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(73)专利权人 CJ第一制糖株式会社
地址 韩国首尔
(72)发明人 李知宣 李光镐 金孝珍 李根喆 黄荣彬
(74)专利代理机构 北京纪凯知识产权代理有限公司 11245
代理人 王永伟 赵蓉民
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审查员 冯娟

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(54)发明名称

具有提高的L-苏氨酸生产能力的微生物以及使用其生产L-苏氨酸的方法

(57)摘要

本发明涉及新型变体RNA聚合酶σ因子70(σ^{70})多肽、编码其的多核苷酸、含有该多肽的微生物以及使用该微生物生产L-苏氨酸的方法。

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1.经修饰的多肽,其具有RNA聚合酶σ因子70的活性,其中SEQ ID NO:8中的两个、三个或七个氨基酸被取代,并且其中所述取代选自以下:

Q579R、D612G;

Q579R、D612Y;

Q579L、D612T;

Q579R、D612N;

Q579T、D612G;

Q579R、D612F;

Q579I、D612K;

Q579L、D612*;

Q579G、D612S;

Q579A、D612F;

Q579P、D612R;

Q579S、D612H;

Q579R、D612H;

T440P、Q579R、D612Y;

Q446P、R448S、I466S、T527P、M567V、Q579L、D612T;

K496N、Q579R、D612G;和

T440P、D612G。

2.根据权利要求1所述的经修饰的多肽,其中所述经修饰的多肽具有选自SEQ ID NOS:9至21、31至33和35的氨基酸序列的氨基酸序列。

3.多核苷酸,其编码权利要求1所述的经修饰的多肽。

4.宿主细胞,其包括权利要求3所述的多核苷酸。

5.微生物,其属于埃希氏菌属(Escherichia),具有L-苏氨酸生产能力,其被修饰以包括具有RNA聚合酶σ因子70活性的经修饰的多肽,其中SEQ ID NO:8中的两个、三个或七个氨基酸被取代,并且其中所述取代选自以下:

Q579R、D612G;

Q579R、D612Y;

Q579L、D612T;

Q579R、D612N;

Q579T、D612G;

Q579R、D612F;

Q579I、D612K;

Q579L、D612*;

Q579G、D612S;

Q579A、D612F;

Q579P、D612R;

Q579S、D612H;

Q579R、D612H;

T440P、Q579R、D612Y；

Q446P、R448S、I466S、T527P、M567V、Q579L、D612T；

K496N、Q579R、D612G；和

T440P、D612G。

6.根据权利要求5所述的微生物，其中所述微生物是大肠杆菌(Escherichia coli)。

7.生产L-苏氨酸的方法，其包括在培养基中培养权利要求5至6中任一项所述的微生物；和从所培养的微生物或其培养基中回收L-苏氨酸。

8.经修饰的多肽，其具有RNA聚合酶σ因子70的活性，其中所述经修饰的多肽具有选自SEQ ID NOS:22至30、34、36和37的氨基酸序列的氨基酸序列。

具有提高的L-苏氨酸生产能力的微生物以及使用其生产L-苏氨酸的方法

技术领域

[0001] 本发明涉及一种新型变体RNA聚合酶σ因子70(σ^{70})多肽、编码其的多核苷酸、含有该多肽的微生物、以及使用该微生物生产L-苏氨酸的方法。

背景技术

[0002] 通常,有用的产物诸如氨基酸可以通过使用经由人工突变或遗传重组开发出的微生物菌株的发酵方法来生产。特别是,在开发用于大规模生产氨基酸的微生物菌株中,发现直接/间接参与生产的更高级联步骤(cascade step)的遗传因子,并适当地利用它们来开发能够产生更高收率的微生物菌株将是有利的。在此方面的代表性技术可以是全局转录机器工程(gTME),其可以通过在RNA聚合酶的招募蛋白质上引起随机突变来调控所有细胞内基因的表达。

[0003] RNA聚合酶是由五种亚基2α、β、β'和ω组成的大分子,并且其全酶表示为$\alpha_2\beta\beta'\omega$。同这些全酶一起,σ因子——存在于原核生物中的转录起始因子——可以允许RNA聚合酶与启动子特异性结合,并且可以通过其分子量进行区分。例如,σ^{70}代表分子量为70kDa的σ因子(Gruber TM,Gross CA,Annu Rev Microbiol.57:441-66,2003)。

[0004] 已知大肠杆菌(Escherichia coli)具有持家σ因子σ^{70}(RpoD)、氮限制σ因子σ^{54}(RpoN)、饥饿/稳定期σ因子σ^{38}(RpoS)、热激σ因子σ^{32}(RpoH)、鞭毛σ因子σ^{28}(RpoF)、胞质外/极端热应力σ因子σ^{24}(RpoE)、柠檬酸铁σ因子σ^{19}(FecI)等。已知这些不同σ因子在不同的环境条件下被激活,并且这些特征σ因子可以与在特定环境条件下转录的基因的启动子结合,从而调控基因的转录。已经报道了关于通过在σ因子70上允许随机突变来增加目标物质生产力的研究(Metabolic Engineering 9.2007.258-267),并且还有关于在大肠杆菌(E.coli)中使用gTME技术增加酪氨酸生产的研究报道(美国专利第8735132号)。

发明内容

[0005] 技术问题

[0006] 本发明人,在努力开发能够以提高的浓度生产L-苏氨酸而不使宿主细胞生长阻滞的微生物时,开发了一种新型经修饰的RNA聚合酶σ因子70多肽,并且还发现可以通过将新型经修饰的RNA聚合酶σ因子70多肽导入到具有L-苏氨酸生产能力的埃希氏菌属(Escherichia sp.)中开发具有提高的L-苏氨酸生产能力的细菌菌株。

[0007] 技术方案

[0008] 本发明的目的是提供具有SEQ ID NO:8的氨基酸序列的RNA聚合酶σ因子70活性的经修饰的多肽,其中一部分氨基酸被取代。

[0009] 本发明的另一目的是提供编码该多肽的多核苷酸。

[0010] 本发明的另一目的是提供包括该多肽的转化微生物。

[0011] 本发明的又一目的是提供生产L-苏氨酸的方法,所述方法包括培养该微生物;和

从培养的微生物或者其培养基中回收L-苏氨酸。

[0012] 有利效果

[0013] 本发明实现了能够上调L-苏氨酸生产能力的RNA聚合酶σ因子70多肽的新型变体的确认。此外，基于其的能够表达经修饰的多肽的微生物具有L-苏氨酸生产的优异收率，并且，因此从工业的角度来看，该微生物可以提供生产便利、以及生产成本的降低。

