

SEQUENCE LISTING

<110> DSM IP Assets B.V.
Raamsdonk, LM
van den Berg, MA
de Laat, WTAM

<120> Butanol production in a eukaryotic cell

<130> 25755WO

<140> 25755WO

<141> 2007-10-30

<160> 30

<170> PatentIn version 3.2

<210> 1

<211> 392

<212> PRT

<213> Clostridium acetobutylicum

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Tyr Gly Lys Ser Leu Lys Asp Val Pro Ala Val Asp Leu Gly Ala Thr
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Ala Ile Lys Glu Ala Val Lys Lys Ala Gly Ile Lys Pro Glu Asp Val
35 40 45

Asn Glu Val Ile Leu Gly Asn Val Leu Gln Ala Gly Leu Gly Gln Asn
50 55 60

Pro Ala Arg Gln Ala Ser Phe Lys Ala Gly Leu Pro Val Glu Ile Pro
65 70 75 80

Ala Met Thr Ile Asn Lys Val Cys Gly Ser Gly Leu Arg Thr Val Ser
85 90 95

Leu Ala Ala Gln Ile Ile Lys Ala Gly Asp Ala Asp Val Ile Ile Ala
100 105 110

Gly Gly Met Glu Asn Met Ser Arg Ala Pro Tyr Leu Ala Asn Asn Ala
115 120 125

Arg Trp Gly Tyr Arg Met Gly Asn Ala Lys Phe Val Asp Glu Met Ile
130 135 140

Thr Asp Gly Leu Trp Asp Ala Phe Asn Asp Tyr His Met Gly Ile Thr
145 150 155 160

Ala Glu Asn Ile Ala Glu Arg Trp Asn Ile Ser Arg Glu Glu Gln Asp
165 170 175

Glu Phe Ala Leu Ala Ser Gln Lys Lys Ala Glu Glu Ala Ile Lys Ser
180 185 190

Gly Gln Phe Lys Asp Glu Ile Val Pro Val Val Ile Lys Gly Arg Lys
195 200 205

Gly Glu Thr Val Val Asp Thr Asp Glu His Pro Arg Phe Gly Ser Thr
210 215 220

Ile Glu Gly Leu Ala Lys Leu Lys Pro Ala Phe Lys Lys Asp Gly Thr
225 230 235 240

Val Thr Ala Gly Asn Ala Ser Gly Leu Asn Asp Cys Ala Ala Val Leu
245 250 255

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

Ala Lys Ile Val Ser Tyr Gly Ser Ala Gly Val Asp Pro Ala Ile Met
275 280 285

Gly Tyr Gly Pro Phe Tyr Ala Thr Lys Ala Ala Ile Glu Lys Ala Gly
290 295 300

Trp Thr Val Asp Glu Leu Asp Leu Ile Glu Ser Asn Glu Ala Phe Ala
305 310 315 320

Ala Gln Ser Leu Ala Val Ala Lys Asp Leu Lys Phe Asp Met Asn Lys
325 330 335

Val Asn Val Asn Gly Gly Ala Ile Ala Leu Gly His Pro Ile Gly Ala
340 345 350

Ser Gly Ala Arg Ile Leu Val Thr Leu Val His Ala Met Gln Lys Arg
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Asp Ala Lys Lys Gly Leu Ala Thr Leu Cys Ile Gly Gly Gly Gln Gly
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Thr Ala Ile Leu Leu Glu Lys Cys

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<211> 1179

<212> DNA

<213> Clostridium acetobutylicum

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ttaggacaga atccagcaag acaggcatct tttaaagcag gattaccagt tgaaattcca      240
gctatgacta ttaataaggt ttgtggttca ggacttagaa cagttagctt agcagcacia      300
attataaaag caggagatgc tgacgtaata atagcaggtg gtatggaaaa tatgtctaga      360
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<213> Clostridium acetobutylicum

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Lys Asp Glu Phe Val Asp Arg Gly Leu Asp Phe Ile Asn Lys Asn Leu
35 40 45

