(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 121 283 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.01.2017 Bulletin 2017/04

(21) Application number: **16175906.3**

(22) Date of filing: **27.08.2010**

(51) Int Cl.:
C12N 15/82 *(2006.01)* ***A01H 5/00*** *(2006.01)*
A01H 5/10 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **31.08.2009 US 238254 P**
31.08.2009 EP 09169079

(60) Divisional application:
16205641.0

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
10747214.4 / 2 473 609

(71) Applicant: **BASF Plant Science Company GmbH**
67056 Ludwigshafen (DE)

(72) Inventors:
- **SENGER, Toralf**
  Durham, NC 27713 (US)
- **BAUER, Jörg**
  14513 Teltow (DE)
- **KUHN, Josef Martin**
  67117 Limburgerhof (DE)

(74) Representative: **Herzog, Fiesser & Partner Patentanwälte PartG mbB**
Dudenstrasse 46
68167 Mannheim (DE)

Remarks:
This application was filed on 23.6.2016 as a divisional application to the application mentioned under INID code 62.

(54) REGULATORY NUCLEIC ACID MOLECULES FOR ENHANCING SEED-SPECIFIC GENE EXPRESSION IN PLANTS PROMOTING ENHANCED POLYUNSATURATED FATTY ACID SYNTHESIS

(57) The invention in principle pertains to the field of recombinant manufacture of fatty acids. It provides novel nucleic acid molecules comprising nucleic acid sequences encoding fatty acid desaturases, elongases, acyltransferases, terminator sequences and high expressing seed-specific promoters operatively linked to the said nucleic acid sequences, wherein nucleic acid expression enhancing nucleic acids (NEENAs) are functionally linked to said promoters.

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The invention in principle pertains to the field of recombinant manufacture of fatty acids. It provides novel nucleic acid molecules comprising nucleic acid sequences encoding fatty acid desaturases, elongases, acyltransferases, terminator sequences and high expressing seed-specific promoters operatively linked to the said nucleic acid sequences wherein nucleic acid expression enhancing nucleic acids (NEENAs) are functionally linked to said promoters.

[0002] The invention also provides recombinant expression vectors containing the nucleic acid molecules, host cells or host cell cultures into which the expression vectors have been introduced, and methods for large-scale production of long chain polyunsaturated fatty acids (LCPUFAs), *e.g.* arachidonic acid (ARA), eicosapentaenoic acid (EPA) or docosahexaenoic acid (DHA).

Description of the Invention

[0003] Expression of transgenes in plants is strongly affected by various external and internal factors resulting in a variable and unpredictable level of transgene expression. Often a high number of transformants have to be produced and analyzed in order to identify lines with desirable expression strength. As transformation and screening for lines with desirable expression strength is costly and labor intensive there is a need for high expression of one or more transgenes in a plant. This problem is especially pronounced, when several genes have to be coordinately expressed in a transgenic plant in order to achieve a specific effect as a plant has to be identified in which each and every gene is strongly expressed.

[0004] For example, expression of a transgene can vary significantly, depending on construct design and positional effects of the T-DNA insertion locus in individual transformation events. Strong promoters can partially overcome these challenges. However, availability of suitable promoters showing strong expression with the desired specificity is often limited. In order to ensure availability of sufficient promoters with desired expression specificity, the identification and characterization of additional promoters can help to close this gap. However, natural availability of promoters of the respective specificity and strength and the time consuming characterization of promoter candidates impedes the identification of suitable new promoters.

[0005] In order to overcome these challenges, diverse genetic elements and/or motifs have been shown to positively affect gene expression. Among these, some introns have been recognized as genetic elements with a strong potential for improving gene expression. Although the mechanism is largely unknown, it has been shown that some introns positively affect the steady state amount of mature mRNA, possibly by enhanced transcriptional activity, improved mRNA maturation, enhanced nuclear mRNA export and/or improved translation initiation (e.g. Huang and Gorman, 1990; Le Hir et al., 2003; Nott et al., 2004). Since only selected introns were shown to increase expression, splicing as such is likely not accountable for the observed effects.

[0006] The increase of gene expression observed upon functionally linking introns to promoters is called intron mediated enhancement (IME) of gene expression and has been shown in various monocotyledonous (e.g. Callis et al., 1987; Vasil et al., 1989; Bruce et al., 1990; Lu et al., 2008) and dicotyledonous plants (e.g. Chung et al., 2006; Kim et al., 2006; Rose et al., 2008). In this respect, the position of the intron in relation to the translational start site (ATG) was shown to be crucial for intron mediated enhancement of gene expression (Rose et al., 2004).

[0007] Next to their potential for enhancing gene expression, few introns were shown to also affect the tissue specificity in their native nucleotide environment in plants. Reporter gene expression was found to be dependent on the presence of genomic regions containing up to two introns (Sieburth et al., 1997; Wang et al., 2004). 5' UTR introns have also been reported to be of importance for proper functionality of promoter elements, likely due to tissue specific gene control elements residing in the introns (Fu et al., 1995a; Fu et al., 1995b; Vitale et al., 2003; Kim et al., 2006). However, these studies also show that combination of introns with heterologous promoters can have strong negative impacts on strength and/or specificity of gene expression (Vitale et al., 2003; Kim et al., 2006, WO2006/003186, WO2007/098042). For example the strong constitutive Cauliflower Mosaic Virus CaMV35S promoter is negatively affected through combination with the sesame SeFAD2 5' UTR intron (Kim et al., 2006). In contrast to these observations, some documents show enhanced expression of a nucleic acid by IME without affecting the tissue specificity of the respective promoter (Schünemann et al., 2004). Introns or NEENAs that enhance seed-specific expression when functionally linked to a heterologous promoter have not been shown in the art.

[0008] In the present application further nucleic acid molecules are described that enhance the expression of said promoters without affecting their specificity upon functionally linkage to seed-specific promoters. These nucleic acid molecules are in the present application described as " nucleic acid expression enhancing nucleic acids" (NEENA). Introns have the intrinsic feature to be spliced out of the respective pre-mRNA. In contrast to that the nucleic acids presented in the application at hand, do not necessarily have to be included in the mRNA or, if present in the mRNA, have not necessarily to be spliced out of the mRNA in order to enhance the expression derived from the promoter the NEENAs are functionally linked to.

Detailed description of the Invention

[0009] A first embodiment of the invention pertains to a polynucleotide that promotes enhancing of polyunsaturated fatty acid synthesis, therefore it pertains in generally in the recombinant manufacture of polyunsaturated fatty acids.

[0010] Fatty acids are carboxylic acids with long-chain hydrocarbon side groups that play a fundamental role in many biological processes. Fatty acids are rarely found free in nature but, rather, occur in esterified form as the major component of lipids. As such, lipids/ fatty acids are sources of energy (*e.g.*, b-oxidation). In addition, lipids/ fatty acids are an integral part of cell membranes and, therefore, are indispensable for processing biological or biochemical information.