具体实施方式

[0014] 在上述目的方面中，本发明提供具有RNA聚合酶σ因子70活性的新型经修饰的多肽。

[0015] 如本文所使用的，术语“RNA聚合酶σ因子70”是指蛋白质σ^{70}—σ因子中的一种，并且被称为σ因子D(RpoD)。同RNA聚合酶一起，蛋白质σ^{70}充当转录起始因子中的一种。σ因子通过与特定启动子和不同转录因子上游上的上游DNA(UP元件)相互作用来参与转录的调控。具体而言，σ因子70(σ^{70})是大肠杆菌σ因子中的主要调节子，其控制着大多数持家基因和核心基因，并且已知在大肠杆菌指数期起主导作用(Jishage M等人，J Bacteriol 178(18)；5447-51,1996)。可从已知数据库(如NCBI GenBank)中获得关于σ因子70蛋白质的信息，例如，其可以是具有登录号NP_417539的蛋白质。具体地，σ^{70}蛋白质可包括SEQ ID NO:8的氨基酸序列，但并不限于此，只要蛋白质具有与本发明的σ^{70}蛋白质相同的活性。

[0016] 如本文所使用的，术语“经修饰的多肽”通常是指其中多肽的部分或全部氨基酸序列被取代的野生型多肽。在本发明中，它指代的是具有RNA聚合酶σ因子70(σ^{70})活性的多肽，其具有与野生型部分不同的氨基酸序列，通过取代野生型σ因子70(σ^{70})的部分氨基酸序列而制得，即，有助于增强L-苏氨酸生产能力的σ因子70(σ^{70})经修饰的多肽

[0017] 具体地，经修饰的多肽可以是具有SEQ ID NO:8的氨基酸序列的RNA聚合酶σ因子70活性的多肽，其中在440至450；459；466；470至479；484；495至499；509；527；565至570；575至580；599；和612位置(自作为第一氨基酸的初始甲硫氨酸起)处的至少一个氨基酸被另一个氨基酸取代。即，经修饰的多肽可以是这样的多肽：其中在45个位置(位置440至450、459、466、470至479、484、495至499、509、527、565至570、575至580、599和612)的至少一个中的氨基酸可被另一个氨基酸取代。例如，位置的个数可以是1、2、3、4、5、6、7、8、9、10个或更多，但并不限于此，只要其具有RNA聚合酶σ因子70的活性。

[0018] 更具体地，在那些处于位置440至450中的位置440、446或448处的氨基酸；在那些处于位置470至479中的位置474或477处的氨基酸；在那些处于位置495至499中的位置496或498处的氨基酸；在那些处于位置565至570中的位置567或569处的氨基酸；以及在那些处于位置575至580中的位置576或579处的氨基酸可被另一个氨基酸取代，但并不限于此。

[0019] 进一步更具体地，在位置440处的氨基酸可被脯氨酸取代(T440P)；在位置446处的氨基酸可被脯氨酸取代(Q446P)；在位置448处的氨基酸可被丝氨酸取代(R448S)；在位置459处的氨基酸可被天冬酰胺取代(T459N)；在位置466处的氨基酸可被丝氨酸取代(I466S)；在位置474处的氨基酸可被缬氨酸取代(M474V)；在位置477处的氨基酸可被甘氨酸取代(E477G)；在位置484处的氨基酸可被缬氨酸取代(A484V)；在位置496处的氨基酸可被天冬酰胺取代(K496N)；在位置498处的氨基酸可被精氨酸取代(L498R)；在位置509处的氨基酸可被甲硫氨酸取代(T509M)；在位置527处的氨基酸可被脯氨酸取代(T527P)；在位置

567处的氨基酸可被缬氨酸取代(M567V)；在位置569处的氨基酸可被脯氨酸取代(T569P)；在位置576处的氨基酸可被甘氨酸取代(N576G)；在位置579处的氨基酸可被精氨酸(Q579R)、亮氨酸(Q579L)、苏氨酸(Q579T)、异亮氨酸(Q579I)、甘氨酸(Q579G)、丙氨酸(Q579A)、脯氨酸(Q579P)或丝氨酸(Q579S)取代；在位置599处的氨基酸可被半胱氨酸取代(R599C)；或位置612处的氨基酸可被甘氨酸(D612G)、酪氨酸(D612Y)、苏氨酸(D612T)、天冬酰胺(D612N)、苯丙氨酸(D612F)、赖氨酸(D612K)、丝氨酸(D612S)、精氨酸(D612R)或组氨酸(D612H)取代，或者可以是具有终止密码子的氨基酸缺失(D612*)，但并不限于此。当核苷酸被终止密码子取代时，可以没有氨基酸。

[0020] 甚至更具体地，经修饰的多肽可以是具有SEQ ID NOS:9至37中的氨基酸序列的多肽，但并不限于此。

[0021] 本发明的经修饰的多肽可以不仅包括SEQ ID NOS:9至37的氨基酸序列，而且还包括与这些序列具有至少70％同源性的那些，具体地至少80％，更具体地至少90％，甚至更具体地至少99％，而不受限制，只要相比于野生型σ因子70(σ^{70})，蛋白质能够有助于增强L-苏氨酸生产能力。

[0022] 作为具有此类同源性的序列，如果氨基酸序列是基本上具有经修饰的σ因子70(σ^{70})的相同或相应生物活性的氨基酸序列，则明显的是，在部分序列中经缺失、修饰、取代或添加的氨基酸序列也应包括在本发明的范围内。

[0023] 如本文所使用的，术语“同源性”是指在编码蛋白质的基因的两种不同氨基酸序列或核苷酸序列之间的核苷酸或氨基酸残基的同一性程度——当对它们进行比对以在特定区域最大配对时。当它们之间有足够高的同源性时，对应基因的表达产物可具有相同或相似的活性。序列之间的同源性可通过本领域已知的技术(例如，包括BLAST(NCBI)、CLCMain Workbench(CLC bio)、MegAlign(DNASTAR Inc)等的已知序列比较程序)测定。

[0024] 另一方面，本发明提供编码经修饰的多肽的多核苷酸。

[0025] 如本文所使用的，术语“多核苷酸”是指核苷酸聚合物，其中核苷酸单体通过共价键以链形状(具体地DNA链或RNA链)纵向连接。更具体地，在本发明中，其可以是编码经修饰的多肽的多核苷酸片段。

[0026] 在本发明的示例性实施方式中，编码RNA聚合酶σ因子70的氨基酸序列的基因是rpoD基因，并且可以具体为源自埃希氏菌属的基因，更具体为源自大肠杆菌的基因。编码野生型RNA聚合酶σ因子70的多核苷酸可由SEQ ID NO:7表示，但并不限于此。此外，基于遗传密码简并性，编码相同氨基酸序列的多核苷酸序列及其变体也应包括在本发明的范围内。