Ser Lys Leu Val Lys Lys Gly Lys Ile Glu Glu Ala Thr Lys Val Glu
50 55 60

Ile Leu Thr Arg Ile Ser Gly Thr Val Asp Leu Asn Met Ala Ala Asp
65 70 75 80

Cys Asp Leu Val Ile Glu Ala Ala Val Glu Arg Met Asp Ile Lys Lys
85 90 95

Gln Ile Phe Ala Asp Leu Asp Asn Ile Cys Lys Pro Glu Thr Ile Leu
100 105 110

Ala Ser Asn Thr Ser Ser Leu Ser Ile Thr Glu Val Ala Ser Ala Thr
115 120 125

Lys Arg Pro Asp Lys Val Ile Gly Met His Phe Phe Asn Pro Ala Pro
130 135 140

Val Met Lys Leu Val Glu Val Ile Arg Gly Ile Ala Thr Ser Gln Glu
145 150 155 160

Thr Phe Asp Ala Val Lys Glu Thr Ser Ile Ala Ile Gly Lys Asp Pro
165 170 175

Val Glu Val Ala Glu Ala Pro Gly Phe Val Val Asn Arg Ile Leu Ile
180 185 190

Pro Met Ile Asn Glu Ala Val Gly Ile Leu Ala Glu Gly Ile Ala Ser
195 200 205

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

Gly Pro Leu Glu Leu Gly Asp Phe Ile Gly Leu Asp Ile Cys Leu Ala
225 230 235 240

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

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<212> DNA

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<213> Clostridium acetobutylicum

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 35 40 45

Val Leu Ala Val Ile Leu Thr Gly Ala Gly Glu Lys Ser Phe Val Ala
50 55 60

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

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

Glu Lys Pro Val Ile Ala Ala Val Asn Gly Phe Ala Leu Gly Gly Gly
100 105 110

Cys Glu Ile Ala Met Ser Cys Asp Ile Arg Ile Ala Ser Ser Asn Ala
115 120 125

Arg Phe Gly Gln Pro Glu Val Gly Leu Gly Ile Thr Pro Gly Phe Gly
130 135 140

Gly Thr Gln Arg Leu Ser Arg Leu Val Gly Met Gly Met Ala Lys Gln
145 150 155 160

Leu Ile Phe Thr Ala Gln Asn Ile Lys Ala Asp Glu Ala Leu Arg Ile
165 170 175

Gly Leu Val Asn Lys Val Val Glu Pro Ser Glu Leu Met Asn Thr Ala
180 185 190

Lys Glu Ile Ala Asn Lys Ile Val Ser Asn Ala Pro Val Ala Val Lys
195 200 205

Leu Ser Lys Gln Ala Ile Asn Arg Gly Met Gln Cys Asp Ile Asp Thr
210 215 220

Ala Leu Ala Phe Glu Ser Glu Ala Phe Gly Glu Cys Phe Ser Thr Glu
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Gly Phe Lys Asn Arg
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<213> Clostridium acetobutylicum

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<213> Clostridium acetobutylicum

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Glu Thr Glu Arg Phe Pro Met Glu Asn Val Lys Lys Met Gly Gln Tyr
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Gly Met Met Gly Ile Pro Phe Ser Lys Glu Tyr Gly Gly Ala Gly Gly
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Asp Val Leu Ser Tyr Ile Ile Ala Val Glu Glu Leu Ser Lys Val Cys
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Gly Thr Thr Gly Val Ile Leu Ser Ala His Thr Ser Leu Cys Ala Ser
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Leu Ile Asn Glu His Gly Thr Glu Glu Gln Lys Gln Lys Tyr Leu Val
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Pro Leu Ala Lys Gly Glu Lys Ile Gly Ala Tyr Gly Leu Thr Glu Pro
115 120 125