[0011] Fatty acids can be divided into two groups: saturated fatty acids formed of single carbon bonds and the unsaturated fatty acids which contain one or more carbon double bonds in *cis*-configuration. Unsaturated fatty acids are produced by terminal desaturases that belong to the class of nonheme-iron enzymes. Each of these enzymes are part of an electron-transport system that involves one or two other proteins, namely cytochrome b_5 and NADH-cytochrome b_5 reductase. The cytochrome b5 functionality can also be n-terminaly fused to the desaturase mojety of one single protein. Specifically, such enzymes catalyze the formation of double bonds between the carbon atoms of a fatty acid molecule, for example, by catalyzing the oxygen-dependent dehydrogenation of fatty acids (Sperling *et al.,* 2003). Human and other mammals have a limited spectrum of desaturases that are required for the formation of particular double bonds in unsaturated fatty acids and thus, have a limited capacity for synthesizing essential fatty acids, *e.g.,* long chain polyunsaturated fatty acids (LCPUFAs). Thus, humans have to take up some fatty acids through their diet. Such essential fatty acids include, for example, linoleic acid (C18:2), linolenic acid (C18:3). In contrast, insects, microorganisms and plants are able to synthesize a much larger variety of unsaturated fatty acids and their derivatives. Indeed, the biosynthesis of fatty acids is a major activity of plants and microorganisms.

[0012] Long chain polyunsaturated fatty acids (LCPUFAs) such as docosahexaenoic acid (DHA, 22:6(4,7,10,13,16,19)) are essential components of cell membranes of various tissues and organelles in mammals (nerve, retina, brain and immune cells). For example, over 30% of fatty acids in brain phospholipid are 22:6 (n-3) and 20:4 (n-6) (Crawford, M.A., et al., (1997) Am. J. Clin. Nutr. 66:1032S-1041S). In retina, DHA accounts for more than 60% of the total fatty acids in the rod outer segment, the photosensitive part of the photoreceptor cell (Giusto, N.M., et al. (2000) Prog. Lipid Res. 39:315-391). Clinical studies have shown that DHA is essential for the growth and development of the brain in infants, and for maintenance of normal brain function in adults (Martinetz, M. (1992) J. Pediatr. 120:S129-S138). DHA also has significant effects on photoreceptor function involved in the signal transduction process, rhodopsin activation, and rod and cone development (Giusto, N.M., et al. (2000) Prog. Lipid Res. 39:315-391). In addition, some positive effects of DHA were also found on diseases such as hypertension, arthritis, atherosclerosis, depression, thrombosis and cancers (Horrocks, L.A. and Yeo, Y.K. (1999) Pharmacol. Res. 40:211-215). Therefore, appropriate dietary supply of the fatty acid is important for human health. Because such fatty acids cannot be efficiently synthesized by infants, young children and senior citizens, it is particularly important for these individuals to adequately intake these fatty acids from the diet (Spector, A.A. (1999) Lipids 34:S1-S3).

[0013] Currently the major sources of DHA are oils from fish and algae. Fish oil is a major and traditional source for this fatty acid, however, it is usually oxidized by the time it is sold. In addition, the supply of fish oil is highly variable, particularly in view of the shrinking fish populations. Moreover, the algal source of oil is expensive due to low yield and the high costs of extraction.

[0014] EPA and ARA are both Δ5 essential fatty acids. They form a unique class of food and feed constituents for humans and animals. EPA belongs to the n-3 series with five double bonds in the acyl chain. EPA is found in marine food and is abundant in oily fish from North Atlantic. ARA belongs to the n-6 series with four double bonds. The lack of a double bond in the ω-3 position confers on ARA different properties than those found in EPA. The eicosanoids produced from ARA have strong inflammatory and platelet aggregating properties, whereas those derived from EPA have anti-inflammatory and anti-platelet aggregating properties. ARA can be obtained from some foods such as meat, fish and eggs, but the concentration is low.

[0015] Gamma-linolenic acid (GLA) is another essential fatty acid found in mammals. GLA is the metabolic intermediate for very long chain n-6 fatty acids and for various active molecules. In mammals, formation of long chain polyunsaturated fatty acids is rate-limited by Δ6 desaturation. Many physiological and pathological conditions such as aging, stress, diabetes, eczema, and some infections have been shown to depress the Δ6 desaturation step. In addition, GLA is readily catabolized by the oxidation and rapid cell division associated with certain disorders, e.g., cancer or inflammation. Therefore, dietary supplementation with GLA can reduce the risks of these disorders. Clinical studies have shown that dietary supplementation with GLA is effective in treating some pathological conditions such as atopic eczema, premenstrual syndrome, diabetes, hypercholesterolemia, and inflammatory and cardiovascular disorders.

[0016] A large number of benefitial health effects have been shown for DHA or mixtures of EPA/DHA. DHA is a n-3 very long chain fatty acid with six double bonds.

[0017] Although biotechnology offers an attractive route for the production of specialty fatty acids, current techniques fail to provide an efficient means for the large scale production of unsaturated fatty acids. Accordingly, there exists a need for an improved and efficient method of producing unsaturated fatty acids, such as DHA, EPA and ARA.

[0018] Thus, the present invention relates to a polynucleotide comprising:

a) at least one nucleic acid sequence encoding a polypeptide having desaturase or elongase activity;
b) at least one seed-specific and/or a seed-preferential plant promoter operatively linked to the said nucleic acid sequence;
c) at least one terminator sequence operatively linked to the said nucleic acid sequence and
d) one or more nucleic acid expression enhancing nucleic acid (NEENA) molecule functionally linked to said promoter and which is/are heterologous to said promoter and to said polypeptide defined in a).

[0019] In one embodiment the term " polynucleotide" as used in accordance with the present invention relates to a polynucleotide comprising a nucleic acid sequence which encodes a polypeptide having desaturase or elongase activity. Preferably, the polypeptide encoded by the polynucleotide of the present invention having desaturase, or elongase activity upon expression in a plant shall be capable of increasing the amount of PUFA and, in particular, LCPUFA in, e.g., seed oils or the entire plant or parts thereof. Such an increase is, preferably, statistically significant when compared to a LCPUFA producing transgenic control plant which expresses the the present state of the art set of desaturases and elongases requiered for LCPUFA synthesis but does not express the polynucleotide of the present invention. Whether an increase is significant can be determined by statistical tests well known in the art including, e.g., Student's t-test. More preferably, the increase is an increase of the amount of triglycerides containing LCPUFA of at least 5%, at least 10%, at least 15%, at least 20% or at least 30% compared to the said control. Preferably, the LCPUFA referred to before is a polyunsaturated fatty acid having a C-20 or C-22 fatty acid body, more preferably, ARA, EPA or DHA. Suitable assays for measuring the activities mentioned before are described in the accompanying Examples.

[0020] The term " desaturase" or " elongase" as used herein refers to the activity of a desaturase, introducing a double bond into the carbon chain of a fatty acid, preferably into fatty acids with 18, 20 or 22 carbon molecules, or an elongase, introducing two carbon molecules into the carbon chain of a fatty acid, preferably into fatty acids with 18, 20 or 22 carbon molecules

[0021] Preferred polynucleotides are those having a nucleic acid sequence as shown in SEQ ID NOs: 95, 96, 97, 98, 99, 100 or 101 encoding for polypeptides exhibit desaturase or elongase activity (see table 3)

[0022] Other preferred polynucleotides are those having a nucleic acid sequence are shown in SEQ ID NOs: 102 or 103 encoding a polypeptide having desaturase or elongase activity (see table 4, also), that are especially used in addition to the polynucleotides listed in table 3 for synthesis of 22:6n-3 (DHA), i.e. in rapeseed.