[0027] 此外，对于本发明的经修饰的多核苷酸而言，基于遗传密码简并性，编码相同氨基酸序列的多核苷酸序列及其变体也应包括在本发明的范围内。具体地，可以包括编码SEQ ID NO:8的氨基酸序列的多肽的核苷酸序列——其中至少一个氨基酸被另一个上述氨基酸取代——或其变体。具体而言，上述变异位置可以是在440至450；459；466；470至479；484；495至499；509；527；565至570；575至580；599；和612处(自作为第一氨基酸的初始甲硫氨酸起)的氨基酸位置。

[0028] 更具体地，上述变异位置可以是在位置440处的氨基酸被脯氨酸取代(T440P)；在位置446处的氨基酸被脯氨酸取代(Q446P)；在位置448处的氨基酸被丝氨酸取代(R448S)；在位置459处的氨基酸被天冬酰胺取代(T459N)；在位置466处的氨基酸被丝氨酸取代

(I466S)；在位置474处的氨基酸被缬氨酸取代(M474V)；在位置477处的氨基酸被甘氨酸取代(E477G)；在位置484处的氨基酸被缬氨酸取代(A484V)；在位置496处的氨基酸被天冬酰胺取代(K496N)；在位置498处的氨基酸被精氨酸取代(L498R)；在位置509处的氨基酸被甲硫氨酸取代(T509M)；在位置527处的氨基酸被脯氨酸取代(T527P)；在位置567处的氨基酸被缬氨酸取代(M567V)；在位置569处的氨基酸被脯氨酸取代(T569P)；在位置576处的氨基酸被甘氨酸取代(N576G)；在位置579处的氨基酸被精氨酸(Q579R)、亮氨酸(Q579L)、苏氨酸(Q579T)、异亮氨酸(Q579I)、甘氨酸(Q579G)、丙氨酸(Q579A)、脯氨酸(Q579P)或丝氨酸(Q579S)取代；在位置599处的氨基酸被半胱氨酸取代(R599C)；或者在位置612处的氨基酸被甘氨酸(D612G)、酪氨酸(D612Y)、苏氨酸(D612T)、天冬酰胺(D612N)、苯丙氨酸(D612F)、赖氨酸(D612K)、丝氨酸(D612S)、精氨酸(D612R)或组氨酸(D612H)取代；或者核苷酸被终止密码子取代(D612*)，并且可包括编码经修饰的多肽的氨基酸序列的核苷酸序列——其中氨基酸取代是上述34种氨基酸取代中的至少一种的组合——或其变体。

[0029] 甚至更具体地，可包括编码SEQ ID NOS:9至37的氨基酸序列中的任何氨基酸序列的核苷酸序列或其变体。

[0030] 另一方面，本发明提供包括编码经修饰的多肽的多核苷酸的宿主细胞、用包括编码经修饰的多肽的多核苷酸的载体转化的微生物、或引入有经修饰的多肽的微生物。具体地，可以通过转化进行引入，但并不限于此。

[0031] 具体地，相比于包括野生型σ因子70(σ^{70})多肽的微生物，包括σ因子70(σ^{70})修饰的多肽的微生物可具有增强的L-苏氨酸生产能力而不对宿主细胞生长抑制，因此可以从这些微生物中以高收率得到L-苏氨酸。

[0032] 如本文所使用的，术语“载体”是指用于克隆和/或将核苷酸序列转移到宿主细胞中的任何介质。载体可以是能够与不同DNA片段结合的复制子，其导致组合片断的复制。如本文所使用的，术语“复制子”是指可以通过自调节复制的任何遗传单元(例如，质粒、噬菌体、黏粒、染色体和病毒)。载体可包括在体内、先体外后体内(ex-vivo)或体外将核苷酸引入到宿主细胞中的病毒性或非病毒性介质，并且也可包括小环DNA。例如，载体可包括不具有任何细菌DNA序列的质粒(Ehrhardt,A等人.(2003)HumGene Ther 10:215-25;Yet,N.S.(2002)MoI Ther 5:731-38;Chen,Z.Y.等人.(2004)Gene Ther 11:856-64)。此外，载体可包括转座子(Annu Rev Genet.2003;37:3-29.)或人工染色体。具体地，可使用pACYC177、pACYC184、pCL1920、pECCG117、pUC19、pBR322、pDZ、pCC1BAC和pMW118载体，但它们并不限于此。

[0033] 如本文所使用的，术语“转化”是指将基因引入到宿主细胞中以在宿主细胞中表达，并且转化的基因可不受具体限制，只要其可以在宿主细胞中表达，无论转化的基因是否插入到宿主细胞的染色体中或位于染色体外部。

[0034] 可以以表达盒的形式将基因引入到宿主细胞中，所述表达盒是包括所有自表达必要元件的多核苷酸构建体。表达盒可包括以传统方式可操作地连接至基因的启动子、转录终止信号、核糖体结合结构域和翻译终止信号。表达盒可以是可自复制的表达载体。此外，基因可以是作为基因自身或者以与在宿主细胞中表达所必要的序列连接的多核苷酸构建体的形式被引入到宿主细胞中的基因，但并不限于此。

[0035] 如本文所使用的，术语“宿主细胞”或“微生物”可以是指包括编码经修饰的多肽的

多核苷酸、或者由包括编码经修饰的多肽的多核苷酸的载体转化并因此可以表达经修饰的多肽的任何细胞或微生物。

[0036] 在本发明中，宿主细胞或微生物可以是能够生产L-苏氨酸并且包括修饰的σ因子70(σ^{70})的任何细胞或微生物。微生物的实例可包括埃希氏菌属(Escherichia sp.)、沙雷氏菌属(Serratia sp.)、欧文氏菌属(Erwinia sp.)、肠杆菌属(Enterobacteria sp.)、沙门氏菌属(Salmonella sp.)、链霉菌属(Streptomyces sp.)、假单胞菌属(Pseudomona sp.)、短杆菌属(Brevibacterium sp.)、棒杆菌属(Corynebacteria sp.)等；具体地属于埃希氏菌属的微生物，更具体地大肠杆菌，但其并不限于此。

