

SEQUENCE LISTING

<110> Bonumose LLC

<120> Enzymatic Production of Hexoses

<130> 146.0004-W000

<150> 62/470,605

<151> 2017-03-13

<150> 62/470,620

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<151> 2017-04-03

<160> 21

<170> PatentIn version 3.5

<210> 1

<211> 149

<212> PRT

<213> Clostridium thermocellum

<400> 1

Met Lys Ile Gly Ile Gly Ser Asp His Gly Gly Tyr Asn Leu Lys Arg
1 5 10 15

Glu Ile Ile Asp Phe Leu Lys Lys Arg Glu Tyr Glu Val Ile Asp Phe
20 25 30

Gly Thr Tyr Gly Thr Asp Ser Val Asp Tyr Pro Asp Phe Gly Leu Lys
35 40 45

Val Ala Glu Ala Val Lys Gly Gly Glu Cys Asp Arg Gly Ile Val Val
50 55 60

Cys Gly Thr Gly Val Gly Ile Ser Ile Ser Ala Asn Lys Val Pro Gly
65 70 75 80

Ile Arg Ala Ala Val Cys Thr Asn Ser Tyr Met Ala Arg Met Ser Arg
85 90 95

Glu His Asn Asp Ala Asn Ile Leu Ala Leu Gly Glu Arg Val Val Gly
100 105 110

Leu Asp Leu Ala Leu Asp Ile Val Asp Thr Trp Leu Lys Ala Glu Phe
115 120 125

Gln Gly Gly Arg His Ser Ala Arg Val Gly Lys Ile Gly Glu Ile Glu
130 135 140

Glu Lys Tyr Ser Lys
145

<210> 2
<211> 154
<212> PRT
<213> Symbiobacterium thermophilum

<400> 2

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

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

Gly Thr Asp Ser Thr Glu Arg Thr Asp Tyr Pro Ile Tyr Gly Glu Arg
35 40 45

Val Ala Arg Ala Val Ala Ala Gly Glu Val Asp Cys Gly Ile Leu Ile
50 55 60

Cys Gly Thr Gly Val Gly Ile Ser Leu Ala Ala Asn Lys Val Arg Gly
65 70 75 80

Ile Arg Ala Val Val Cys Ser Glu Pro Tyr Thr Ala Arg Leu Ser Lys
85 90 95

Gln His Asn Asn Thr Asn Ile Leu Ala Phe Gly Ala Arg Val Val Gly
100 105 110

Val Asp Leu Ala Lys Met Ile Val Asp Glu Trp Leu Asn Ala Ser Phe
115 120 125

Glu Gly Gly Arg His Gln Arg Arg Val Asp Met Ile Ala Asp Ile Glu
130 135 140

Arg Arg Glu Glu Cys Gly Pro Glu Gly Cys
145 150

<210> 3
<211> 217
<212> PRT
<213> Rubellimicrobium thermophilum

<400> 3

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

Ile Asp Thr Glu Ser Leu Cys Asn Ala Ala Gly Val Glu Ala Cys Ala
20 25 30

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

Ile Asp Asp Arg Thr Arg Val Gln Leu Ile Gly Glu His Val Gly Thr
50 55 60

Ala Val Asp Leu Ser Ala Phe Leu Ala Ala Trp Asp Arg Leu Cys Ile
65 70 75 80

Glu Arg Phe Ala Gln Gly Ile Pro Leu Lys Pro Gly Ala Ile Glu Leu
85 90 95

Leu Glu Gln Ile Ala Ala Ala Gly Ile Pro Leu Ala Leu Ala Thr Ser
100 105 110

Ser Arg Arg Gly Pro Ala Glu Asp Lys Leu Arg Met Ala Gly Leu Ala
115 120 125

Arg His Phe Arg Thr Val Val Thr Phe Asp Asp Val Ala Ala Pro Lys
130 135 140

Pro Ala Pro Asp Ala Tyr Leu Leu Ala Val Asp Arg Leu Gly Val Pro
145 150 155 160

Pro Ala Arg Ala Leu Ala Phe Glu Asp Ser Glu Thr Gly Ala Arg Ala
165 170 175

Ala His Ala Ala Gly Leu Thr Val Val Gln Val Pro Asp Leu His Pro
180 185 190

Thr Gln Gly Ala His Ala His His Val Ala Ser Ser Leu Leu Glu Gly
195 200 205

Ala Ala Met Ala Gly Leu Leu Pro Val
210 215

<210> 4
<211> 216
<212> PRT
<213> Thermotoga maritima

<400> 4

Met Glu Ala Val Ile Phe Asp Met Asp Gly Val Leu Met Asp Thr Glu
1 5 10 15

Pro Leu Tyr Phe Glu Ala Tyr Arg Arg Val Ala Glu Ser Tyr Gly Lys
20 25 30

Pro Tyr Thr Glu Asp Leu His Arg Arg Ile Met Gly Val Pro Glu Arg
35 40 45

Glu Gly Leu Pro Ile Leu Met Glu Ala Leu Glu Ile Lys Asp Ser Leu
50 55 60

Glu Asn Phe Lys Lys Arg Val His Glu Glu Lys Lys Arg Val Phe Ser
65 70 75 80

Glu Leu Leu Lys Glu Asn Pro Gly Val Arg Glu Ala Leu Glu Phe Val
85 90 95

Lys Ser Lys Arg Ile Lys Leu Ala Leu Ala Thr Ser Thr Pro Gln Arg
100 105 110

Glu Ala Leu Glu Arg Leu Arg Arg Leu Asp Leu Glu Lys Tyr Phe Asp