[0023] A preferred seed-specific promoter as meant herein is selected from the group consisting of Napin, USP, Conlinin, SBP, Fae, Arc and LuPXR.. Other most preferred seed-specific promoter as meant herein are encoded by a nucleic acid sequence as shown in SEQ ID NOs: 25, 26, 27, 28, 29 or 30. A person skilled in the art is aware of methods for rendering a unidirectional to a bidirectional promoter and of methods to use the complement or reverse complement of a promoter sequence for creating a promoter having the same promoter specificity as the original sequence. Such methods are for example described for constitutive as well as inducible promoters by Xie et al. (2001) " Bidirectionalization of polar promoters in plants" (Nature Biotechnology 19, pages 677 - 679). The authors describe that it is sufficient to add a minimal promoter to the 5' prime end of any given promoter to receive a promoter controlling expression in both directions with same promoter specificity.

[0024] The term " NEENA" as described below is used for the expression " nucleic acid expression enhancing nucleic acid" referring to a sequence and/or a nucleic acid molecule of a specific sequence having the intrinsic property to enhance expression of a nucleic acid under the control of a promoter to which the NEENA is functionally linked. Hence a high expression promoter functionally linked to a NEENA as claimed is functional in complement or reverse complement and therefore the NEENA is functional in complement or reverse complement too.

[0025] In principal the NEENA may be functionally linked to any promoter such as tissue specific, inducible, developmental specific or constitutive promoters. The respective NEENA will lead to an enhanced seed-specific expression of the heterologous nucleic acid under the control of the respective promoter to which the one or more NEENA is functionally linked to. The enhancement of expression of promoters other than seed-specific promoters, for example constitutive promoters or promoters with differing tissue specificity, will influence the specificity of these promoters. Expression of the nucleic acid under control of the respective promoter will be significantly increased in seeds, where the transcript of said nucleic acid may have not or only weakly been detected without the NEENA functionally linked to its promoter. Hence, tissue-or developmental specific or any other promoter may be rendered to seed-specific promoters by functionally linking one or more of the NEENA molecules as described above to said promoter. Preferred NEENAs as for the present invention are encoded by the sequences shown in SEQ ID NOs: 11, 12, 13, 14, 15, 16, 17, 18, 19, 10, 21, 22, 23 or 24. More preferred NEENAs as for the present invention are encoded by the sequenves shown in SEQ ID NOs: 6, 7, 8, 9 or 10 . Also (i) nucleic acid molecule having a sequence with an identity of 80% or more to any of the sequences as defined by SEQ ID NO: 6 to 24, preferably, the identity is 85% or more, more preferably the identity is 90% or more, even more preferably, the identity is 95% or more, 96% or more, 97% or more, 98% or more or 99% or more, in the most preferred embodiment, the identity is 100% to any of the sequences as defined by SEQ ID NO: 6 to 24 or (ii) a fragment of 100 bases or more consecutive bases, preferably 150 or more consecutive bases, more preferably 200 consecutive bases or more even more preferably 250 or more consecutive bases of a nucleic acid molecule of i) or ii) which has an expressing enhancing activity, for example 65% or more, preferably 70% or more, more preferably 75% or more, even more preferably 80% or more, 85% or more or 90% or more, in a most preferred embodiment it has 95% or more of the expression enhancing activity as the corresponding nucleic acid molecule having the sequence of any of the sequences as defined by SEQ ID NO: 6 to 24, or iii) a nucleic acid molecule which is the complement or reverse complement of any of the previously mentioned nucleic acid molecules under i) to ii) or iv) a nucleic acid molecule which is obtainable by PCR using oligonucleotide primers as shown in Table 6 or v) a nucleic acid molecule of 100 nucleotides or more, 150 nucleotides or more, 200 nucleotides or more or 250 nucleotides or more, hybridizing under conditions equivalent to hybridization in 7% sodium dodecyl sulfate (SDS), 0.5 M NaPO4, 1 mM EDTA at 50°C with washing in 2 X SSC, 0.1% SDS at 50°C or 65°C, preferably 65°C to a nucleic acid molecule comprising at least 50, preferably at least 100, more preferably at least 150, even more preferably at least 200, most preferably at least 250 consecutive nucleotides of a transcription enhancing nucleotide sequence described by SEQ ID NO: 6 to 24 or the complement thereof are encompassed by the present invention. Preferably, said nucleic acid molecule is hybridizing under conditions equivalent to hybridization in 7% sodium dodecyl sulfate (SDS), 0.5 M NaPO4, 1 mM EDTA at 50°C with washing in 1 X SSC, 0.1% SDS at 50°C or 65°C, preferably 65°C to a nucleic acid molecule comprising at least 50, preferably at least 100, more preferably at least 150, even more preferably at least 200, most preferably at least 250 consecutive nucleotides of a transcription enhancing nucleotide sequence described by SEQ ID NO: 6 to 24 or the complement thereof, more preferably, said nucleic acid molecule is hybridizing under conditions equivalent to hybridization in 7% sodium dodecyl sulfate (SDS), 0.5 M NaPO4, 1 mM EDTA at 50°C with washing in 0,1 X SSC, 0.1% SDS at 50°C or 65°C, preferably 65°C to a nucleic acid molecule comprising at least 50, preferably at least 100, more preferably at least 150, even more preferably at least 200, most preferably at least 250 consecutive nucleotides of a transcription enhancing nucleotide sequence described by any of the sequences as defined by SEQ ID NO:1 to 15 or the complement thereof.

[0026] As described above under iv) the nucleic acid molecule obtainable by PCR using oligonucleotides shown in table 6 is obtainable for example from genomic DNA from Arabidopsis plants such as A. thaliana using the conditions as described in Example 3.2 below.

[0027] Preferably, the one or more NEENA is functionally linked to seed-specific promoters and will enhance expression of the nucleic acid molecule under control of said promoter. Seed-specific promoters to be used in any method of the invention may be derived from plants, for example monocotyledonous or dicotyledonous plants, from bacteria and/or viruses or may be synthetic promoters. Seed specific promoters to be used functionally linked to a NEENA are in a preferred embodiment the seed-specific promoter linked to NEENAs shown in SEQ ID NOs: 1, 2, 3, 4 or 5, table 5.

[0028] The high expression seed-specific promoters functionally linked to a NEENA may be employed in any plant comprising for example moss, fern, gymnosperm or angiosperm, for example monocotyledonous or dicotyledonous plant. In a preferred embodiment said promoter of the invention functionally linked to a NEENA may be employed in monocotyledonous or dicotyledonous plants, preferably crop plant such as corn, soy, canola, cotton, potato, sugar beet, rice, wheat, sorghum, barley, musa, sugarcane, miscanthus and the like. In a preferred embodiment of the invention, said promoter which is functionally linked to a NEENA may be employed in monocotyledonous crop plants such as corn, rice, wheat, sorghum, barley, musa, miscanthus or sugarcane. In an especially preferred embodiment the promoter functionally linked to a NEENA may be employed in dicotyledonous crop plants such as soy, canola, cotton or potato.