[0037] 另一方面，本发明提供生产L-苏氨酸的方法，其包括在培养基中培养所述微生物，和从培养的微生物或其培养基中回收L-苏氨酸。

[0038] 如本文所使用的，术语“培养”是指在适当和人工调节的环境下使微生物生长。根据本领域已知的合适的培养基和培养条件可进行培养过程。根据本领域普通技术人员的公知常识或本领域已知的常规方法可进行具体的培养过程，并且可相应地进行适当调整。具体地，在[Chmiel;Bioprozesstechnik 1.Einfuhrung indie Bioverfahrenstechnik (Gustav Fischer Verlag,Stuttgart,1991)和Storhas;Bioreaktoren und periphere Einrichtungen(Vieweg Verlag,Braunschweig/Wiesbaden,1994)]中详细描述了培养方法。此外，培养方法可包括分批培养、连续培养和补料分批培养，具体地，可以在补料分批或重复补料分批过程中进行连续培养，但并不限于此。

[0039] 用于培养的培养基应当满足每种具体菌株的需求。包含在培养基中的碳源的实例可包括糖和碳水化合物，如葡萄糖、蔗糖、乳糖、果糖、麦芽糖、淀粉和纤维素；油类及脂肪类，如大豆油、葵花油、蓖麻油和椰子油；脂肪酸，如软脂酸、硬脂酸和亚油酸；醇类，如甘油和乙醇；以及有机酸，如醋酸。这些碳源可单独或组合使用，但并不限于此。包含在培养基中的氮源的实例可包括蛋白胨、酵母提取物、肉汁、麦芽提取物、玉米浆和豆粉、尿素或无机氮源，如硫酸铵、氯化铵、磷酸铵、碳酸铵和硝酸铵。这些氮源可单独或组合使用，但并不限于此。包含在培养基中的磷源的实例可包括磷酸二氢钾、磷酸氢二钾以及相应的含钠盐，但并不限于此。培养基可包括金属，如硫酸镁和硫酸铁。此外，也可包括生长所必须的物质(如氨基酸和维生素)。此外，也可使用适用于培养基的前体。可以以分批培养或连续培养的形式将这些物质添加至培养物中，但并不限于此。

[0040] 此外，在培养过程中可以以适当的方式通过添加化合物诸如氢氧化铵、氢氧化钾、氨、磷酸和硫酸来调节培养物的pH。此外，在培养过程中可以使用消泡剂诸如脂肪酸聚乙二醇酯预防泡沫形成。此外，为了保持培养液中的需氧条件，可以将氧气或含氧气体添加至培养物；不添加空气以保持厌氧条件或微需氧条件；或者可以注入氮气、氢气或二氧化碳。可以在27℃至37℃下进行培养，具体在30℃至35℃下。可以继续培养直到可以获得期望数量的有用物质的生产，具体地进行10小时至100小时。L-苏氨酸可以被导出到培养基中或可以保持包含在微生物中。

[0041] 从微生物或其培养物中回收L-苏氨酸的方法是本领域众所周知的。例如，可使用诸如过滤、阴离子交换色谱、结晶、HPLC等的方法，但并不限于此。

[0042] 发明方式

[0043] 下文中，参照下列实施例将对本发明进行更加详细的描述。然而，这些实施例仅是

为了说明性目的，并且发明并不意在受这些实施例的限制。

[0044] 实施例1.重组载体pCC1BAC-rpoD的构建

[0045] 为了得到包括rpoD基因(NCBI Gene ID:947567,SEQ ID NO:7)的大小为约2.0kb的DNA片段，利用Genomic-tip系统(Qiagen)提取大肠杆菌野生型菌株W3110的染色体DNA(gDNA)，并使用gDNA作为模板以PCR HL预混合液试剂盒(BIONEER,Korea;在下文中使用相同的产品)进行聚合酶链反应(下称“PCR”)。

[0046] 按以下方式使用引物SEQ ID NO:1和SEQ ID NO:2进行扩增rpoD基因的PCR反应27个循环：于95℃变性30秒、于56℃退火30秒以及于72℃延伸2分钟。用HindIII和EcoRI消化PCR产物，在0.8％琼脂糖凝胶上进行电泳，并通过洗脱从中得到2.0kb DNA片段(下称“rpoD片段”)。

[0047] 【表1】

[0048]

引物号	核苷酸序列	SEQ ID NO
1	5’-TACTCAAGCTTCGGCTTAAGTGCCGAAGAGC-3’	1
2	5’-AGGGCGAATTCCTGATCCGGCCTACCGATTA-3’	2

[0049] 随后，用HindIII和EcoRI消化Copycontrol pCC1BAC载体(EPICENTRE,USA)，在0.8％琼脂糖凝胶上进行电泳，并通过洗脱从中得到。将生成物连接至rpoD片段以构建pCC1BAC-rpoD质粒。

[0050] 实施例2:重组载体pCC1BAC-部分rpoD的构建

[0051] 为了得到包括从大肠杆菌W3110的rpoD基因中启动子到BamHI限制位点的区域的、大小为约1.5kb的DNA片段，使用实施例1中制备的gDNA作为模板进行PCR。

[0052] 按以下方式使用引物SEQ ID NO:1和SEQ ID NO:3进行PCR反应(同实施例1中一样进行27个循环)：于95℃变性30秒、于56℃退火30秒以及于72℃延伸1分钟。用BamHI和HindIII消化PCR产物，在0.8％琼脂糖凝胶上进行电泳，并通过洗脱从中得到1.5kb DNA片段。

[0053] 【表2】

[0054]

引物号	核苷酸序列	SEQ ID NO
1	5’-TACTCAAGCTTCGGCTTAAGTGCCGAAGAGC-3’	1
3	5’-GACGGATCCACCAGGTTGCGTA-3’	3

[0055] 随后，用BamHI和HindIII消化Copycontrol pCC1BAC载体，在0.8％琼脂糖凝胶上进行电泳，并通过洗脱得到。将生成物连接至部分rpoD片段以构建pCC1BAC-部分rpoD质粒。

[0056] 实施例3:通过易错PCR生成$rpoD^{m}$片段

[0057] 为了在W3110的rpoD基因的保守区2.4、3和4中引入随机修饰，发明人想要得到rpoD片段的DNA池，其中从基因内的BamHI限制位点至编码该基因的末端引入随机修饰。

[0058] 为达到此目的，根据在其使用手册中所述的表III中的诱变反应4(mutagenesis reactions)的条件，使用实施例1中得到的gDNA以多样化PCR随机诱变试剂盒(目录编号：630703;Clonetech)进行PCR反应。具体地，按以下方式使用SEQ ID NO:2和SEQ ID NO:4引物进行PCR反应25个循环：于94℃变性30秒、于56℃退火30秒以及于68℃延伸30秒。

[0059] 【表3】

[0060]

引物号	核苷酸序列	SEQ ID NO
2	5’-AGGGCGAATTCCTGATCCGGCCTACCGATTA-3’	2
4	5’-AACCTGGTGGATCCGTCAGGCGATC-3’	4

[0061] 随后，作为PCR产物得到在其中引入随机核苷酸取代的突变的人工(mutated art) rpoD DNA池，并用BamHI和EcoRI消化PCR产物，在0.8％琼脂糖凝胶上进行电泳，并通过洗脱从中得到0.5kb DNA片段(下称“人工rpoD片段”)。