Asn Ala Gly Thr Asp Ser Gly Ala Gln Gln Thr Val Ala Val Leu Glu
130 135 140

Gly Asp His Tyr Val Ile Asn Gly Ser Lys Ile Phe Ile Thr Asn Gly
145 150 155 160

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

Gly Thr Lys Gly Ile Ser Ala Phe Ile Ile Glu Lys Gly Phe Lys Gly
180 185 190

Phe Ser Ile Gly Lys Val Glu Gln Lys Leu Gly Ile Arg Ala Ser Ser
195 200 205

Thr Thr Glu Leu Val Phe Glu Asp Met Ile Val Pro Val Glu Asn Met
210 215 220

Ile Gly Lys Glu Gly Lys Gly Phe Pro Ile Ala Met Lys Thr Leu Asp
225 230 235 240

Gly Gly Arg Ile Gly Ile Ala Ala Gln Ala Leu Gly Ile Ala Glu Gly
245 250 255

Ala Phe Asn Glu Ala Arg Ala Tyr Met Lys Glu Arg Lys Gln Phe Gly
260 265 270

Arg Ser Leu Asp Lys Phe Gln Gly Leu Ala Trp Met Met Ala Asp Met
275 280 285

Asp Val Ala Ile Glu Ser Ala Arg Tyr Leu Val Tyr Lys Ala Ala Tyr
290 295 300

Leu Lys Gln Ala Gly Leu Pro Tyr Thr Val Asp Ala Ala Arg Ala Lys
305 310 315 320

Leu His Ala Ala Asn Val Ala Met Asp Val Thr Thr Lys Ala Val Gln
325 330 335

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

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Gln Lys Leu Val Ile Ser Gly Lys Ile Phe Arg
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 <212> DNA
 <213> Clostridium acetobutylicum

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 <212> PRT

<213> Clostridium acetobutylicum

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Lys Ile Phe Lys Gln Cys Ala Ile Ala Ala Ala Lys Glu Arg Ile Asn
35 40 45

Leu Ala Lys Leu Ala Val Glu Glu Thr Gly Ile Gly Leu Val Glu Asp
50 55 60

Lys Ile Ile Lys Asn His Phe Ala Ala Glu Tyr Ile Tyr Asn Lys Tyr
65 70 75 80

Lys Asn Glu Lys Thr Cys Gly Ile Ile Asp His Asp Asp Ser Leu Gly
85 90 95

Ile Thr Lys Val Ala Glu Pro Ile Gly Ile Val Ala Ala Ile Val Pro
100 105 110

Thr Thr Asn Pro Thr Ser Thr Ala Ile Phe Lys Ser Leu Ile Ser Leu
115 120 125

Lys Thr Arg Asn Ala Ile Phe Phe Ser Pro His Pro Arg Ala Lys Lys
130 135 140

Ser Thr Ile Ala Ala Ala Lys Leu Ile Leu Asp Ala Ala Val Lys Ala
145 150 155 160

Gly Ala Pro Lys Asn Ile Ile Gly Trp Ile Asp Glu Pro Ser Ile Glu
165 170 175

Leu Ser Gln Asp Leu Met Ser Glu Ala Asp Ile Ile Leu Ala Thr Gly
180 185 190

Gly Pro Ser Met Val Lys Ala Ala Tyr Ser Ser Gly Lys Pro Ala Ile
195 200 205

Gly Val Gly Ala Gly Asn Thr Pro Ala Ile Ile Asp Glu Ser Ala Asp
210 215 220

Ile Asp Met Ala Val Ser Ser Ile Ile Leu Ser Lys Thr Tyr Asp Asn

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

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Ile Thr Lys Val Leu Asp Glu Ile Asp Ile Lys Tyr Ser Ile Phe Thr
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Asp Ile Lys Ser Asp Pro Thr Ile Asp Ser Val Lys Lys Gly Ala Lys
515 520 525