[0029] A high expressing seed-specific promoter as used in the application means for example a promoter which is functionally linked to a NEENA causing enhanced seed-specific expression of the promoter in a plant seed or part thereof wherein the accumulation of RNA or rate of synthesis of RNA in seeds derived from the nucleic acid molecule under the control of the respective promoter functionally linked to a NEENA is higher, preferably significantly higher than the expression in seeds caused by the same promoter lacking a NEENA of the invention. Preferably the amount of RNA of the respective nucleic acid and/or the rate of RNA synthesis and/or the RNA stability in a plant is increased 50% or more, for example 100% or more, preferably 200% or more, more preferably 5 fold or more, even more preferably 10 fold or more, most preferably 20 fold or more for example 50 fold compared to a control plant of same age grown under the same conditions comprising the same seed-specific promoter the latter not being functionally linked to a NEENA of the invention.

[0030] When used herein, significantly higher refers to statistical significance the skilled person is aware how to determine, for example by applying statistical tests such as the t-test to the respective data sets.

[0031] Methods for detecting expression conferred by a promoter are known in the art. For example, the promoter may be functionally linked to a marker gene such as GUS, GFP or luciferase and the activity of the respective protein encoded by the respective marker gene may be determined in the plant or part thereof. As a representative example, the method for detecting luciferase is described in detail below. Other methods are for example measuring the steady state level or synthesis rate of RNA of the nucleic acid molecule controlled by the promoter by methods known in the art, for example Northern blot analysis, qPCR, run-on assays or other methods described in the art, or detecting the encoded protein using specific antibodies by methods known in the art, e.g. Western Blot and/or enzyme-linked immunosorbent assay (ELISA).

[0032] A skilled person is aware of various methods for functionally linking two or more nucleic acid molecules. Such methods may encompass restriction/ligation, ligase independent cloning, recombineering, recombination or synthesis. Other methods may be employed to functionally link two or more nucleic acid molecules.

[0033] The term "heterologous" with respect to a nucleic acid molecule or DNA refers to a nucleic acid molecule which is operably linked to, or is manipulated to become operably linked to, a second nucleic acid molecule to which it is not operably linked in nature, or to which it is operably linked at a different location in nature. For example, a NEENA of the invention is in its natural environment functionally linked to its native promoter, whereas in the present invention it is linked to another promoter which might be derived from the same organism, a different organism or might be a synthetic promoter. It may also mean that the NEENA of the present invention is linked to its native promoter but the nucleic acid molecule under control of said promoter is heterologous to the promoter comprising its native NEENA. It is in addition to be understood that the promoter and/or the nucleic acid molecule under the control of said promoter functionally linked to a NEENA of the invention are heterologous to said NEENA as their sequence has been manipulated by for example mutation such as insertions, deletions and the forth so that the natural sequence of the promoter and/or the nucleic acid molecule under control of said promoter is modified and therefore have become heterologous to a NEENA of the invention. It may also be understood that the NEENA is heterologous to the nucleic acid to which it is functionally linked when the NEENA is functionally linked to its native promoter wherein the position of the NEENA in relation to said promoter is changed so that the promoter shows higher expression after such manipulation.

[0034] A plant exhibiting enhanced seed-specific expression of a nucleic acid molecule as meant herein means a plant having a higher, preferably statistically significant higher seed-specific expression of a nucleic acid molecule compared to a control plant grown under the same conditions without the respective NEENA functionally linked to the respective nucleic acid molecule. Such control plant may be a wild-type plant or a transgenic plant comprising the same promoter controlling the same gene as in the plant of the invention wherein the promoter is not linked to a NEENA of the invention. In generally the NEENA may be heterologous to the nucleic acid molecule which is under the control of said promoter to which the NEENA is functionally linked or it may be heterologous to both the promoter and the nucleic acid molecule under the control of said promoter.

[0035] The term " elongase activity" as meant by the present invention refers to the activity of the entire elongation complex as defined in the passage below and it is also be understood as the activity of the first component of the elongation complex with beta-ketoacyl-CoA synthase activity, which determines the substrate specificity of the entire elongation complex. By understanding the elongase activity as synthase activity only, the polypeptide of the of the present invention needs also comprising:

e) at least one nucleic acid sequence encoding a polypeptide having beta-ketoacyl reductase activity;
f) at least one nucleic acid sequence encoding a polypeptide having dehydratase activity or
g) at least one nucleic acid sequence encoding a polypeptide having enoyl-CoA reductase activity
, wherein the nucleic acid sequences defined in e) to g) are heterologous to said polypeptide having desaturase or elongase activity.

[0036] Preferably, the polynucleotide of the present invention comprises nucleic acid sequence encoding fatty acid dehydratase-/enoyl-CoA reductase (nECR) protein having an activity of catalyzing the dehydration and reduction of fatty acid elongated intermediates.

[0037] Fatty acid elongation is catalyzed in four steps, represented by four enzymes: KCR (β -keto-acyl-CoA-synthase), KCR (β -keto-acyl-CoA reductase), DH (dehydratase) and ECR (enoyl-CoA-reductase) forming the entire elongation complex. In the first step a fatty acid-CoA ester is condensed with malonyl-CoA producing a β -keto-acyl-CoA intermediate, which is elongated by to carbon atoms, and CO_2. The keto-group of the intermediate is then reduced by the KCR to a hydroxyl-group. In the next step the DH cleaves of the hydroxyl-group (H_2O is produced), forming a 2-acylen-CoA ester. In the final step the double bound at position 2, 3 is reduced by the ECR forming the elongated acyl-CoA ester (Buchanan, Gruissem, Jones (2000) Biochemistry & Molecular biology of plants, American Society of Plant Physiologists). DH and ECR activity might also be confered by one single protein beeing a natural or artificial fusion of a DH-mojety and a ECR mojety, refered to as novel enoyl-CoA-reductase (nECR) in the present infention. In the current invention either all nucleic acid sequences defined in e) to f) could be comprised in the polynucleotide or only at least one of these nucleic acid sequences defined in e) to f) could be comprised in the polynucleotide in any combination occurred from different oganisms.

[0038] A polynucleotide comprising a fragment of any of the aforementioned nucleic acid sequences is also encompassed as a nucleic acid molecule of the present invention. The fragment shall encode a polypeptide which still has nECR activity as specified above. Accordingly, the polypeptide may comprise or consist of the domains of the polypeptide of the present invention conferring the said biological activity. A fragment as meant herein, preferably, comprises at least 15, at least 20, at least 50, at least 100, at least 250 or at least 500 consecutive nucleotides of any one of the aforementioned nucleic acid sequences or encodes an amino acid sequence comprising at least 5, at least 10, at least 20, at least 30, at least 50, at least 80, at least 100 or at least 150 consecutive amino acids of any one of the aforementioned amino acid sequences.

[0039] The variant nucleic acid molecule or fragments referred to above, preferably, encode polypeptides retaining at least 10%, at least 20%, at least 30%, at least 40%, at least 50%, at least 60%, at least 70%, at least 80% or at least 90% of the nECR activity exhibitited by the polypeptide encoded by the nucleotide sequences.