115 120 125

Val Met Val Phe Gly Asp Gln Val Lys Asn Gly Lys Pro Asp Pro Glu
130 135 140

Ile Tyr Leu Leu Val Leu Glu Arg Leu Asn Val Val Pro Glu Lys Val
145 150 155 160

Val Val Phe Glu Asp Ser Lys Ser Gly Val Glu Ala Ala Lys Ser Ala
165 170 175

Gly Ile Glu Arg Ile Tyr Gly Val Val His Ser Leu Asn Asp Gly Lys
180 185 190

Ala Leu Leu Glu Ala Gly Ala Val Ala Leu Val Lys Pro Glu Glu Ile
195 200 205

Leu Asn Val Leu Lys Glu Val Leu
210 215

<210> 5
<211> 218
<212> PRT
<213> Thermoanaerobacterium saccharolyticum

<400> 5

Met Phe Glu Ala Val Ile Leu Asp Met Asp Gly Val Leu Ile Asp Ser
1 5 10 15

Glu Pro Leu His Ile Gln Leu Glu Glu Glu Ile Phe Lys Glu Ile Gly
20 25 30

Ala Asp Ile Ser Leu Glu Glu His Ile Ser Phe Val Gly Thr Thr Ser
35 40 45

His Tyr Met Trp Glu Tyr Val Lys Asn Lys Cys Asn Val Ser Phe Thr
50 55 60

Val Glu Glu Leu Val Glu Met Asp Arg Lys Arg Tyr Phe Asp Tyr Ile
65 70 75 80

Ser Lys His Asp Gly Ala Val Lys Pro Ile Glu Gly Val Asp Glu Leu
85 90 95

Val Lys Glu Leu Tyr Ser Arg Glu Val Arg Leu Ala Val Ala Ser Ser
100 105 110

Ser Pro Ile Asp Val Ile Glu Leu Val Val Lys Lys Leu His Leu Asn
115 120 125

Asp Tyr Phe Cys Glu Leu Val Ser Gly Asp Phe Val Lys Arg Ser Lys
130 135 140

Pro Tyr Pro Asp Ile Phe Leu Tyr Ala Ala Glu Lys Leu Gly Val Ser
145 150 155 160

Pro Glu Arg Cys Leu Val Val Glu Asp Ser Asn Lys Gly Val Leu Ala
165 170 175

Ala Lys Ser Ala Gly Met Lys Val Ile Gly Phe Ile Asn Pro Asn Ser
180 185 190

Gly Asp Gln Asp Ile Ser Met Ala Asp Met Val Ile Arg Ser Phe Ser
195 200 205

Glu Leu Asn Tyr Glu Lys Leu Gln Asn Ile
210 215

<210> 6
 <211> 220
 <212> PRT
 <213> Streptomyces thermoautotrophicus

<400> 6

Met Pro Ser Ser Ser Gly Gly Leu Gln Ala Val Phe Phe Asp Met Asp
 1 5 10 15

Gly Leu Leu Val Asp Thr Glu Pro Thr Trp His Glu Val Glu Ala Glu
 20 25 30

Val Met Ala Glu Tyr Gly Tyr Ala Trp Thr Pro Glu Asp Arg Leu Ala
 35 40 45

Cys Leu Gly Gly Pro Met Glu Arg Thr Cys Arg Tyr Met Ile Glu Arg
 50 55 60

Cys Gly Ala Asp Ile Thr Val Glu Ala Leu Gly Ala Thr Leu Val Glu
 65 70 75 80

Arg Met Ala Leu Arg Val Arg Glu Glu Val Ala Val Gln Pro Gly Ala
 85 90 95

Lys Glu Leu Leu Ser Glu Leu Ile Glu Ala Gly Val Pro Arg Ala Leu
 100 105 110

Val Ser Ser Ser Phe Arg Val Leu Val Asp Ala Val Leu Asp Ala Val
 115 120 125

Gly His Asp Leu Phe Val Val Thr Val Ala Gly Asp Glu Val Ala Arg
 130 135 140

Ala Lys Pro His Pro Glu Pro Tyr Leu Thr Ala Ala Ala Arg Leu Gly
 145 150 155 160

Val Asp Pro Ala Arg Cys Val Val Leu Glu Asp Ser Pro Pro Gly Val
 165 170 175

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

Ala Pro Leu Glu Pro Ala Pro Arg Arg Leu Val Val Arg Ser Leu Thr
195 200 205

Glu Leu Ser Leu Asp Arg Leu Arg Ala Leu Ile Ala
210 215 220

<210> 7
<211> 219
<212> PRT
<213> Sphaerobacter thermophilus

<400> 7

Met Ser Gln Gly Val Arg Gly Val Val Phe Asp Leu Asp Gly Leu Leu
1 5 10 15

Val Glu Ser Glu Glu Tyr Trp Glu Gln Ala Arg Arg Glu Phe Val Ser
20 25 30

Arg Tyr Gly Gly Thr Trp Gly Asp Asp Ala Gln Gln Ala Val Met Gly
35 40 45

Ala Asn Thr Arg Gln Trp Ser Arg Tyr Ile Arg Glu Ala Phe Asp Ile
50 55 60

Pro Leu Thr Glu Glu Glu Ile Ala Ala Ala Val Ile Ala Arg Met Gln
65 70 75 80

Glu Leu Tyr His Asp His Leu Pro Leu Leu Pro Gly Ala Ile Pro Ala
85 90 95

Val Arg Ala Leu Ala Asp Arg Tyr Pro Leu Ala Val Ala Ser Ser Ser
100 105 110

Pro Pro Val Leu Ile Arg Phe Val Leu Ala Glu Met Gly Val Ala Glu
115 120 125

Cys Phe Gln Ser Val Thr Ser Ser Asp Glu Val Ala His Gly Lys Pro
 130 135 140