Glu Met Leu Asn Phe Glu Pro Asp Thr Ile Ile Ser Ile Gly Gly Gly
530 535 540

Ser Pro Met Asp Ala Ala Lys Val Met His Leu Leu Tyr Glu Tyr Pro
545 550 555 560

Glu Ala Glu Ile Glu Asn Leu Ala Ile Asn Phe Met Asp Ile Arg Lys
565 570 575

Arg Ile Cys Asn Phe Pro Lys Leu Gly Thr Lys Ala Ile Ser Val Ala
580 585 590

Ile Pro Thr Thr Ala Gly Thr Gly Ser Glu Ala Thr Pro Phe Ala Val
595 600 605

Ile Thr Asn Asp Glu Thr Gly Met Lys Tyr Pro Leu Thr Ser Tyr Glu
610 615 620

Leu Thr Pro Asn Met Ala Ile Ile Asp Thr Glu Leu Met Leu Asn Met
625 630 635 640

Pro Arg Lys Leu Thr Ala Ala Thr Gly Ile Asp Ala Leu Val His Ala
645 650 655

Ile Glu Ala Tyr Val Ser Val Met Ala Thr Asp Tyr Thr Asp Glu Leu
660 665 670

Ala Leu Arg Ala Ile Lys Met Ile Phe Lys Tyr Leu Pro Arg Ala Tyr
675 680 685

Lys Asn Gly Thr Asn Asp Ile Glu Ala Arg Glu Lys Met Ala His Ala
690 695 700

Ser Asn Ile Ala Gly Met Ala Phe Ala Asn Ala Phe Leu Gly Val Cys
705 710 715 720

His Ser Met Ala His Lys Leu Gly Ala Met His His Val Pro His Gly
725 730 735

Ile Ala Cys Ala Val Leu Ile Glu Glu Val Ile Lys Tyr Asn Ala Thr
740 745 750

Asp Cys Pro Thr Lys Gln Thr Ala Phe Pro Gln Tyr Lys Ser Pro Asn
755 760 765

Ala Lys Arg Lys Tyr Ala Glu Ile Ala Glu Tyr Leu Asn Leu Lys Gly
770 775 780

Thr Ser Asp Thr Glu Lys Val Thr Ala Leu Ile Glu Ala Ile Ser Lys
785 790 795 800

Leu Lys Ile Asp Leu Ser Ile Pro Gln Asn Ile Ser Ala Ala Gly Ile
805 810 815

Asn Lys Lys Asp Phe Tyr Asn Thr Leu Asp Lys Met Ser Glu Leu Ala
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Phe Asp Asp Gln Cys Thr Thr Ala Asn Pro Arg Tyr Pro Leu Ile Ser
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Glu Leu Lys Asp Ile Tyr Ile Lys Ser Phe
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<212> DNA
<213> Clostridium acetobutylicum

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<210> 11
 <211> 862
 <212> PRT
 <213> Clostridium acetobutylicum