[0040] The term " polynucleotide" as used in accordance with the present invention also relates to a polynucleotide comprising a nucleic acid sequence which encodes a polypeptide havingacyltransferase activity. Preferably, the polypeptide encoded by the polynucleotide of the present invention having acyltransferaes activity upon expression in a plant shall be capable of increasing the amount of PUFA and, in particular, LCPUFA esterified to triglycerides in, e.g., seed oils or the entire plant or parts thereof. Such an increase is, preferably, statistically significant when compared to a LCPUFA producing transgenic control plant which expresses the minimal set of desaturases and elongases requiered for LCPUFA synthesis but does not express the polynucleotide of the present invention. Such a transgenic plant may, preferably, express desaturases and elongases comprised by the vector LJB765 listed in table 11 of example 5 in WO2009/016202 or a similar set of desaturases and elongases required for DHA synthesis. Whether an increase is significant can be determined by statistical tests well known in the art including, e.g., Student's t-test. More preferably, the increase is an increase of the amount of triglycerides containing LCPUFA of at least 5%, at least 10%, at least 15%, at least 20% or at least 30% compared to the said control. Preferably, the LCPUFA referred to before is a polyunsaturated fatty acid having a C-20, C-22 or C24 fatty acid body, more preferably, EPA or DHA, most preferably, DHA. Suitable assays for measuring the activities mentioned before are described in the accompanying Examples. Variant nucleic acid molecules as referred above may be obtained by various natural as well as artificial sources. For example, nucleic acid molecules may be obtained by in vitro and in vivo mutagenesis approaches using the above mentioned mentioned specific nucleic acid molecules as a basis. Moreover, nucleic acid molecules being homologs or orthologs may be obtained from various animal, plant or fungus species. Preferably, they are obtained from plants such as algae, for example Isochrysis, Mantoniella, Ostreococcus or Crypthecodinium, algae/diatoms such as Phaeodactylum, Thalassiosira or Thraustochytrium, mosses such as Physcomitrella or Ceratodon, or higher plants such as the Primulaceae such as Aleuritia, Calendula stellata, Osteospermum spinescens or Osteospermum hyoseroides, microorganisms such as fungi, such as Aspergillus, Phytophthora, Entomophthora, Mucor or Mortierella, bacteria such as Shewanella, yeasts or animals. Preferred animals are nematodes such as Caenorhabditis, insects or vertebrates. Among the vertebrates, the nucleic acid molecules may, preferably, be derived from Euteleostomi, Actinopterygii; Neopterygii; Teleostei; Euteleostei, Protacanthopterygii, Salmoniformes; Salmonidae or Oncorhynchus, more preferably, from the order of the Salmoniformes, most preferably, the family of the Salmonidae, such as the genus Salmo, for example from the genera and species Oncorhynchus mykiss, Trutta trutta or Salmo trutta fario. Moreover, the nucleic acid molecules may be obtained from the diatoms such as the genera Thallasiosira or Phaeodactylum.

[0041] Thus the present invention also relates to a polynucleotide comprising at least one nucleic acid sequence encoding a polypeptide having acyltransferase activity additionally to the above-mentioned polypeptides exhibit desaturase, elongase orbeta-ketoacyl reductase, dehydratase or enoyl-CoA reductase activity. Therefore the polynucleotide of the present invention also comprising at least one nucleic acid sequence encoding a polypeptide having acyltransferase activity, wherein the nucleic acid sequence is heterologous to said polypeptide having desaturase, elongase, beta-ketoacyl reductase, dehydratase or enoyl-CoA reductase activity and wherein at least one seed-specific plant promoter and at least one terminator sequence are operatively linked to the said nucleic acid sequence and wherein one or more nucleic acid expression enhancing nucleic acid (NEENA) molecule is/are functionally linked to said promoter and which is/are heterologous to said promoter.

[0042] The term " acyltransferase activity" or " acyltransferase" as used herein encompasses all enymatic activities and enzymes which are capable of transferring or are involved in the transfer of PUFA and, in particular; LCPUFA from the acly-CoA pool or the membrane phospholipis to the triglycerides, from the acyl-CoA pool to membrane lipids and from membrane lipids to the acyl-CoA pool by a transesterification process. It will be understood that this acyltransferase activity will result in an increase of the LCPUFA esterified to triglycerides in, e.g., seed oils. In particular, it is envisaged that these acyltransferases are capable of producing triglycerides having esterified EPA or even DHA, or that these acyltransferases are capable of enhancing synthesis of desired PUFA by increasing the flux for specific intermediates of the desired PUFA between the acyl-CoA pool (the site of elongation) and membrane lipids (the predominant site of desaturation). Specifically, acyltransferase activity as used herein pertains to lysophospholipid acyltransferase (LPLAT) activity, preferably, lysophosphatidylcholine acyltransferase (LPCAT) or Lysophosphophatidylethanolamine acyltransferase (LPEAT) activity, lysophosphosphatidic acid acyltransferase (LPAAT) activity, phospholipid:diacylglycerol acyltransferase (PDAT) activity, glycerol-3-phosphate acyltransferase (GPAT) activity or diacylglycerol acyltransferase (DGAT), and, more preferably, to PLAT, LPAAT, DGAT, PDAT or GPAT activity.

[0043] A polynucleotide encoding a polypeptide having a acyltransferase activity as specified above could be obtained for example from *Phythophthora infestance.* Polynucleotides encoding a polypeptide having desaturase or elongase activity as specified above could be obtained in accordance with the present invention from *Thraustochytrium ssp.* for example. Preferred acyltransferases which shall be present in the host cell are at least one enzyme selected from the group consisting of: LPLATs, LPAATs, DGATs, PDATs and GPATs. Especially prefered are the LPLATs LPLAT(Ce) from Caenorhabditis elegans (WO2004076617), LPCAT(Ms) from Mantoniella squamata (WO2006069936) and LP-CAT(Ot) from Ostreococcus tauri (WO2006069936), pLPLAT_01332(Pi) (SEQ-ID No.:104 encoding the polypeptide SEQ-ID No.:125) pLPLAT_01330(Pi) (SEQ-ID No.:105 encoding the polypeptide SEQ-ID No.:126), pLPLAT_07077(Pi) (SEQ-ID No.:106 encoding the polypeptide SEQ-ID No.:127), LPLAT_18374(Pi) (SEQ-ID No.:107 encoding the polypeptide SEQ-ID No.:128), pLPLAT_14816(Pi) (SEQ-ID No.:108 encoding the polypeptide SEQ-ID No.:129), LPCAT_02075(Pi) (SEQ-ID No.:111 encoding the polypeptide SEQ-ID No.:132), pLPAAT_06638(Pi) (SEQ-ID No.:112 encoding the polypeptide SEQ-ID No.:133) form Phytophthora infestance, the LPAATs LPAAT(Ma)1.1 from Mortierella alpina (WO2004087902), LPAAT(Ma)1.2 from Mortierella alpina (WO2004087902), the LPAAT_13842(Pi) (SEQ-ID No.:109 encoding the polypeptide SEQ-ID No.:130), pLPAAT_10763(Pi) (SEQ-ID No.:110 encoding the polypeptide SEQ-ID No.:131) from Phytophthora infestance, the DGATs DGAT2(Cc) from Crypthecodinium cohnii (WO2004087902), pDGAT1_12278(Pi) (SEQ-ID No.:113 encoding the polypeptide SEQ-ID No.:134), DGAT2_03074(Pi) (SEQ-ID No.:114 encoding the polypeptide SEQ-ID No.:135), pDGAT2_08467(Pi) (SEQ-ID No.:115 encoding the polypeptide SEQ-ID No.:136), DGAT2_08470(Pi) (SEQ-ID No.:116 encoding the polypeptide SEQ-ID No.:137), pDGAT2_03835-mod(Pi) (SEQ-ID No.:117 encoding the polypeptide SEQ-ID No.:138), DGAT2_11677-mod(Pi) (SEQ-ID No.:118 encoding the polypeptide SEQ-ID No.:139), DGAT2_08432-mod(Pi) (SEQ-ID No.:119 encoding the polypeptide SEQ-ID No.:140), pDGAT2_08431(Pi) (SEQ-ID No.:120 encoding the polypeptide SEQ-ID No.:141), DGAT_13152-mod(Pi) (SEQ-ID No.:121 encoding the polypeptide SEQ-ID No.:142), the PDAT pPDAT_11965-mod(Pi) (SEQ-ID No.:122 encoding the polypeptide SEQ-ID No.:143) and the GPATs pGPAT-PITG_18707 (SEQ-ID No.:123 encoding the polypeptide SEQ-ID No.:144) and pGPAT-PITG_03371 (SEQ-ID No.:124 encoding the polypeptide SEQ-ID No.:145).