[0062] 实施例4：包括经修饰的rpoD的重组载体pCC1BAC-rpoD突变文库的构建

[0063] 用BamHI和EcoRI处理在实施例2中构建的pCC1BAC-部分rpoD载体，随后用碱性磷酸酶(NEB)进行处理。

[0064] 然后，分别用BamHI和EcoRI处理实施例3中得到的人工rpoD片段，并将其连接至已经用限制酶进行处理的pCC1BAC-部分rpoD载体、转化到TransforMax EPI300电感受态大肠杆菌(EPICENTRE)中、在含15μg/mL氯霉素的LB板中培养，并从中选出菌落。收集所选择的菌落并经历质粒制备(plasmid prep)以构建pCC1BAC-rpoD突变文库。

[0065] 实施例5：将pCC1BAC-rpoD突变文库引入到苏氨酸生产菌株中

[0066] 通过转化将在实施例4中构建的pCC1BAC-rpoD突变文库引入到为苏氨酸生产菌株的KCCM10541的电感受态细胞中。

[0067] 具体而言，KCCM10541(韩国专利号10-0576342)——在该实施例中所用的大肠杆菌菌株——是源自KFCC10718(韩国专利号10-0058286)的大肠杆菌菌株，其中galR基因失活。

[0068] 实施例6：重组微生物之间的L-苏氨酸生产能力的比较，以及核苷酸序列的确认

[0069] 在下表4中所示的效价培养基(titer medium)中培养在实施例5中构建的重组微生物文库，并检测L-苏氨酸生产的提高。

[0070] 【表4】

[0071]

组成	浓度(每1L)
葡萄糖	70g
KH_2PO_4	2g
$(NH_4)_2SO_4$	25g
$MgSO_4 \cdot 7H_2O$	1g
$FeSO_4 \cdot 7H_2O$	5mg
$MnSO_4 \cdot 4H_2O$	5mg
DL-甲硫氨酸	0.15g
酵母提取物	2g
碳酸钙	30g
pH	6.8

[0072] 具体地，通过铂金环分别将在33℃培养箱中在固体LB培养基中过夜培养大肠杆菌KCCM10541/pCC1BAC-rpoD和大肠杆菌KCCM10541/pCC1BAC-rpoD突变文库接种到25mL效价培养基中，并在33℃培养箱中同时以200rpm振动培养48小时。重复整个过程以评估rpoD突变文库，并选出具有提高收率的那些克隆。

[0073] 【表5】

[0074]

菌株	L-苏氨酸（g/L）	L-苏氨酸浓度的增加率（%）	修饰位置	SEQ ID NO
KCCM 10541（亲本菌株）	30.4	-		
KCCM 10541/pCC1BAC-rpoD	30.4	-		8
KCCM 10541/pCC1BAC-rpoD^{m1}	32.8	7.9	579、612	9
KCCM 10541/pCC1BAC-rpoD^{m2}	33.0	8.6	579、612	10
KCCM 10541/pCC1BAC-rpoD^{m3}	33.6	10.5	579、612	11
KCCM 10541/pCC1BAC-rpoD^{m4}	34.0	11.8	579、612	12
KCCM 10541/pCC1BAC-rpoD^{m5}	33.4	9.9	579、612	13
KCCM 10541/pCC1BAC-rpoD^{m6}	34.0	11.8	579、612	14
KCCM 10541/pCC1BAC-rpoD^{m7}	33.5	10.2	579、612	15
KCCM 10541/pCC1BAC-rpoD^{m8}	32.5	6.9	579、612	16
KCCM 10541/pCC1BAC-rpoD^{m9}	32.0	5.3	579、612	17
KCCM 10541/pCC1BAC-rpoD^{m10}	32.0	5.3	579、612	18
KCCM 10541/pCC1BAC-rpoD^{m11}	32.1	5.6	579、612	19
KCCM 10541/pCC1BAC-rpoD^{m12}	32.0	5.3	579、612	20
KCCM 10541/pCC1BAC-rpoD^{m13}	34.0	11.8	579、612	21
KCCM 10541/pCC1BAC-rpoD^{m14}	34.2	12.6	440	22
KCCM 10541/pCC1BAC-rpoD^{m15}	34.0	11.8	440、496	23
KCCM 10541/pCC1BAC-rpoD^{m16}	32.4	6.6	446、448、466、527、567	24
KCCM 10541/pCC1BAC-rpoD^{m17}	32.5	7.1	440、477、498	25

[0075]

KCCM 10541/pCC1BAC-rpoD^{m18}	31.9	4.8	440、599	26
KCCM 10541/pCC1BAC-rpoD^{m19}	33.8	11.3	440、484	27
KCCM 10541/pCC1BAC-rpoD^{m20}	34.0	11.9	459、474、509	28
KCCM 10541/pCC1BAC-rpoD^{m21}	31.9	4.8	440、576	29
KCCM 10541/pCC1BAC-rpoD^{m22}	33.9	11.6	440、569	30

[0076] 上表5所示的结果表明，当培养48小时，亲本菌株KCCM 10541和对照菌株KCCM10541/pCC1BAC-rpoD产生约30.4g/L的L-苏氨酸。

[0077] 相反，相比于其亲本菌株，引入有pCC1BAC-rpoD突变文库的重组大肠杆菌产生从31.9g/L至34.2g/L范围的L-苏氨酸，从而显示出提高的L-苏氨酸生产能力，即，相比于其亲本菌株，L-苏氨酸生产能力提高4.8％至12.6％。

[0078] 另外，通过测序检测在具有提高的L-苏氨酸生产能力的大肠杆菌的修饰rpoD基因的每个修饰中的修饰位置和取代氨基酸，结果显示在表5中。

[0079] 同时，在转化的大肠杆菌之中具有L-苏氨酸生产能力最大提高的重组大肠杆菌(命名为“KCCM10541/pCC1BAC-rpoD^{m19}”)于2014年8月6日保藏于韩国微生物保藏中心(登录号:KCCM11560P)。

[0080] 实施例7:引入有选择的rpoD变体的野生型菌株和对其苏氨酸生产有增强的生物合成途径的野生型菌株的构建

[0081] 在实施例6中确认有提高的苏氨酸生产能力的rpoD变体中的一些变异基于野生型菌株经历对其作用再确认。以与实施例5中相同的方式，用在实施例6中确认的rpoD变异对野生型菌株W3110进行转化，并且被指定为W3110/pCC1BAC-rpoD^{m}。使引入有rpoD变异的菌株引入有pACYC184-thrABC载体，以提供具有苏氨酸生产能力的菌株。按下述构建pACYC184-thrABC。

