCR reaction

 <400> 37
 atgcattata gtttagctg 19

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

<220>
<223> glpF oligo for PCR reaction and for Sanger sequencing

<400> 38
cgtatttatg ttaacacagg 20

<210> 39
<211> 22
<212> DNA
<213> artificial

<220>
<223> glpF oligo for Sanger sequencing

<400> 39
ctgtgacaaa tccattata tg 22

<210> 40
<211> 22
<212> DNA
<213> artificial

<220>
<223> etfA oligo for PCR reaction and for Sanger sequencing

<400> 40
gaagttaaag gacagggaga ag 22

<210> 41
<211> 20
<212> DNA
<213> artificial

<220>
<223> etfA oligo for PCR reaction and for Sanger sequencing

<400> 41
gcaaatgcct gagaattcc 20

<210> 42
<211> 19
<212> DNA
<213> artificial

<220>
<223> gapC primer F

<400> 42
tgctgctgta agtatcatc 19

<210> 43
<211> 18
<212> DNA
<213> artificial

<220>
<223> gapC primer R

<400> 43
gttggaactg gaactctt 18

<210> 44
<211> 19
<212> DNA
<213> artificial

<220>
<223> cpn60 primer F

<400> 44
ttatatgtgc accgatatg 19

<210> 45
<211> 19
<212> DNA
<213> artificial

<220>
<223> cpn60 primer R

<400> 45
gagaagtctt gcgccggac 19

<210> 46
<211> 18
<212> DNA
<213> artificial

<220>
<223> tpi primer F

<400> 46
ccagcggat tagaagaa 18

<210> 47
<211> 24
<212> DNA
<213> artificial

<220>
<223> tpi primer R

<400> 47
gtcctataat tacataatga actc

24