[0044] However, orthologs, paralogs or other homologs may be identified from other species. Preferably, they are obtained from plants such as algae, for example Isochrysis, Mantoniella, Ostreococcus or Crypthecodinium, algae/diatoms such as Phaeodactylum or Thalassiosira or Thraustochytrium, mosses such as Physcomitrella or Ceratodon, or higher plants such as the Primulaceae such as Aleuritia, Calendula stellata, Osteospermum spinescens or Osteospermum hyoseroides, microorganisms such as fungi, such as Aspergillus, Phytophthora, Entomophthora, Mucor or Mortierella, bacteria such as Shewanella, yeasts or animals. Preferred animals are nematodes such as Caenorhabditis, insects or vertebrates. Among the vertebrates, the nucleic acid molecules may, preferably, be derived from Euteleostomi, Actinopterygii; Neopterygii; Teleostei; Euteleostei, Protacanthopterygii, Salmoniformes; Salmonidae or Oncorhynchus, more preferably, from the order of the Salmoniformes, most preferably, the family of the Salmonidae, such as the genus Salmo, for example from the genera and species Oncorhynchus mykiss, Trutta trutta or Salmo trutta fario. Moreover, the nucleic acid molecules may be obtained from the diatoms such as the genera Thallasiosira or Phaeodactylum.

[0045] Thus, the term " polynucleotide" as used in accordance with the present invention further encompasses variants of the aforementioned specific polynucleotides representing orthologs, paralogs or other homologs of the polynucleotide of the present invention. Moreover, variants of the polynucleotide of the present invention also include artificially generated muteins. Said muteins include, e.g., enzymes which are generated by mutagenesis techniques and which exhibit improved or altered substrate specificity, or codon optimized polynucleotides. The polynucleotide variants, preferably, comprise a nucleic acid sequence characterized in that the sequence can be derived from the aforementioned specific nucleic acid sequences shown in any one of SEQ ID NOs: 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122,123 or 124 by a polynucleotide encoding a polypeptide having an amino acid sequence (i.e. as shown in any one of SEQ ID NOs: 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144 or 145 as for acyltransferases) by at least one nucleotide substitution, addition and/or deletion, whereby the variant nucleic acid sequence shall still encode a polypeptide having a desaturase or elongase activity as specified above. Variants also encompass polynucleotides comprising a nucleic acid sequence which is capable of hybridizing to the aforementioned specific nucleic acid sequences, preferably, under stringent hybridization conditions. These stringent conditions are known to the skilled worker and can be found in Current Protocols in Molecular Biology, John Wiley & Sons, N. Y. (1989), 6.3.1-6.3.6. A preferred example for stringent hybridization conditions are hybridization conditions in 6 x sodium chloride/sodium citrate (= SSC) at approximately 45°C, followed by one or more wash steps in 0.2 x SSC, 0.1 % SDS at 50 to 65°C. The skilled worker knows that these hybridization conditions differ depending on the type of nucleic acid and, for example when organic solvents are present, with regard to the temperature and concentration of the buffer. For example, under " standard hybridization conditions" the temperature differs depending on the type of nucleic acid between 42°C and 58°C in aqueous buffer with a concentration of 0.1 to 5 x SSC (pH 7.2). If organic solvent is present in the abovementioned buffer, for example 50% formamide, the temperature under standard conditions is approximately 42°C. The hybridization conditions for DNA: DNA hybrids are, preferably, 0.1 x SSC and 20°C to 45°C, preferably between 30°C and 45°C. The hybridization conditions for