Ala Pro Asp Val Tyr His Leu Ala Cys Glu Arg Leu Gly Val Ala Pro
 145 150 155 160

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

Leu Ala Ala Gly Leu Arg Val Ile Ala Val Pro Asn Arg Ser Tyr Pro
 180 185 190

Pro Asp Pro Asp Val Leu Arg Arg Ala Asp Leu Thr Leu Pro Ser Leu
 195 200 205

Glu Glu Phe Asp Pro Ala Val Leu Glu Gln Trp
 210 215

<210> 8
 <211> 400
 <212> PRT
 <213> Pseudonocardia thermophila

<400> 8

Met Glu Leu Leu Asp Asn Pro Ile Arg Pro Tyr Ala Trp Gly Ser Arg
 1 5 10 15

Thr Val Leu Ala Glu Leu Leu Gly His Glu Ser Pro Ser Pro His Pro
 20 25 30

Glu Ala Glu Met Trp Leu Gly Ala His Pro Gly Asp Pro Ser Arg Leu
 35 40 45

Arg Ser Gly Glu Ser Leu Leu Asp Ala Leu Cys Ala Asp Pro Glu Gly
 50 55 60

Leu Leu Gly Ala Asp Arg Ala Arg Lys Trp Asp Gly Lys Leu Pro Phe
 65 70 75 80

Leu Leu Lys Val Leu Ala Ala Asp Glu Pro Leu Ser Leu Gln Ala His
85 90 95

Pro Ser Leu Asp Gln Ala Arg Val Gly Phe Glu Arg Glu Glu Arg Ala
100 105 110

Gly Ile Ala Arg Asp Ala Pro Glu Arg Asn Tyr Arg Asp Pro Asn His
115 120 125

Lys Pro Glu Leu Leu Cys Ala Leu Thr Glu Phe His Ala Leu Val Gly
130 135 140

Phe Arg Pro Pro Glu Lys Thr Val Glu Leu Leu Ala Ala Leu Ala Val
145 150 155 160

Pro Glu Leu Asp Ala Tyr Ser Gln Leu Leu Thr Ala Gln Pro Asp Ala
165 170 175

Asn Gly Leu Arg Ala Leu Phe Thr Thr Trp Ile Thr Leu Pro Gln Ser
180 185 190

Val Leu Asp Thr Leu Val Pro Ala Leu Gln Ala Gly Cys Val Arg Leu
195 200 205

Ala Ala Ala Asp Gly Pro Phe Lys Ala Glu Ala Arg Thr Val Leu Glu
210 215 220

Leu Ser Glu Arg Tyr Pro Gly Asp Ala Gly Val Leu Ala Ala Val Leu
225 230 235 240

Leu Asn Arg Val Thr Leu Gln Pro Gly Glu Ala Val Tyr Leu Pro Ala
245 250 255

Gly Asn Leu His Ala Tyr Leu Glu Gly Ala Gly Ile Glu Val Met Ala
260 265 270

Ser Ser Asp Asn Val Leu Arg Gly Gly Leu Thr Pro Lys His Val Asp
275 280 285

Val Pro Glu Leu Leu Arg Val Leu Asp Phe His Ala Ala Val Pro Pro
 290 295 300

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

Phe Glu Glu Phe Leu Leu Arg Arg Leu Glu Gly Asp Pro Ala Ala Gly
 325 330 335

Leu Val Ala Val Pro Asp Gly Gly Pro Arg Ile Val Leu Cys Thr Arg
 340 345 350

Gly Ala Ala Val Leu Arg Gly Arg Asp Glu Gln Leu Asp Leu His Arg
 355 360 365

Gly Ala Ser Ala Trp Leu Gly Ala Asp Asp Thr Gly Leu Thr Val Glu
 370 375 380

Ala Val Glu Gln Asn Thr Gln Leu Phe Leu Ala Gly Asp Gly Leu Asp
 385 390 395 400

<210> 9
 <211> 405
 <212> PRT
 <213> *Caldithrix abyssi*

<400> 9

Met Lys Leu Lys Phe Val Ala Arg Pro Tyr Glu Leu Ile Asn Lys Ile
 1 5 10 15

Gln Asn Tyr Ser Trp Gly Thr Arg Asn Glu Gln Ala Phe Ile Pro Arg
 20 25 30

Leu Leu Asn Met Ala Val Glu Pro Asp Thr Pro Tyr Ala Glu Leu Trp
 35 40 45

Met Gly Thr His Pro Asn Ala Pro Ser Glu Val Val Val Asp Gly Arg
 50 55 60

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

Gly Thr Arg Val Ile Glu Arg Phe Gly Val Gln Leu Pro Phe Leu Phe
85 90 95

Lys Val Leu Ser Ala Ala Glu Ala Leu Ser Ile Gln Ala His Pro Asn
100 105 110

Lys Gln Gln Ala Glu Val Leu His Gln Arg Asp Pro Glu His Tyr Pro
115 120 125

Asp Asp Asn His Lys Pro Glu Ile Ala Ile Ala Leu Asp Glu Leu Thr
130 135 140

Ala Leu Val Gly Phe Arg Ser Leu Lys Glu Met Asp Ala Val Leu Arg
145 150 155 160

Thr Phe Pro Glu Ile Leu Glu Phe Thr Gly Pro Leu Glu Phe Thr Phe
165 170 175

Glu Gly Ala Arg His Glu Glu Gln Glu Asn Arg Gln Lys Phe Arg Gln
180 185 190

Phe Tyr Gln Thr Leu Met Leu Lys Ser Gln Thr His Ala Thr Glu Met
195 200 205

Glu Ala Thr Leu Asn Lys Ile Glu Gln Lys Leu Leu Gln Lys Lys Lys
210 215 220

Arg Thr Glu Arg Asp Glu Trp Phe Leu Lys Leu Lys Lys Lys Tyr Gly