<400> 11

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 20 25 30

Glu Ile Phe Arg Asn Ala Ala Met Ala Ala Ile Asp Ala Arg Ile Glu
 35 40 45

Leu Ala Lys Ala Ala Val Leu Glu Thr Gly Met Gly Leu Val Glu Asp
 50 55 60

Lys Val Ile Lys Asn His Phe Ala Gly Glu Tyr Ile Tyr Asn Lys Tyr
 65 70 75 80

Lys Asp Glu Lys Thr Cys Gly Ile Ile Glu Arg Asn Glu Pro Tyr Gly
 85 90 95

Ile Thr Lys Ile Ala Glu Pro Ile Gly Val Val Ala Ala Ile Ile Pro
 100 105 110

Val Thr Asn Pro Thr Ser Thr Thr Ile Phe Lys Ser Leu Ile Ser Leu
 115 120 125

Lys Thr Arg Asn Gly Ile Phe Phe Ser Pro His Pro Arg Ala Lys Lys
 130 135 140

Ser Thr Ile Leu Ala Ala Lys Thr Ile Leu Asp Ala Ala Val Lys Ser
 145 150 155 160

Gly Ala Pro Glu Asn Ile Ile Gly Trp Ile Asp Glu Pro Ser Ile Glu
 165 170 175

Leu Thr Gln Tyr Leu Met Gln Lys Ala Asp Ile Thr Leu Ala Thr Gly
 180 185 190

Gly Pro Ser Leu Val Lys Ser Ala Tyr Ser Ser Gly Lys Pro Ala Ile
195 200 205

Gly Val Gly Pro Gly Asn Thr Pro Val Ile Ile Asp Glu Ser Ala His
210 215 220

Ile Lys Met Ala Val Ser Ser Ile Ile Leu Ser Lys Thr Tyr Asp Asn
225 230 235 240

Gly Val Ile Cys Ala Ser Glu Gln Ser Val Ile Val Leu Lys Ser Ile
245 250 255

Tyr Asn Lys Val Lys Asp Glu Phe Gln Glu Arg Gly Ala Tyr Ile Ile
260 265 270

Lys Lys Asn Glu Leu Asp Lys Val Arg Glu Val Ile Phe Lys Asp Gly
275 280 285

Ser Val Asn Pro Lys Ile Val Gly Gln Ser Ala Tyr Thr Ile Ala Ala
290 295 300

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

Val Thr Ser Leu Gly Glu Glu Glu Pro Phe Ala His Glu Lys Leu Ser
325 330 335

Pro Val Leu Ala Met Tyr Glu Ala Asp Asn Phe Asp Asp Ala Leu Lys
340 345 350

Lys Ala Val Thr Leu Ile Asn Leu Gly Gly Leu Gly His Thr Ser Gly
355 360 365

Ile Tyr Ala Asp Glu Ile Lys Ala Arg Asp Lys Ile Asp Arg Phe Ser
370 375 380

Ser Ala Met Lys Thr Val Arg Thr Phe Val Asn Ile Pro Thr Ser Gln
385 390 395 400

Gly Ala Ser Gly Asp Leu Tyr Asn Phe Arg Ile Pro Pro Ser Phe Thr
405 410 415

Leu Gly Cys Gly Phe Trp Gly Gly Asn Ser Val Ser Glu Asn Val Gly
420 425 430

Pro Lys His Leu Leu Asn Ile Lys Thr Val Ala Glu Arg Arg Glu Asn
435 440 445

Met Leu Trp Phe Arg Val Pro His Lys Val Tyr Phe Lys Phe Gly Cys
450 455 460

Leu Gln Phe Ala Leu Lys Asp Leu Lys Asp Leu Lys Lys Lys Arg Ala
465 470 475 480

Phe Ile Val Thr Asp Ser Asp Pro Tyr Asn Leu Asn Tyr Val Asp Ser
485 490 495

Ile Ile Lys Ile Leu Glu His Leu Asp Ile Asp Phe Lys Val Phe Asn
500 505 510

Lys Val Gly Arg Glu Ala Asp Leu Lys Thr Ile Lys Lys Ala Thr Glu
515 520 525

Glu Met Ser Ser Phe Met Pro Asp Thr Ile Ile Ala Leu Gly Gly Thr
530 535 540

Pro Glu Met Ser Ser Ala Lys Leu Met Trp Val Leu Tyr Glu His Pro
545 550 555 560

Glu Val Lys Phe Glu Asp Leu Ala Ile Lys Phe Met Asp Ile Arg Lys
565 570 575

Arg Ile Tyr Thr Phe Pro Lys Leu Gly Lys Lys Ala Met Leu Val Ala
580 585 590

Ile Thr Thr Ser Ala Gly Ser Gly Ser Glu Val Thr Pro Phe Ala Leu
595 600 605

Val Thr Asp Asn Asn Thr Gly Asn Lys Tyr Met Leu Ala Asp Tyr Glu
610 615 620

Met Thr Pro Asn Met Ala Ile Val Asp Ala Glu Leu Met Met Lys Met
625 630 635 640

Pro Lys Gly Leu Thr Ala Tyr Ser Gly Ile Asp Ala Leu Val Asn Ser
645 650 655

Ile Glu Ala Tyr Thr Ser Val Tyr Ala Ser Glu Tyr Thr Asn Gly Leu
660 665 670

Ala Leu Glu Ala Ile Arg Leu Ile Phe Lys Tyr Leu Pro Glu Ala Tyr
675 680 685

Lys Asn Gly Arg Thr Asn Glu Lys Ala Arg Glu Lys Met Ala His Ala
690 695 700

Ser Thr Met Ala Gly Met Ala Ser Ala Asn Ala Phe Leu Gly Leu Cys
705 710 715 720

His Ser Met Ala Ile Lys Leu Ser Ser Glu His Asn Ile Pro Ser Gly
725 730 735