DNA:RNA hybrids are, preferably, 0.1 x SSC and 30°C to 55°C, preferably between 45°C and 55°C. The abovementioned hybridization temperatures are determined for example for a nucleic acid with approximately 100 bp (= base pairs) in length and a G + C content of 50% in the absence of formamide. The skilled worker knows how to determine the hybridization conditions required by referring to textbooks such as the textbook mentioned above, or the following textbooks: Sambrook et al., "Molecular Cloning" , Cold Spring Harbor Laboratory, 1989; Hames and Higgins (Ed.) 1985," Nucleic Acids Hybridization: A Practical Approach" , IRL Press at Oxford University Press, Oxford; Brown (Ed.) 1991, "Essential Molecular Biology: A Practical Approach" , IRL Press at Oxford University Press, Oxford. Alternatively, polynucleotide variants are obtainable by PCR-based techniques such as mixed oligonucleotide primer- based amplification of DNA, i.e. using degenerated primers against conserved domains of the polypeptides of the present invention. Conserved domains of the polypeptide of the present invention may be identified by a sequence comparison of the nucleic acid sequences of the polynucleotides or the amino acid sequences of the polypeptides of the present invention. Oligonucleotides suitable as PCR primers as well as suitable PCR conditions are described in the accompanying Examples. As a template, DNA or cDNA from bacteria, fungi, plants or animals may be used. Further, variants include polynucleotides comprising nucleic acid sequences which are at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 98% or at least 99% identical to the nucleic acid sequences shown in any one of SEQ ID NOs: 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122,123 or 124 preferably, encoding polypeptides retaining a desaturase, elongase, or acyltransferase activity as specified above. Moreover, also encompassed are polynucleotides which comprise nucleic acid sequences encoding a polypeptide having an amino acid sequences which are at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, at least 98% or at least 99% identical to the amino acid sequences encoded by the nucleic acid sequences shown in any one of SEQ ID NOs: 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122,123 or 124 (i.e. as shown in any one of SEQ ID NOs: 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144 or 145 as for acyltransferases), wherein the polypeptide, preferably, retains desaturase, elongase or acyltransferase activity as specified above. The percent identity values are, preferably, calculated over the entire amino acid or nucleic acid sequence region. A series of programs based on a variety of algorithms is available to the skilled worker for comparing different sequences. In a preferred embodiment, the percent identity between two amino acid sequences is determined using the Needleman and Wunsch algorithm (Needleman 1970, J. Mol. Biol. (48):444-453) which has been incorporated into the needle program in the EMBOSS software package *(*EMBOSS: The European Molecular Biology Open Software Suite, Rice,P., Longden,I., and Bleasby,A, Trends in Genetics 16(6), 276-277, 2000*),* using either a BLOSUM 45 or PAM250 scoring matrix for distantly related proteins, or either a BLOSUM 62 or PAM160 scoring matrix for closer related proteins, and a gap opening penalty of 16, 14, 12, 10, 8, 6, or 4 and a gap entension pentalty of 0.5, 1, 2, 3, 4, 5, or 6. Guides for local installation of the EMBOSS package as well as links to WEB-Services can be found at http://emboss.sourceforge.net. A preferred, non-limiting example of parameters to be used for aligning two amino acid sequences using the needle program are the default parameters, including the EBLOSUM62 scoring matrix, a gap opening penalty of 10 and a gap extension penalty of 0.5. In yet another preferred embodiment, the percent identity between two nucleotide sequences is determined using the needle program in the EMBOSS software package *(*EMBOSS: The European Molecular Biology Open Software Suite, Rice,P., Longden,I., and Bleasby,A, Trends in Genetics 16(6), 276-277, 2000), using the EDNAFULL scoring matrix and a gap opening penalty of 16, 14, 12, 10, 8, 6, or 4 and a gap extension penalty of 0.5,1, 2, 3, 4, 5, or 6. A preferred, non-limiting example of parameters to be used in conjunction for aligning two amino acid sequences using the needle program are the default parameters, including the EDNAFULL scoring matrix, a gap opening penalty of 10 and a gap extension penalty of 0.5. The nucleic acid and protein sequences of the present invention can further be used as a " query sequence" to perform a search against public databases to, for example, identify other family members or related sequences. Such searches can be performed using the BLAST series of programs (version 2.2) of Altschul *et al.* (Altschul 1990, J. Mol. Biol. 215:403-10). BLAST using nucleic acid sequences of the invention as query sequence can be performed with the BLASTn, BLASTx or the tBLASTx program using default parameters to obtain either nucleotide sequences (BLASTn, tBLASTx) or amino acid sequences (BLASTx) homologous to sequences encoded by the nucleic acid sequences of the invention. BLAST using protein sequences encoded by the nucleic acid sequences of the invention as query sequence can be performed with the BLASTp or the tBLASTn program using default parameters to obtain either amino acid sequences (BLASTp) or nucleic acid sequences (tBLASTn) homologous to sequences of the invention. To obtain gapped alignments for comparison purposes, Gapped BLAST using default parameters can be utilized as described in Altschul *et al.* (Altschul 1997, Nucleic Acids Res. 25(17):3389-3402).

[0046] The following block diagram shows the relation of sequence types of querry and hit sequences for various BLASt programs

Input query sequence	Converted Query	Algorithm	Converted Hit	Actual Database
DNA		BLASTn		**DNA**
PRT		BLASTp		**PRT**
DNA	**PRT**	BLASTx		**PRT**
PRT		tBLASTn	**PRT**	DNA
DNA	**PRT**	tBLASTx	**PRT**	DNA

[0047] A polynucleotide comprising a fragment of any of the aforementioned nucleic acid sequences is also encompassed as a polynucleotide of the present invention. The fragment shall encode a polypeptide which still has desaturase and elongase activity as specified above. Accordingly, the polypeptide may comprise or consist of the domains of the polypeptide of the present invention conferring the said biological activity. A fragment as meant herein, preferably, comprises at least 50, at least 100, at least 250 or at least 500 consecutive nucleotides of any one of the aforementioned nucleic acid sequences or encodes an amino acid sequence comprising at least 20, at least 30, at least 50, at least 80, at least 100 or at least 150 consecutive amino acids of any one of the aforementioned amino acid sequences.

[0048] The variant polynucleotides or fragments referred to above, preferably, encode polypeptides retaining desaturase or elongase activity to a significant extent, preferably, at least 10%, at least 20%, at least 30%, at least 40%, at least 50%, at least 60%, at least 70%, at least 80% or at least 90% of the desaturase and elongase activity exhibited by any of the polypeptide encoded by the nucleic acid sequences shown in any one of SEQ ID NOs: 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122,123 or 124 (i.e. as shown in anyone of SEQ ID NOs: 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144 or 145 as for acyltransferases). The activity may be tested as described in the accompanying Examples.

[0049] The polynucleotides of the present invention either essentially consist of the aforementioned nucleic acid sequences or comprise the aforementioned nucleic acid sequences. Thus, they may contain further nucleic acid sequences as well. Preferably, the polynucleotide of the present invention may comprise in addition to an open reading frame further untranslated sequence at the 3' and at the 5' terminus of the coding gene region: at least 500, preferably 200, more preferably 100 nucleotides of the sequence upstream of the 5' terminus of the coding region and at least 100, preferably 50, more preferably 20 nucleotides of the sequence downstream of the 3' terminus of the coding gene region. Furthermore, the polynucleotides of the present invention may encode fusion proteins wherein one partner of the fusion protein is a polypeptide being encoded by a nucleic acid sequence recited above. Such fusion proteins may comprise as additional part other enzymes of the fatty acid or PUFA biosynthesis pathways, polypeptides for monitoring expression (e.g., green, yellow, blue or red fluorescent proteins, alkaline phosphatase and the like) or so called " tags" which may serve as a detectable marker or as an auxiliary measure for purification purposes. Tags for the different purposes are well known in the art and comprise FLAG-tags, 6-histidine-tags, MYC-tags and the like.

[0050] The polynucleotide of the present invention shall be provided, preferably, either as an isolated polynucleotide (i.e. purified or at least isolated from its natural context such as its natural gene locus) or in genetically modified or exogenously (i.e. artificially) manipulated form. An isolated polynucleotide can, for example, comprise less than approximately 5 kb, 4 kb, 3 kb, 2 kb, 1 kb, 0.5 kb or 0.1 kb of nucleotide sequences which naturally flank the nucleic acid molecule in the genomic DNA of the cell from which the nucleic acid is derived. The polynucleotide, preferably, is provided in the form of double or single stranded molecule. It will be understood that the present invention by referring to any of the aforementioned polynucleotides of the invention also refers to complementary or reverse complementary strands of the specific sequences or variants thereof referred to before. The polynucleotide encompasses DNA, including cDNA and genomic DNA, or RNA polynucleotides.

[0051] However, the present invention also pertains to polynucleotide variants which are derived from the polynucleotides of the present invention and are capable of interefering with the transcription or translation of the polynucleotides of the present invention. Such variant polynucleotides include anti-sense nucleic acids, ribozymes, siRNA molecules, morpholino nucleic acids (phosphorodiamidate morpholino oligos), triple-helix forming oligonucleotides, inhibitory oligonucleotides, or micro RNA molecules all of which shall specifically recognize the polynucleotide of the invention due to the presence of complementary or substantially complementary sequences. These techniques are well known to the skilled artisan. Suitable variant polynucleotides of the aforementioned kind can be readily designed based on the structure of the polynucleotides of this invention.