225 230 235 240

Ala Asp Val Gly Leu Phe Ser Ile Tyr Leu Leu Asn Leu Leu His Leu
245 250 255

Lys Lys Gly Gln Gly Val Phe Leu Lys Ala Gly Val Pro His Ala Tyr

260

265

270

Leu Lys Gly Asn Ile Val Glu Cys Met Ala Asn Ser Asp Asn Val Val
 275 280 285

Arg Ala Gly Leu Thr Pro Lys Phe Lys Asp Val Lys Thr Leu Ile Glu
 290 295 300

Val Leu Thr Tyr Glu Thr Gly Pro Val Glu Ile Tyr Glu Gly Ala Gln
 305 310 315 320

Asn Ala Lys Tyr Val Tyr Lys Thr Pro Val Asp Glu Phe Ser Ile Thr
 325 330 335

His Val Asn Leu Asp Glu Lys Ser Lys Leu Arg Phe Phe Leu Glu Thr
 340 345 350

Val Ser Ile Met Met Val Val Asn Gly Lys Gly Glu Ile Val Phe Asn
 355 360 365

Gly Gly Arg Leu Ala Ile Gln Lys Gly Gln Ser Ile Leu Leu Pro Ala
 370 375 380

Glu Ile Ala Ser Phe Glu Leu Val Ser Asp Gly Ser Leu Glu Ile Phe
 385 390 395 400

Ser Ala Tyr Val Pro
 405

<210> 10

<211> 453

<212> PRT

<213> Myceliophthora thermophila

<400> 10

Met Gln Val Pro Leu Ile Arg Leu Gln Cys Gly Ala Asn Ser Tyr Glu
 1 5 10 15

Trp Gly Lys Lys Gly Ser Ser Ser Ala Val Ala Arg Phe Ala Ala Ala

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

Ala Ala Thr Ala Gly Ala Asp Phe Ala Ala Gly Gly Val Ala Ala Thr
 225 230 235 240

Ser Gly Ser Thr Leu Ala Glu Leu Val Gln Arg Leu His Gly Gln Phe
 245 250 255

Gly Ala Asp Tyr Gly Leu Phe Val Leu Phe Phe Leu Asn Phe Val Thr
 260 265 270

Leu Gln Pro Gly Glu Ala Leu Phe Leu Arg Ala Asp Asp Ile His Ala
 275 280 285

Tyr Val Ser Gly Asp Ile Ile Glu Cys Met Ala Ser Ser Asp Asn Val
 290 295 300

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

Asn Met Leu Thr Tyr Ser Tyr Ala Pro Ile Asp Glu Gln Lys Met Gly
 325 330 335

Pro Ser Asp Tyr Pro Tyr Ala Thr Leu Asn Arg Thr Gly Tyr Ser Ser
 340 345 350

Gly Ser Thr Ile Ser Phe Tyr Asp Pro Pro Ile Glu Glu Phe Ser Val
 355 360 365

Ile Arg Thr Asn Leu Lys Glu Ser Gly Ser Lys Ala Thr Phe Asp Pro
 370 375 380

Val Asp Gly Pro Ser Ile Ile Ile Cys Thr Ala Gly Lys Gly Lys Ile
 385 390 395 400

Ser Val Gly Pro Thr Ala Gln Glu Val Lys Glu Gly Tyr Val Phe Phe
 405 410 415

Val Gly Ala Ser Ala Lys Cys Val Leu Glu Ser Glu Gly Ser Ser Glu
 420 425 430

Asp Asp Glu Phe Ile Thr Phe Lys Ala Phe Cys Asp Val Glu Glu His
435 440 445

Arg Gly Ala Ser Leu
450

<210> 11
<211> 410
<212> PRT
<213> Treponema caldarium
<400> 11

Met Asn Asn Lys Lys Lys Pro Asn Phe Tyr Leu Leu Lys Asn Pro Ile
1 5 10 15

Gln Arg Tyr Ala Trp Gly Ser Lys His Trp Ile Gln Asp Leu Leu Asp
20 25 30

Leu Ser Glu Gln Asp Arg Gln Gly Pro Met Ala Glu Leu Trp Met Gly
35 40 45

Ala His Ser Arg Ser Pro Ser Ile Ala Phe Thr Asp Glu Thr Glu Gln
50 55 60

Pro Leu Asp Lys Leu Ile Gln Glu His Pro Val His Phe Leu Gly Asp
65 70 75 80

Thr Ile Ala His Asp Phe Ser Ser Leu Pro Tyr Leu Phe Lys Ile Leu
85 90 95

Ala Ala Ala Ser Pro Leu Ser Ile Gln Ala His Pro Asp Lys Gln Gln
100 105 110

Ala Glu Gln Gly Phe Ala Arg Glu Ala Lys Ala Gly Ile Pro Leu Ser
115 120 125

Ala Glu Asn Arg Asn Tyr Lys Asp Ser Asn His Lys Pro Glu Ile Ile
130 135 140

Cys Ala Ile Ser Pro Phe Thr Ala Met Cys Gly Phe Arg Thr Gln Ala
 145 150 155 160

Glu Ile Ala Glu Leu Leu Ser Leu Leu Asp Val Thr Glu Leu Glu Gln
 165 170 175

Ser Leu Val Ala Ile Gln Gln Ile Asp Arg Lys Glu Ala Tyr Arg Asp
 180 185 190

Phe Leu Leu Ser Leu Phe Leu Leu Pro Gln Gln Thr Arg Glu Arg Ile
 195 200 205

Thr Lys His Ile Gln Ala Lys Leu Pro Lys Leu Glu Gln Lys His Pro
 210 215 220

Arg Tyr Ala Lys Glu Trp Glu Leu Ile Asn Leu Phe Cys Thr Leu Tyr
 225 230 235 240

Pro Gly Asp Ser Ala Ile Ile Ser Pro Leu Tyr Leu Asn Val Leu Ser
 245 250 255