Ile Ala Asn Ala Leu Leu Ile Glu Glu Val Ile Lys Phe Asn Ala Val
740 745 750

Asp Asn Pro Val Lys Gln Ala Pro Cys Pro Gln Tyr Lys Tyr Pro Asn
755 760 765

Thr Ile Phe Arg Tyr Ala Arg Ile Ala Asp Tyr Ile Lys Leu Gly Gly
770 775 780

Asn Thr Asp Glu Glu Lys Val Asp Leu Leu Ile Asn Lys Ile His Glu
785 790 795 800

Leu Lys Lys Ala Leu Asn Ile Pro Thr Ser Ile Lys Asp Ala Gly Val
805 810 815

Leu Glu Glu Asn Phe Tyr Ser Ser Leu Asp Arg Ile Ser Glu Leu Ala
820 825 830

Leu Asp Asp Gln Cys Thr Gly Ala Asn Pro Arg Phe Pro Leu Thr Ser
835 840 845

Glu Ile Lys Glu Met Tyr Ile Asn Cys Phe Lys Lys Gln Pro
850 855 860

<210> 12
<211> 2589
<212> DNA
<213> Clostridium acetobutylicum

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gcagcaatcg acgcaaggat agagctagca aaagcagctg ttttggaac cggtatgggc 180
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aaggatgaaa aaacctgcgg tataattgaa cgaaatgaac cctacggaat tacaaaaata	300
gcagaaccta taggagttgt agctgctata atccctgtaa caaacccac atcaacaaca	360
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caaccttaa 2589

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<210> 13
<211> 389
<212> PRT
<213> Clostridium acetobutylicum
<400> 13

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Met Leu Ser Phe Asp Tyr Ser Ile Pro Thr Lys Val Phe Phe Gly Lys
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Gly Lys Ile Asp Val Ile Gly Glu Glu Ile Lys Lys Tyr Gly Ser Arg
          20          25          30

```

```

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

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Asp Arg Ala Thr Ala Ile Leu Lys Glu Asn Asn Ile Ala Phe Tyr Glu
          50          55          60

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Leu Ser Gly Val Glu Pro Asn Pro Arg Ile Thr Thr Val Lys Lys Gly
65          70          75          80

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

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Gly Gly Ser Ala Ile Asp Cys Ser Lys Val Ile Ala Ala Gly Val Tyr
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Tyr Asp Gly Asp Thr Trp Asp Met Val Lys Asp Pro Ser Lys Ile Thr
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Lys Val Leu Pro Ile Ala Ser Ile Leu Thr Leu Ser Ala Thr Gly Ser

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130

135

140

Glu Met Asp Gln Ile Ala Val Ile Ser Asn Met Glu Thr Asn Glu Lys
 145 150 155 160

Leu Gly Val Gly His Asp Asp Met Arg Pro Lys Phe Ser Val Leu Asp
 165 170 175

Pro Thr Tyr Thr Phe Thr Val Pro Lys Asn Gln Thr Ala Ala Gly Thr
 180 185 190

Ala Asp Ile Met Ser His Thr Phe Glu Ser Tyr Phe Ser Gly Val Glu
 195 200 205

Gly Ala Tyr Val Gln Asp Gly Ile Ala Glu Ala Ile Leu Arg Thr Cys
 210 215 220

Ile Lys Tyr Gly Lys Ile Ala Met Glu Lys Thr Asp Asp Tyr Glu Ala
 225 230 235 240

Arg Ala Asn Leu Met Trp Ala Ser Ser Leu Ala Ile Asn Gly Leu Leu
 245 250 255

Ser Leu Gly Lys Asp Arg Lys Trp Ser Cys His Pro Met Glu His Glu
 260 265 270

Leu Ser Ala Tyr Tyr Asp Ile Thr His Gly Val Gly Leu Ala Ile Leu
 275 280 285

Thr Pro Asn Trp Met Glu Tyr Ile Leu Asn Asp Asp Thr Leu His Lys
 290 295 300

Phe Val Ser Tyr Gly Ile Asn Val Trp Gly Ile Asp Lys Asn Lys Asp
 305 310 315 320

Asn Tyr Glu Ile Ala Arg Glu Ala Ile Lys Asn Thr Arg Glu Tyr Phe
 325 330 335

Asn Ser Leu Gly Ile Pro Ser Lys Leu Arg Glu Val Gly Ile Gly Lys
 340 345 350

Asp Lys Leu Glu Leu Met Ala Lys Gln Ala Val Arg Asn Ser Gly Gly
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Thr Ile Gly Ser Leu Arg Pro Ile Asn Ala Glu Asp Val Leu Glu Ile
 370 375 380