[0082] 使用源自大肠杆菌菌株KCCM 10718(韩国专利号10-0058286)的L-苏氨酸生产大肠杆菌菌株KCCM 10541(韩国专利号10-0576342;中国专利号100379851C)的基因组DNA作为模板同引物SEQ ID NOS:5和6(表6)一起进行PCR。从中得到的DNA片段被分离/纯化、通过用HindIII处理，随后进行纯化而制备，从而制备出thrABC DNA片段。通过用HindIII处理随后进行纯化制备pACYC184载体，并将其连接从而构建pACYC184-thrABC载体。将由此制备的载体引入到W3110/pCC1BAC-rpoD^{m}菌株中，以构建W3110/pCC1BAC-rpoD^{m}、pACYC184-thrABC菌株。

[0083] 【表6】

[0084]

SEQ ID NO	引物序列
5	5’-CGAGAAGCTTAGCTTTTCATTCTGACTGCA-3’’
6	5’-CGAGAAGCTTATTGAGATAATGAATAGATT-3’

[0085] 实施例8:野生型菌株、具有rpoD变异的基于野生型菌株的重组微生物以及对其苏

氨酸生产有增强的生物合成途径的菌株之间的L-苏氨酸生产能力的比较

[0086] 在使用苏氨酸效价培养基的锥形烧瓶中培养实施例7中制备的重组微生物，并从而确定其提高的L-苏氨酸生产力。

[0087] 【表7】

[0088]

组成	浓度(每1L)
葡萄糖	70g
KH_2PO_4	2g
$(NH_4)_2SO_4$	25g
$MgSO_4 \cdot 7H_2O$	1g
$FeSO_4 \cdot 7H_2O$	5mg
$MnSO_4 \cdot 4H_2O$	5mg
酵母提取物	2g
碳酸钙	30g
pH	6.8

[0089] 将在33℃培养箱中在固体LB培养基中过夜培养的W3110/pCC1BAC-rpoD^{m}、

[0090] W3110/pACYC184-thrABC、pCC1BAC和W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m}菌株中的每一个的铂金环接种在表7中所示的效价培养基(25mL)，并在33℃培养箱中以200rpm的速率培养48小时。结果显示在下表8中。

[0091] 【表8】

[0092]

菌株	OD	葡萄糖消耗（g/L）	L-苏氨酸（g/L）	收率（%）
W3110/pCC1BAC	15.4	52.2	0	0
W3110/pCC1BAC-rpoD	15.4	52.2	0	0
W3110/pCC1BAC-rpoD^{m2}	15.0	50.6	0	0
W3110/pCC1BAC-rpoD^{m19}	15.5	52.0	0	0
W3110/pACYC184-thrABC、pCC1BAC	13.4	50.1	1.42	2.8
W3110/pACYC184-thrABC、pCC1BAC-rpoD	13.3	50.2	1.43	2.8
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m2}	12.5	51.2	1.52	3.0
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m19}	11.2	51.0	1.56	3.1

[0093] 如表8所示，野生型菌株W3110/pCC1BAC以及其它菌株W3110/pCC1BAC-rpoD、W3110/pCC1BAC-rpoD^{m2}和W3110/pCC1BAC-rpoD^{m19}当被培养48小时不再产生L-苏氨酸，而引入有变体的菌株显示出葡萄糖消耗的减少。W3110/pACYC184-thrABC、pCC1BAC菌株——为生产L-苏氨酸而在野生型基础上构建的重组菌株——产生1.42g/L的L-苏氨酸，而W3110/pACYC184-thrABC、pCC1BAC-rpoD菌株产生1.43g/L的L-苏氨酸，从而显示出2.8％的收率。

[0094] 相反，W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m2}菌株和W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m19}菌株——为引入有rpoD变异的基于野生型的重组菌株——分别显示出48小时51.2g/L和51.0g/L量的葡萄糖消耗，并且分别产生1.50g/L和1.53g/L量的苏氨酸，从而显示出苏氨酸的3.0％和3.1％收率。即，证实了rpoD变异的引入提高了苏氨酸收率约7％

至10％，从而再次确认本发明中所选择的rpoD变异是有效的变体。

[0095] 实施例9：通过组合选择的重组rpoD变异对L-苏氨酸生产能力的检测

[0096] 为了通过组合包括在选择的变异中每个不同对象中的变异来检测苏氨酸生产能力的变化，为一些最常选择的变异构建具有组合变异的载体。通过组合上述评估的$rpoD^{m2}$变异和$rpoD^{m14}$变异来构建$rpoD^{m23}$(SEQ ID NO:31)变异——其中组合了在440、579和612位置处的氨基酸序列的变异。进一步地，通过组合$rpoD^{m16}$变异和$rpoD^{m3}$变异来构建引入有最多变异的$rpoD^{m24}$(SEQ ID NO:32)变异。使$rpoD^{m24}$变异引入有在446、448、466、527和567位置处的氨基酸序列变异的$rpoD^{m16}$变异和在579和612位置处的氨基酸序列变异$rpoD^{m3}$变异两者。此外，在3种区变异之中，通过组合$rpoD^{m15}$的位置496处的氨基酸序列变异和$rpoD^{m1}$的位置579和612处的氨基酸序列变异来构建$rpoD^{m25}$(SEQ ID NO:33)变异。

[0097] 此外，构建存在于相互不同的变异中的氨基酸变异的组合以确认其作用。例如，将在最常选择的440、579和/或612位置处的氨基酸变异进行组合以构建$rpoD^{m26}$(SEQ ID NO:34)——其中组合位置440和579处的变异；和$rpoD^{m27}$(SEQ ID NO:35)——其中组合位置440和612处的变异。

[0098] 此外，构建在选择的变异中低频率变异的组合以确认其作用。例如，为了构建$rpoD^{m28}$(SEQ ID NO:36)，将$rpoD^{m17}$的位置477处的变异、$rpoD^{m19}$的位置484处的变异和$rpoD^{m20}$的位置509处的变异进行组合；和为了构建$rpoD^{m29}$(SEQ ID NO:37)，将$rpoD^{m18}$的位置599处的变异、$rpoD^{m20}$的位置459处的变异和$rpoD^{m21}$的位置576处的变异进行组合。

[0099] 将由此制备的引入有$rpoD^{m23}$、$rpoD^{m24}$、$rpoD^{m25}$、$rpoD^{m26}$、$rpoD^{m27}$、$rpoD^{m28}$和$rpoD^{m29}$变异的载体与在实施例7中制备的pACYC184-thrABC载体一起引入到W3110中，并使用表7中所示的培养基进行效价评估。结果显示在下表9中。