Leu Asn Pro Gly Glu Ala Ile Phe Leu Pro Ala Gly Val Leu His Ala
 260 265 270

Tyr Ile His Gly Phe Gly Val Glu Leu Met Ala Asn Ser Asp Asn Val
 275 280 285

Leu Arg Gly Gly Leu Thr Pro Lys His Ile Asp Ile Lys Glu Leu Leu
 290 295 300

Asn Ile Ile Arg Phe Glu Ser Phe Lys Pro Ala Val Leu Ser Ala Gln
 305 310 315 320

Lys Thr Gln Gln Gly Tyr His Ile Tyr Pro Ser Gln Val Arg Glu Phe
 325 330 335

Ser Leu Phe His Val Ala Val Thr Met Asp Lys Ala Gln Gln Leu Met
 340 345 350

Pro Gly Thr Pro Ile Ile Leu Ile Val Leu Asp Gly Cys Val Ser Ile
 355 360 365

Gly Thr Glu Gln Glu Lys Lys Thr Leu Gln Lys Gly Met Ser Val Phe
 370 375 380

Leu Pro Ala Glu Arg Glu Gln Leu Ile Leu Glu Gly Ser Ala His Ile
 385 390 395 400

Phe Gly Ala Thr Thr Gly Glu Gly Thr Arg
 405 410

<210> 12
 <211> 223
 <212> PRT
 <213> Tepidimonas fonticaldi

<400> 12

Met Thr Arg Trp Arg Gly Ile Arg Ala Val Leu Phe Asp Leu Asp Gly
 1 5 10 15

Thr Leu Val Asp Ser Ala Pro Asp Leu Gly His Ala Ala Asp Leu Met
 20 25 30

Arg Gln Arg Arg Gly Leu Pro Pro Leu Asp Glu Ala Tyr Tyr Arg Pro
 35 40 45

Arg Ala Ser Ser Gly Ala Arg Gly Met Ile Glu Ala Ala Phe Gly Leu
 50 55 60

Thr Pro Glu His Pro Glu Phe Glu Ala Tyr Arg Thr Glu Tyr Leu Asp
 65 70 75 80

Thr Tyr Gly Gln Val Leu Thr Arg Arg Thr Arg Pro Phe Asp Gly Val
 85 90 95

Ala Glu Leu Ile Ala Ala Leu Asp Arg Ala Gln Val Ala Trp Gly Val
 100 105 110

Val Thr Asn Lys Val Glu Arg Phe Ala Leu Pro Leu Thr Ala Ala Ile
115 120 125

Pro Leu Phe Ala Thr Ala Ala Thr Val Ile Gly Gly Asp Thr Thr Pro
130 135 140

His Pro Lys Pro His Pro Ala Pro Leu Leu Glu Ala Ala Arg Arg Leu
145 150 155 160

Gln Leu Pro Pro Gln Ala Cys Leu Tyr Val Gly Asp Asp Glu Arg Asp
165 170 175

Ile Val Ala Gly Arg Ala Ala Gly Met Pro Thr Val Ala Ala Arg Tyr
180 185 190

Gly Tyr Leu Gly Val Ala Ala Asp Val Glu Ala Trp Ala Ala Asp Ala
195 200 205

Ile Ile Glu Ser Pro Gln Ala Leu Leu Asn Phe Leu Asp Leu Ala
210 215 220

<210> 13
<211> 221
<212> PRT
<213> Thermomonas hydrothermalis

<400> 13

Met Ser Ala Arg Arg Phe Pro Pro Leu Val Leu Phe Asp Leu Asp Gly
1 5 10 15

Thr Leu Leu Asp Ser Ala Pro Asp Met Leu Val Thr Val Asn Arg Met
20 25 30

Arg Ala Met Arg Gly Asp Ala Pro Met Ala Leu Asp Ala Leu Arg Pro
35 40 45

His Val Ser Arg Gly Ala Arg Ala Met Ile Ala Ala Ser Phe Pro Ala
50 55 60

Leu Gly Gly Glu Val Pro Ala Glu Met Val Arg Glu Phe Leu Asp Ile
65 70 75 80

Tyr Ala Gln Val Leu Gly Gln His Gly Ala Pro Phe Asp Gly Val Val
85 90 95

Glu Leu Leu Ala Ala Leu Glu Ala Ala Gly Ser Arg Trp Gly Ile Val
100 105 110

Thr Asn Lys Pro Glu Ser Leu Ala Arg Gln Leu Leu Pro Gly Leu Gly
115 120 125

Trp Asp Ala Arg Cys Ala Ile Leu Val Gly Gly Asp Ser Leu Pro Glu
130 135 140

Arg Lys Pro His Pro Leu Pro Leu Leu His Ala Ala Gly Gln Leu Gly
145 150 155 160

Val Ser Cys Gln Asp Cys Ala Tyr Val Gly Asp Asp Arg Arg Asp Ile
165 170 175

Glu Ala Ala Arg Ala Ala Gly Met Arg Ser Val Val Ala Leu Trp Gly
180 185 190

Tyr Arg Leu Pro Asp Glu Asn Pro Gln Asp Trp Gly Gly Asp Ala Leu
195 200 205

Ser Pro Thr Pro Gln Ala Leu Leu Asp Trp Pro Leu Pro
210 215 220

<210> 14
<211> 221
<212> PRT
<213> Sulfurivirga caldicuralii

<400> 14

Met Arg Glu Phe Asp Cys Val Leu Phe Asp Leu Asp Gly Thr Leu Leu
1 5 10 15

Asp Thr Ser Tyr Asp Phe Ala Trp Ala Leu Asn Thr Leu Gln Lys Gln
20 25 30

Glu Ser Val Pro Leu Thr Pro Tyr Trp Arg Ile Arg Gln Thr Ile Ser
35 40 45

Ser Gly Gly Arg Ala Val Val Lys Leu Gly Phe Pro Asp Ala Asp Asp
50 55 60

Ala Thr Ile Glu Ala Leu Arg Glu Arg Phe Leu Ala Leu Tyr His Glu
65 70 75 80