Phe Lys Lys Ser Tyr
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<210> 14
<211> 1170
<212> DNA
<213> Clostridium acetobutylicum

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agtataaaaa ggaacgggat atatgataga gcaacagcta tattaaaaga aaacaatata 180
gctttctatg aactttcagg agtagagcca aatcctagga taacaacagt aaaaaaaggc 240
atagaaatat gtagagaaaa taatgtggat ttagtattag caataggggg aggaagtgc 300
atagactggt ctaaggtaat tgcagctgga gtttattatg atggcgatac atgggacatg 360
gttaaagatc catctaaaat aactaaagtt cttccaattg caagtatact tactctttca 420
gcaacagggg ctgaaatgga tcaaattgca gtaatttcaa atatggagac taatgaaaag 480
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tttacagtac ctaaaaatca aacagcagcg ggaacagctg acattatgag tcacaccttt 600
gaatcttact ttagtggtgt tgaaggtgct tatgtgcagg acggtatagc agaagcaatc 660
ttaagaacat gtataaagta tggaaaaata gcaatggaga agactgatga ttacgaggct 720
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gatagaaaat ggagttgtca tcctatggaa cacgagttaa gtgcatatta tgatataaca 840
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gttcttgaga tatttaaaaa atcttattaa 1170

<210> 15
<211> 390
<212> PRT
<213> Clostridium acetobutylicum

<400> 15

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

Thr Tyr Gly Lys Asp Thr Asn Trp Ser Val His Leu Met Glu His Glu
260 265 270

Leu Ser Ala Tyr Tyr Asp Ile Thr His Gly Val Gly Leu Ala Ile Leu
275 280 285

Thr Pro Asn Trp Met Glu Tyr Ile Leu Asn Asn Asp Thr Val Tyr Lys
290 295 300

Phe Val Glu Tyr Gly Val Asn Val Trp Gly Ile Asp Lys Glu Lys Asn
305 310 315 320

His Tyr Asp Ile Ala His Gln Ala Ile Gln Lys Thr Arg Asp Tyr Phe
325 330 335

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

Glu Glu Lys Leu Asp Ile Met Ala Lys Glu Ser Val Lys Leu Thr Gly
355 360 365

Gly Thr Ile Gly Asn Leu Arg Pro Val Asn Ala Ser Glu Val Leu Gln
370 375 380

Ile Phe Lys Lys Ser Val
385 390

<210> 16

<211> 1173

<212> DNA

<213> Clostridium acetobutylicum

<400> 16

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aaattttatg aacttgcagg agtagagcca aatccaagag taactacagt tgaaaaagga	240
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atagattgcg caaagggttat agcagcagca tgtgaatatg atggaaatcc atgggatatt	360
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gcaacaggat cagaaatgga tacgtgggca gtaataaata atatggatac aaacgaaaaa	480
ctaattgcfg cacatccaga tatggctcct aagttttcta tattagatcc aacgtatacg	540

tataccgtac ctaccaatca aacagcagca ggaacagctg atattatgag tcatatattt	600
gaggtgtatt ttagtaatac aaaaacagca tatttgcagg atagaatggc agaagcgta	660
ttaagaactt gtattaaata tggaggaata gctcttgaga agccggatga ttatgaggca	720
agagccaatc taatgtgggc ttcaagtctt gcgataaatg gacttttaac atatggtaaa	780
gacactaatt ggagtgtaca cttaatggaa catgaattaa gtgcttatta cgacataaca	840
cacggcgtag ggcttgcaat tttaacacct aattggatgg agtatatttt aaataatgat	900
acagtgtaca agtttgttga atatggtgta aatgtttggg gaatagacaa agaaaaaat	960
cactatgaca tagcacatca agcaatacaa aaaacaagag attactttgt aaatgtacta	1020
ggtttaccat ctagactgag agatgttgga attgaagaag aaaaattgga cataatggca	1080
aaggaatcag taaagcttac aggaggaacc ataggaaacc taagaccagt aaacgcctcc	1140
gaagtcctac aaatattcaa aaaatctgtg taa	1173