[0100] 【表9】

[0101]

菌株	OD	葡萄糖消耗（g/L）	L-苏氨酸（g/L）	收率（%）	变异位置	SEQ ID NO
W3110/pACYC184-thrABC、pCC1BAC	13.2	50.5	1.40	2.8		
W3110/pACYC184-thrABC、pCC1BAC-rpoD	13.1	50.8	1.44	2.8		
W3110/pACYC184-thrABC、pCC1BAC-$rpoD^{m23}$	13.6	52.5	1.61	3.1	440、579、612	31

[0102]

W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m24}	12.0	49.5	1.50	3.0	446、448、466、527、567、579、612	32
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m25}	12.9	52.5	1.52	2.9	496、579、612	33
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m26}	13.3	51.4	1.52	3.0	440、579	34
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m27}	13.9	50.5	1.54	3.0	440、612	35
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m28}	12.8	48.5	1.39	2.9	477、484、509	36
W3110/pACYC184-thrABC、pCC1BAC-rpoD^{m29}	12.6	50.3	1.49	3.0	459、576、599	37

[0103] 基于上述，本发明所属的本领域技术人员将能够理解，可以以其它具体的形式体现本发明，而不改变本发明的技术理念或本质特征。在这方面，本文公开的示例性实施方式仅是为了说明性目的，并且不应被理解为限制本发明的范围。相反，本发明旨在不仅涵盖示例性实施方式，而且涵盖可以包括在由所附权利要求限定的本发明的精神和范围内的各种替换、修改、等同物和其它实施方式。

关于用于专利程序的微生物保藏的国际承认的布达佩斯条约
国际表格

CJ 第一制糖株式会社
CJ CHEILJEDANG CENTER,
330，DONGHO-RO,
JUNG-GU，首尔 100-400，
大韩民国

[0104]

I. 微生物鉴定	
由保藏者提供鉴定参考： 大肠杆菌(*Escherichia coli*) CA03-0534P	由国际保藏机构提供的登录号： KCCM11560P
II. 科学描述和/或建议的分类学名称	
如上 I 鉴定的微生物带有： □ 科学描述 □ 建议的分类学名称 （如果适用，用叉号标记）	
III. 收到和接收	
该国际保藏机构接收如上 I 鉴定的微生物，其于 2014 年 8 月 6 日收到。（原始保藏日）[1]	
IV. 国际保藏机构	
名称：韩国微生物保藏中心 地址：Yurim B/D 45，Hongjenae-2ga-gil Seodaemun-gu 首尔 120-861 大韩民国	具有代表该国际保藏机构的权力的自然人或授权官员签名：（盖章） 日期：2014 年 8 月 6 日

上述译文内容与原文一致无误，特此证明。

2015 年 8 月 24 日

专利代理人 孙敏(印)

序列表

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[0004]

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Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

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

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
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65                  70                  75                  80

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Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
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Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
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Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
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Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
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[0005]

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Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
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Leu Phe Thr Gly Asn Glu Thr Ser Asp Thr Trp Phe Asn Ala Ala Ile
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Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
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Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
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Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
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Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
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         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
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Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
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Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
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260 265 270

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290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

[0007]

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg

595 600 605

Ser Phe Leu Tyr Asp
610

<210> 11
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 11
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

[0008] Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu

325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

[0009] Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Leu Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Thr Asp
610

<210> 12
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 12
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp

50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

[0010]

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

```
Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Asn Asp
    610
```

<210> 13
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

[0011]

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<400> 13
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190
```

```
Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400
```

[0012]

```
Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Thr Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605
```

Ser Phe Leu Gly Asp
610

<210> 14
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 14
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

[0013]

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

[0014]

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Phe Asp
610

<210> 15
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 15
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

[0015]

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro

```
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Ile Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Lys Asp
    610
```

<210> 16
<211> 611
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

[0016]

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<400> 16
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
```

195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

[0017]

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Leu Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu
610

<210> 17
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 17
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

[0018]

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

[0019]

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gly Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Ser Asp
610

<210> 18
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 18
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

```
Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270
```

[0020]

```
Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480
```

```
Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Ala Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Phe Asp
    610
```

<210> 19
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

[0021]

<400> 19

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
            20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
        35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
    50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205
```

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

[0022]

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Pro Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Arg Asp

610

<210> 20
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 20
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

[0023] Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly

340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

[0024] His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Ser Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu His Asp
610

<210> 21
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 21
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala

65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

[0025]

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

```
Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu His Asp
    610
```

<210> 22
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

[0026]

<400> 22

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205
```

```
Asp Asn Ser Ile Asp Pro Glu Leu Ala Arg Glu Lys Phe Ala Glu Leu
    210                 215                 220

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415
```

[0027]

```
Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Asp Asp
    610
```

<210> 23
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 23

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140
```

[0028]

```
Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350
```

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Asn
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

[0029]

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 24
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 24
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

```
Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                  85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
             100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
         115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
     130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                 165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
             180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
         195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                 245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
             260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
         275                 280                 285
```

[0030]

```
Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
     290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                 325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
             340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
         355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
     370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                 405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
             420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Pro Ala Ser
         435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
     450                 455                 460

Arg Ser Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
```

485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Pro Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Val Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 25
<211> 613
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<213> 人工序列

<220>
<223> rpoD变体

<400> 25

[0031]

Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

Asp Asn Ser Ile Asp Pro Glu Leu Ala Arg Glu Lys Phe Ala Glu Leu

210 215 220

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

[0032]

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Gly Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Arg Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 26
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 26

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Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140
```

[0033]

```
Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350
```

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

[0034]

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Cys His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 27
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<212> PRT
<213> 人工序列

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<400> 27
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

[0035]

```
Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Val Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495
```

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

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<220>
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Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

[0036]

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

[0037] Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Asn Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Val Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Met Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 29
<211> 613
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<213> 人工序列

<220>
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<400> 29

Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

[0038] Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly

355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

[0039] Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Gly
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 30
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 30
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp

85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

[0040]

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

```
Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Pro Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Asp Asp
    610
```

<210> 31
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 31

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Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15
```

[0041]

```
Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

Asp Asn Ser Ile Asp Pro Glu Leu Ala Arg Glu Lys Phe Ala Glu Leu
    210                 215                 220
```

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

[0042]

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Tyr Asp
610

<210> 32

<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 32

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365
```

[0043]

```
Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Pro Ala Ser
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ser Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Pro Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Val Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575
```

[0044]

```
Gly Lys Leu Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Thr Asp
    610
```

<210> 33
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 33

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
             20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
         35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
     50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
 65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                 85                  90                  95
```