Asn Ile Ser Val His Thr Asp Leu Phe Pro Gly Leu Glu Lys Val Leu
85 90 95

Thr His Leu Gln Glu Lys Ala Val Pro Trp Gly Ile Val Thr Asn Lys
100 105 110

Pro Ala Trp Leu Thr Asp Lys Leu Leu Gly Glu Leu Asp Leu Pro Ala
115 120 125

Gln Pro Gln Thr Val Val Ser Gly Asp Thr Leu Ala Val Arg Lys Pro
130 135 140

His Pro Glu Pro Met Trp Leu Ala Ala Glu Gln Cys Gly Val Ala Pro
145 150 155 160

Glu Arg Cys Leu Tyr Ile Gly Asp His Pro Arg Asp Ile Glu Ala Pro
165 170 175

Arg Asn Ala Gly Met Gln Ser Ala Ala Ala Leu Tyr Gly Phe Leu Pro
180 185 190

Leu Asp Ala Glu Pro Asp Ser Trp Pro Ala Asp Tyr Arg Tyr His Ala
195 200 205

Pro Ala Asp Ile Leu His His Met Gln Lys Val Phe Pro

210

215

220

<210> 15

<211> 344

<212> PRT

<213> Syntrophothermus lipocalidus

<400> 15

Met Ala Val Glu Met Gly Pro Glu Met Met Phe Glu Phe Leu Tyr Asn
 1 5 10 15

Leu Pro Ala Gln Phe Glu Gly Cys Leu Lys Met Asp Phe Ser Lys Ala
 20 25 30

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

Gly Ser Ala Ile Gly Gly Asp Ile Leu Arg Cys Tyr Cys Gln Ser Arg
 50 55 60

Leu Pro Ile Pro Val Val Val Asn Arg Asp Tyr Met Leu Pro Arg Phe
 65 70 75 80

Val Gly Pro Asp Ser Leu Val Leu Ala Val Ser Tyr Ser Gly Asn Thr
 85 90 95

Glu Glu Thr Leu Ser Ala Tyr Glu Asp Ala Arg Glu Lys Gly Ala Ser
 100 105 110

Ile Ile Ala Phe Thr Thr Gly Gly Lys Leu Ala Glu Met Ala Ala Leu
 115 120 125

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

Ala Thr Gly Tyr Leu Phe Ala Pro Leu Val Leu Val Leu Glu Arg Leu
 145 150 155 160

Gly Leu Val Ser Gly Ala Ser Glu Asp Val Lys Glu Thr Val Thr Val

165

170

175

Leu Thr Gln Leu Arg Glu Glu Ile Glu Pro Gly Arg Glu Glu Asp Ser
 180 185 190

Asn Arg Ala Arg Phe Ile Ala Gly Gln Leu Tyr Gln Arg Ile Pro Val
 195 200 205

Ile Trp Gly Cys Ser Ser Thr Ser Glu Val Ala Ala Met Arg Trp Lys
 210 215 220

Gly Gln Ile Asn Glu Asn Ala Lys Ala Pro Ala Tyr Phe Asn Val Phe
 225 230 235 240

Pro Glu Leu Asn His Asn Glu Ile Val Gly Phe Glu Val Pro Glu Asp
 245 250 255

Leu Val Lys Lys Leu Ala Val Ile Ile Leu Arg Asp Pro Asp Asp His
 260 265 270

Gly Arg Ile Thr Lys Arg Ile Glu Ile Thr Lys Asp Ile Leu Gln Gly
 275 280 285

Lys Val Ser Ser Val Ala Glu Val Glu Ala Arg Gly Asn Ser Phe Leu
 290 295 300

Ala Lys Thr Tyr Ser Leu Ile Tyr Val Gly Asp Tyr Ala Ser Val Tyr
 305 310 315 320

Leu Ala Glu Leu Tyr Gly Ile Asn Pro Thr Pro Val Gln Val Ile Asp
 325 330 335

Tyr Leu Lys Ala Arg Met Ala Glu
 340

<210> 16

<211> 328

<212> PRT

<213> Schleiferia thermophila

<400> 16

Met Leu Thr Leu Ile Glu Asn Phe Pro Lys His Leu Val Asp Ala Met
1 5 10 15

Ile Thr Ala Lys Lys Ala Ser Phe Lys Gln Ser Asn Arg Ala Ile Lys
20 25 30

Asn Val Ile Ile Thr Gly Leu Gly Gly Ser Gly Ile Gly Ala Ser Met
35 40 45

Val Gln Asp Leu Leu Ser Pro His Ala Glu Ile Pro Ile Ile Val Asn
50 55 60

Lys Asp Tyr His Leu Pro Ala Phe Ala Asp Glu Asn Thr Leu Val Ile
65 70 75 80

Ala Cys Ser Tyr Ser Gly Glu Thr Glu Glu Thr Leu Ala Ala Leu Ala
85 90 95

Glu Ala Glu Glu His Ser Cys Glu Ile Ala Ile Ile Thr Ser Gly Gly
100 105 110

Thr Leu Leu Gln Met Ala Lys Ser Lys Asn Tyr Asn Tyr Leu Gln Met
115 120 125

Pro Glu Gly Asn Pro Pro Arg Ser Met Ile Gly Tyr Ser Leu Val Tyr
130 135 140

Gln Leu Tyr Met Leu Ala Tyr Tyr Gly Ile Ser Arg Leu Ala Leu Asp
145 150 155 160

Asn Asp Ile Ile Leu Ser Ser Asn Tyr Leu Leu Glu Phe Arg Glu Lys
165 170 175

Ile Gln Ser Gln Ala Arg Tyr Ile Ala Val Arg Leu His Lys Lys Ile
180 185 190

Pro Ala Val Tyr Ala Cys Ser Gly Phe Gly Ser Leu Ala Glu Arg Phe
195 200 205

Arg Gln Gln Leu Asn Glu Asn Ser Lys Met Leu Ala Trp Asn Gly Thr