<210> 17
 <211> 1179
 <212> DNA
 <213> Artificial sequence

<220>
 <223> Codon pair opt thil gene counterclockwise

<400> 17	
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acccttcttg gcatcacgct tttgcatagc gtggactaaa gtaaccaaga ttctggcacc	120
ggaagcacca attgggtgac ccaaagcaat ggcaccaccg ttaacgttga ccttgttcat	180
gtcgaatttc aagtccttgg caacagccaa agattgagca gcgaaagctt cgttggattc	240
aatcaaattc aattcgtcaa cggccaacc agccttttcg atagcagcct tggtagcgta	300
gaaaggaccg taaccocatga tggctgggtc aacaccagca gaaccgtagg agacaatctt	360
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accagcaatg atgacatcag cgtcaccagc cttgatgatt tgagcagcca aagaaacagt	900
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agccttgaaa gaagcttgac gagctgggtt ttgacctaaa ccagcttgca aaacggtacc	1020
taagataact tcgttaacat cttctggctt gataccagcc ttcttgacag cttccttgat	1080
ggcggtagca cccaagtcca cagctgggac gtccttcaaa gacttaccgt aagaaccaat	1140
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<210> 18
 <211> 850
 <212> DNA
 <213> Artificial sequence

<220>
 <223> codon pair opt hbd gene

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taccaaggtc gaaatcttga ccagaatctc cgggtactgtt gacttgaaca tggctgctga	240
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catcactgaa gttgcttctg ctaccaagag accagacaag gttatcggta tgcacttctt	420
caaccagct ccagtcata agttggtcga agtcatacaga ggtattgcca cctctcaaga	480
aactttcgat gctgtcaagg aaacttccat tgccattgggt aaggaccag ttgaagttgc	540
tgaagctcca ggtttcgttg tcaacagaat cttgattcca atgatcaacg aagctgtcgg	600
tattttggct gaaggatttg cttctgttga agatatcgac aaggccatga aattgggtgc	660
taaccacca atgggtccat tggaattagg tgacttcata ggtttggata tctgtttggc	720
catcatggat gtcttatact ctgaaaccgg tgactctaag tacagacctc acactttatt	780
gaagaagtac gttagagctg gttggttagg tagaaagtct ggtaagggtt tctacgacta	840
ctccaaatag	850

<210> 19
 <211> 789
 <212> DNA
 <213> Artificial sequence

<220>
 <223> Codon pair opt crt gene counterclockwise

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 gtcgatatca cattgcatac ctctgttgat ggcttgcttg gacaatttga cagcaactgg 180
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 aatttcacca atgacgtagt ccatttcctt caaagtgtca gaggttcaaag cattcaaagc 720
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<210> 20
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<220>
 <223> codon pair opt bcd gene

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<210> 21
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 <212> DNA
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<220>
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<210> 22

<211> 2589

<212> DNA

<213> Artificial sequence

<220>

<223> Codon pair opt adhE1 gene

<400> 22

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 <212> DNA
 <213> Artificial sequence

<220>
 <223> codon pair opt bdhA gene

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 <212> DNA
 <213> Artificial sequence

<220>
 <223> Codon pair opt bdhB gene

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<210> 25
<211> 290
<212> DNA
<213> Artificial sequence

<220>
<223> Promotor gal7

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cgaaggactg gctatacagt gttcacaaaa tagccaagct gaaaataatg tgtagctatg 180
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atgcagagca tcaacatgat aaaaaaaaaac agttgaatat tccctcaaaa 290

<210> 26
<211> 348
<212> DNA
<213> Artificial sequence

<220>
<223> terminator Gal7

<400> 26
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<220>
<223> terminator Gal10 counterclockwise

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<220>
 <223> Promotor Gal10 counterclockwise

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<210> 29
 <211> 300
 <212> DNA
 <213> Artificial sequence

<220>
 <223> Promotor Gal1

<400> 29	
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<210> 30
 <211> 347
 <212> DNA
 <213> Artificial sequence

<220>
 <223> Terminator Gal1

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