```
Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300
```

[0045]

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Asn
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
```

```
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Gly Asp
    610
```

<210> 34
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 34

[0046]

```
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
            20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
        35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
    50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                85                  90                  95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
```

225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
370 375 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385 390 395 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
405 410 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
420 425 430

[0047] Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
435 440 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
450 455 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465 470 475 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
485 490 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
500 505 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Arg Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 35
<211> 613

<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 35

Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

[0048]

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
245 250 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
260 265 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
275 280 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
290 295 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
325 330 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
340 345 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
355 360 365

```
Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Pro Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
                565                 570                 575
```

[0049]

```
Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Gly Asp
    610


<210>    36
<211>    613
<212>    PRT
<213>    人工序列

<220>
<223>    rpoD变体


<400>    36
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
  1               5                  10                  15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
            20                  25                  30

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
        35                  40                  45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
    50                  55                  60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65                  70                  75                  80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
                85                  90                  95
```

```
Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
            100                 105                 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
        115                 120                 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
    130                 135                 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145                 150                 155                 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
                165                 170                 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
            180                 185                 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
        195                 200                 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225                 230                 235                 240

Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300
```

[0050]

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430

Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Thr Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Gly Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Val Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Met Pro Ile Gly
            500                 505                 510
```

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
515 520 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
530 535 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545 550 555 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Val
565 570 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
580 585 590

Lys Ala Leu Arg Lys Leu Arg His Pro Ser Arg Ser Glu Val Leu Arg
595 600 605

Ser Phe Leu Asp Asp
610

<210> 37
<211> 613
<212> PRT
<213> 人工序列

<220>
<223> rpoD变体

<400> 37
Met Glu Gln Asn Pro Gln Ser Gln Leu Lys Leu Leu Val Thr Arg Gly
1 5 10 15

Lys Glu Gln Gly Tyr Leu Thr Tyr Ala Glu Val Asn Asp His Leu Pro
20 25 30

[0051]

Glu Asp Ile Val Asp Ser Asp Gln Ile Glu Asp Ile Ile Gln Met Ile
35 40 45

Asn Asp Met Gly Ile Gln Val Met Glu Glu Ala Pro Asp Ala Asp Asp
50 55 60

Leu Met Leu Ala Glu Asn Thr Ala Asp Glu Asp Ala Ala Glu Ala Ala
65 70 75 80

Ala Gln Val Leu Ser Ser Val Glu Ser Glu Ile Gly Arg Thr Thr Asp
85 90 95

Pro Val Arg Met Tyr Met Arg Glu Met Gly Thr Val Glu Leu Leu Thr
100 105 110

Arg Glu Gly Glu Ile Asp Ile Ala Lys Arg Ile Glu Asp Gly Ile Asn
115 120 125

Gln Val Gln Cys Ser Val Ala Glu Tyr Pro Glu Ala Ile Thr Tyr Leu
130 135 140

Leu Glu Gln Tyr Asp Arg Val Glu Ala Glu Glu Ala Arg Leu Ser Asp
145 150 155 160

Leu Ile Thr Gly Phe Val Asp Pro Asn Ala Glu Glu Asp Leu Ala Pro
165 170 175

Thr Ala Thr His Val Gly Ser Glu Leu Ser Gln Glu Asp Leu Asp Asp
180 185 190

Asp Glu Asp Glu Asp Glu Glu Asp Gly Asp Asp Asp Ser Ala Asp Asp
195 200 205

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

Arg Ala Gln Tyr Val Val Thr Arg Asp Thr Ile Lys Ala Lys Gly Arg
225 230 235 240

```
Ser His Ala Thr Ala Gln Glu Glu Ile Leu Lys Leu Ser Glu Val Phe
                245                 250                 255

Lys Gln Phe Arg Leu Val Pro Lys Gln Phe Asp Tyr Leu Val Asn Ser
            260                 265                 270

Met Arg Val Met Met Asp Arg Val Arg Thr Gln Glu Arg Leu Ile Met
        275                 280                 285

Lys Leu Cys Val Glu Gln Cys Lys Met Pro Lys Lys Asn Phe Ile Thr
    290                 295                 300

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

Ala Met Asn Lys Pro Trp Ser Glu Lys Leu His Asp Val Ser Glu Glu
                325                 330                 335

Val His Arg Ala Leu Gln Lys Leu Gln Gln Ile Glu Glu Glu Thr Gly
            340                 345                 350

Leu Thr Ile Glu Gln Val Lys Asp Ile Asn Arg Arg Met Ser Ile Gly
        355                 360                 365

Glu Ala Lys Ala Arg Arg Ala Lys Lys Glu Met Val Glu Ala Asn Leu
    370                 375                 380

Arg Leu Val Ile Ser Ile Ala Lys Lys Tyr Thr Asn Arg Gly Leu Gln
385                 390                 395                 400

Phe Leu Asp Leu Ile Gln Glu Gly Asn Ile Gly Leu Met Lys Ala Val
                405                 410                 415

Asp Lys Phe Glu Tyr Arg Arg Gly Tyr Lys Phe Ser Thr Tyr Ala Thr
            420                 425                 430
```

[0052]

```
Trp Trp Ile Arg Gln Ala Ile Thr Arg Ser Ile Ala Asp Gln Ala Arg
        435                 440                 445

Thr Ile Arg Ile Pro Val His Met Ile Glu Asn Ile Asn Lys Leu Asn
    450                 455                 460

Arg Ile Ser Arg Gln Met Leu Gln Glu Met Gly Arg Glu Pro Thr Pro
465                 470                 475                 480

Glu Glu Leu Ala Glu Arg Met Leu Met Pro Glu Asp Lys Ile Arg Lys
                485                 490                 495

Val Leu Lys Ile Ala Lys Glu Pro Ile Ser Met Glu Thr Pro Ile Gly
            500                 505                 510

Asp Asp Glu Asp Ser His Leu Gly Asp Phe Ile Glu Asp Thr Thr Leu
        515                 520                 525

Glu Leu Pro Leu Asp Ser Ala Thr Thr Glu Ser Leu Arg Ala Ala Thr
    530                 535                 540

His Asp Val Leu Ala Gly Leu Thr Ala Arg Glu Ala Lys Val Leu Arg
545                 550                 555                 560

Met Arg Phe Gly Ile Asp Met Asn Thr Asp Tyr Thr Leu Glu Glu Gly
                565                 570                 575

Gly Lys Gln Phe Asp Val Thr Arg Glu Arg Ile Arg Gln Ile Glu Ala
            580                 585                 590

Lys Ala Leu Arg Lys Leu Cys His Pro Ser Arg Ser Glu Val Leu Arg
        595                 600                 605

Ser Phe Leu Asp Asp
    610
```