210 215 220

Val Pro Glu Met Asn His Asn Glu Leu Val Gly Trp Lys Gly Gly Asp
225 230 235 240

Glu His Phe Ala Ala Ile Phe Ile His Thr Pro Phe Asp Asp Asn Arg
245 250 255

Asn Ala Lys Arg Thr Glu Ile Ser Ser Asn Ile Ile Gln Asn Phe Thr
260 265 270

Ser Gly Val Phe His Ile His Ser Glu Gly Glu Thr Pro Leu Arg Ala
275 280 285

Phe Phe Tyr Leu Ile His Ile Thr Asp Trp Ile Ser Tyr Tyr Leu Ser
290 295 300

Glu Leu Asn Gly Val Asp Val Met Asp Ile Ser Ala Ile Asn Gln Leu
305 310 315 320

Lys Gly Glu Leu Ala Asn Phe Asn
325

<210> 17
<211> 349
<212> PRT
<213> Thermodesulfobium narugense

<400> 17

Met Asp Lys Asn Val Met Asn Ser Tyr Val Ser Asp Ile Ala Tyr His
1 5 10 15

Met Lys Asp Phe Tyr Lys Asp Leu Thr Phe Tyr Lys Asp Gly Lys Ile
20 25 30

Asp Leu Asn Glu Ile Glu Asn Leu Ile Phe Leu Gly Ile Gly Gly Ser
35 40 45

Ala Ile Ser Pro Lys Ile Phe Thr Glu Ile Met Asn Ile Asn Lys Lys
50 55 60

Val Tyr Phe Phe Ser Thr Leu Asn Gly Phe Glu Ala Leu Pro Asp Pro
65 70 75 80

Ser Thr Ser Phe Val Ile Ala Phe Ser Tyr Ser Gly Asn Thr Val Glu
85 90 95

Thr Leu Arg Ser Ile Glu Leu Ile Ala Lys Asp Arg Phe Arg Gly Ile
100 105 110

Gly Ile Ser Ser Gly Gly Lys Ile Val Asp Leu Cys Lys Ser Leu Asn
115 120 125

Trp Gln His Ile Ala Val Pro Lys Gly Arg Ala Pro Arg Ala Ala Met
130 135 140

Pro Phe Thr Leu Ser Ile Leu Phe Lys Leu Ala Leu Ser Lys Gly Trp
145 150 155 160

Thr Glu Tyr Asn Glu Asp Asp Phe Trp Asn Asp Ile Ile Glu Leu Ser
165 170 175

Asn Ser Lys Asn Asn Phe Leu Pro Glu Val Asp Phe Glu Asp Asn Val
180 185 190

Ser Lys Arg Ile Ala Tyr Lys Leu Ala Thr Lys Lys Asn Val Ile Ile
195 200 205

Trp Gly Val Glu Ser Ile Ser Lys Asn Ile Ala Tyr Arg Phe Lys Ser
210 215 220

Gln Leu Glu Glu Asn Ala Lys Gln Leu Ser Tyr Tyr Ser Tyr Leu Pro
225 230 235 240

Glu Ala Ser His Asn Gln Ile Val Pro Ile Ser Leu Val Asp Asn Lys
245 250 255

Glu Glu Tyr Ile Val Leu Ile Phe Arg Ile Pro Gln Leu Glu Ser Val
260 265 270

Leu Val Ser Asn Ile Ile Ser Thr Val Lys Thr Phe Leu Asn Ser Glu
275 280 285

Gly Ile Glu Val Leu Glu Val Phe Gly Ser Gly Lys Asn His Val Leu
290 295 300

Ala Gly Leu Asp Leu Ile Tyr Ser Thr Asp Phe Val Ser Tyr Tyr Leu
305 310 315 320

Ala Leu Leu Lys Gly Ile Glu Pro Glu Pro Ile Glu Pro Ile Ser Arg
325 330 335

Met Lys Val Ile Leu Asn Asp Asn Leu Arg Lys Ala Leu
340 345

<210> 18
<211> 141
<212> PRT
<213> Lactococcus lactis

<400> 18

Met Ala Ile Val Val Gly Ala Asp Leu Lys Gly Thr Arg Leu Lys Asp
1 5 10 15

Val Val Lys Asn Phe Leu Val Glu Glu Gly Phe Glu Val Ile Asp Val
20 25 30

Thr Lys Asp Gly Gln Asp Phe Val Asp Val Thr Leu Ala Val Ala Ser
35 40 45

Glu Val Asn Lys Asp Glu Gln Asn Leu Gly Ile Val Ile Asp Ala Tyr
50 55 60

Gly Ala Gly Pro Phe Met Val Ala Thr Lys Ile Lys Gly Met Val Ala
65 70 75 80

Ala Glu Val Ser Asp Glu Arg Ser Ala Tyr Met Thr Arg Gly His Asn
85 90 95

Asn Ala Arg Met Ile Thr Val Gly Ala Glu Ile Val Gly Asp Glu Leu
100 105 110

Ala Lys Asn Ile Ala Lys Ala Phe Val Asn Gly Lys Tyr Asp Gly Gly
115 120 125

Arg His Gln Val Arg Val Asp Met Leu Asn Lys Met Cys
130 135 140

<210> 19
<211> 312
<212> PRT
<213> Lactococcus lactis

<400> 19

Met Arg Ile Ala Ile Gly Cys Asp His Ile Val Thr Asp Val Lys Met
1 5 10 15

Ala Val Ser Glu Phe Leu Lys Ser Lys Gly Tyr Glu Val Leu Asp Phe
20 25 30

Gly Thr Tyr Asp His Val Arg Thr His Tyr Pro Ile Tyr Gly Lys Lys
35 40 45

Val Gly Glu Ala Val Val Ser Gly Gln Ala Asp Leu Gly Val Cys Ile
50 55 60

Cys Gly Thr Gly Val Gly Ile Asn Asn Ala Val Asn Lys Val Pro Gly
65 70 75 80

Val Arg Ser Ala Leu Val Arg Asp Met Thr Ser Ala Leu Tyr Ala Lys
85 90 95

Glu Glu Leu Asn Ala Asn Val Ile Gly Phe Gly Gly Met Ile Thr Gly
100 105 110

Gly Leu Leu Met Asn Asp Ile Ile Glu Ala Phe Ile Glu Ala Glu Tyr
115 120 125

Lys Pro Thr Glu Glu Asn Lys Lys Leu Ile Ala Lys Ile Glu His Val
130 135 140

Glu Thr His Asn Ala His Gln Ala Asp Glu Glu Phe Phe Thr Glu Phe
145 150 155 160

Leu Glu Lys Trp Asp Arg Gly Glu Tyr His Asp Met Ala Ile Val Val
165 170 175

Gly Ala Asp Leu Lys Gly Thr Arg Leu Lys Asp Val Val Lys Asn Phe
180 185 190

Leu Val Glu Glu Gly Phe Glu Val Ile Asp Val Thr Lys Asp Gly Gln
195 200 205

Asp Phe Val Asp Val Thr Leu Ala Val Ala Ser Glu Val Asn Lys Asp
210 215 220

Glu Gln Asn Leu Gly Ile Val Ile Asp Ala Tyr Gly Ala Gly Pro Phe
225 230 235 240

Met Val Ala Thr Lys Ile Lys Gly Met Val Ala Ala Glu Val Ser Asp
245 250 255

Glu Arg Ser Ala Tyr Met Thr Arg Gly His Asn Asn Ala Arg Met Ile
260 265 270

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

Lys Ala Phe Val Asn Gly Lys Tyr Asp Gly Gly Arg His Gln Val Arg
290 295 300

Val Asp Met Leu Asn Lys Met Cys
305 310

<210> 20
<211> 270
<212> PRT
<213> Bacteroides thetaiotaomicron

<400> 20

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

Ser Lys Lys Glu Ile Ser Ser Arg Asn Arg Glu Thr Leu Ile Arg Ile
20 25 30

Gln Glu Gln Gly Ile Arg Leu Val Leu Ala Ser Gly Arg Pro Thr Tyr
35 40 45

Gly Ile Val Pro Leu Ala Asn Glu Leu Arg Met Asn Glu Phe Gly Gly
50 55 60

Phe Ile Leu Ser Tyr Asn Gly Gly Glu Ile Ile Asn Trp Glu Ser Lys
65 70 75 80

Glu Met Met Tyr Glu Asn Val Leu Pro Asn Glu Val Val Pro Val Leu
85 90 95

Tyr Glu Cys Ala Arg Thr Asn His Leu Ser Ile Leu Thr Tyr Asp Gly
100 105 110

Ala Glu Ile Val Thr Glu Asn Ser Leu Asp Pro Tyr Val Gln Lys Glu
115 120 125

Ala Phe Leu Asn Lys Met Ala Ile Arg Glu Thr Asn Asp Phe Leu Thr
130 135 140

Asp Ile Thr Leu Pro Val Ala Lys Cys Leu Ile Val Gly Asp Ala Gly
145 150 155 160

Lys Leu Ile Pro Val Glu Ser Glu Leu Cys Ile Arg Leu Gln Gly Lys
165 170 175

Ile Asn Val Phe Arg Ser Glu Pro Tyr Phe Leu Glu Leu Val Pro Gln
180 185 190

Gly Ile Asp Lys Ala Leu Ser Leu Ser Val Leu Leu Glu Asn Ile Gly
195 200 205

Met Thr Arg Glu Glu Val Ile Ala Ile Gly Asp Gly Tyr Asn Asp Leu
210 215 220

Ser Met Ile Lys Phe Ala Gly Met Gly Val Ala Met Gly Asn Ala Gln
225 230 235 240

Glu Pro Val Lys Lys Ala Ala Asp Tyr Ile Thr Leu Thr Asn Asp Glu
245 250 255

Asp Gly Val Ala Glu Ala Ile Glu Arg Ile Phe Asn Val Pro
260 265 270

<210> 21
<211> 217
<212> PRT
<213> Halothermothrix orenii

<400> 21

Met Ile Glu Ala Val Ile Phe Asp Met Asp Gly Val Ile Ile Asn Ser
1 5 10 15

Glu Pro Ile His Tyr Lys Val Asn Gln Ile Ile Tyr Glu Lys Leu Gly
20 25 30

Ile Lys Val Pro Arg Ser Glu Tyr Asn Thr Phe Ile Gly Lys Ser Asn
35 40 45

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

Val Ser Ser Leu Ile Glu Lys Gln Ile Ser Gly Asn Ile Lys Tyr Leu
65 70 75 80

Lys Ser His Glu Val Asn Pro Ile Pro Gly Val Lys Pro Leu Leu Asp
85 90 95

Glu Leu Ser Glu Lys Gln Ile Thr Thr Gly Leu Ala Ser Ser Ser Pro
100 105 110

Glu Ile Tyr Ile Glu Thr Val Leu Glu Glu Leu Gly Leu Lys Ser Tyr
115 120 125

Phe Lys Val Thr Val Ser Gly Glu Thr Val Ala Arg Gly Lys Pro Glu
130 135 140

Pro Asp Ile Phe Glu Lys Ala Ala Arg Ile Leu Gly Val Glu Pro Pro
145 150 155 160

His Cys Val Val Ile Glu Asp Ser Lys Asn Gly Val Asn Ala Ala Lys
165 170 175

Ala Ala Gly Met Ile Cys Ile Gly Tyr Arg Asn Glu Glu Ser Gly Asp
180 185 190

Gln Asp Leu Ser Ala Ala Asp Val Val Val Asp Ser Leu Glu Lys Val
195 200 205

Asn Tyr Gln Phe Ile Lys Asp Leu Ile
210 215