[0052] Moreover, comprised are also chemically modified polynucleotides including naturally occurring modified polynucleotides such as glycosylated or methylated polynucleotides or artificial modified ones such as biotinylated polynucleotides.

[0053] In a preferred embodiment of the polynucleotide of the present invention, said polynucleotide further comprises an expression control sequence operatively linked to the said nucleic acid sequence.

[0054] The term " expression control sequence" as used herein refers to a nucleic acid sequence which is capable of governing, i.e. initiating and controlling, transcription of a nucleic acid sequence of interest, in the present case the nucleic sequences recited above. Such a sequence usually comprises or consists of a promoter or a combination of a promoter and enhancer sequences. Expression of a polynucleotide comprises transcription of the nucleic acid molecule, preferably, into a translatable mRNA. Additional regulatory elements may include transcriptional as well as translational enhancers. The following promoters and expression control sequences may be, preferably, used in an expression vector according to the present invention. The cos, tac, trp, tet, trp-tet, Ipp, lac, Ipp-lac, laclq, T7, T5, T3, gal, trc, ara, SP6, λ - PR or λ -PL promoters are, preferably, used in Gram-negative bacteria. For Gram-positive bacteria, promoters amy and SPO2 may be used. From yeast or fungal promoters ADC1, AOX1r, GAL1, MFα , AC, P-60, CYC1, GAPDH, TEF, rp28, ADH are, preferably, used. For animal cell or organism expression, the promoters CMV-, SV40-, RSV-promoter (Rous sarcoma virus), CMV-enhancer, SV40-enhancer are preferably used. From plants the promoters CaMV/35S (Franck 1980, Cell 21: 285-294], PRP1 (Ward 1993, Plant. Mol. Biol. 22), SSU, OCS, lib4, usp, STLS1, B33, nos or the ubiquitin or phaseolin promoter. Also preferred in this context are inducible promoters, such as the promoters described in EP 0 388 186 A1 (i.e. a benzylsulfonamide-inducible promoter), Gatz 1992, Plant J. 2:397-404 (i.e. a tetracyclin-inducible promoter), EP 0 335 528 A1 (i.e. a abscisic-acid-inducible promoter) or WO 93/21334 (i.e. a ethanol- or cyclohexenol-inducible promoter). Further suitable plant promoters are the promoter of cytosolic FBPase or the ST-LSI promoter from potato (Stockhaus 1989, EMBO J. 8, 2445), the phosphoribosyl-pyrophosphate amidotransferase promoter from Glycine max (Genbank accession No. U87999) or the node-specific promoter described in EP 0 249 676 A1. Particularly preferred are promoters which enable the expression in tissues which are involved in the biosynthesis of fatty acids. Also particularly preferred are seed-specific promoters such as the USP promoter in accordance with the practice, but also other promoters such as the LeB4, DC3, phaseolin or napin promoters. Further especially preferred promoters are seed-specific promoters which can be used for monocotyledonous or dicotyledonous plants and which are described in US 5,608,152 (napin promoter from oilseed rape), WO 98/45461 (oleosin promoter from Arobidopsis, US 5,504,200 (phaseolin promoter from Phaseolus vulgaris), WO 91/13980 (Bce4 promoter from Brassica), by Baeumlein et al., Plant J., 2, 2, 1992:233-239 (LeB4 promoter from a legume), these promoters being suitable for dicots. The following promoters are suitable for monocots: Ipt-2 or Ipt-1 promoter from barley (WO 95/15389 and WO 95/23230), hordein promoter from barley and other promoters which are suitable and which are described in WO 99/16890. In principle, it is possible to use all natural promoters together with their regulatory sequences, such as those mentioned above, for the novel process. Likewise, it is possible and advantageous to use synthetic promoters, either additionally or alone, especially when they mediate a seed-specific expression, such as, for example, as described in WO 99/16890. In a particular embodiment, seed-specific promoters are utilized to enhance the production of the desired PUFA or LCPUFA. In a preferred embodiment of the present invention promoters encoded by the nucleic acid sequences shown in any one of SEQ ID NOs: 25, 26, 27, 28, 29 or 30 are used.

[0055] The term " operatively linked" as used herein means that the expression control sequence and the nucleic acid of interest are linked so that the expression of the said nucleic acid of interest can be governed by the said expression control sequence, i.e. the expression control sequence shall be functionally linked to the said nucleic acid sequence to be expressed. Accordingly, the expression control sequence and, the nucleic acid sequence to be expressed may be physically linked to each other, e.g., by inserting the expression control sequence at the 5'end of the nucleic acid sequence to be expressed. Alternatively, the expression control sequence and the nucleic acid to be expressed may be merely in physical proximity so that the expression control sequence is capable of governing the expression of at least one nucleic acid sequence of interest. The expression control sequence and the nucleic acid to be expressed are, preferably, separated by not more than 500 bp, 300 bp, 100 bp, 80 bp, 60 bp, 40 bp, 20 bp, 10 bp or 5 bp.

[0056] In a further preferred embodiment of the polynucleotide of the present invention, said polynucleotide further comprises a terminator sequence operatively linked to the nucleic acid sequence. Preferably used terminators are encoded by the nucleotide sequences shown in SEQ ID NOs: 36 or 37. More preferably used terminators are encoded by the nucleotide sequences shown in SEQ ID NOs: 31, 32, 33, 34 or 35

[0057] The term " terminator" as used herein refers to a nucleic acid sequence which is capable of terminating transcription. These sequences will cause dissociation of the transcription machinery from the nucleic acid sequence to be transcribed. Preferably, the terminator shall be active in plants and, in particular, in plant seeds. Suitable terminators are known in the art and, preferably, include polyadenylation signals such as the SV40-poly-A site or the tk-poly-A site or one of the plant specific signals indicated in Loke et al. (Loke 2005, Plant Physiol 138, pp. 1457-1468), downstream of the nucleic acid sequence to be expressed.

[0058] The present invention also relates to a vector comprising the polynucleotide of the present invention.

[0059] The term " vector" , preferably, encompasses phage, plasmid, viral vectors as well as artificial chromosomes, such as bacterial or yeast artificial chromosomes. Moreover, the term also relates to targeting constructs which allow for random or site- directed integration of the targeting construct into genomic DNA. Such target constructs, preferably, comprise DNA of sufficient length for either homolgous or heterologous recombination as described in detail below. The vector encompassing the polynucleotide of the present invention, preferably, further comprises selectable markers for propagation and/or selection in a host. The vector may be incorporated into a host cell by various techniques well known in the art. If introduced into a host cell, the vector may reside in the cytoplasm or may be incorporated into the genome. In the latter case, it is to be understood that the vector may further comprise nucleic acid sequences which allow for homologous recombination or heterologous insertion. Vectors can be introduced into prokaryotic or eukaryotic cells via conventional transformation or transfection techniques. The terms " transformation" and " transfection" , conjugation and transduction, as used in the present context, are intended to comprise a multiplicity of prior-art processes for introducing foreign nucleic acid (for example DNA) into a host cell, including calcium phosphate, rubidium chloride or calcium chloride co-precipitation, DEAE-dextran-mediated transfection, lipofection, natural competence, carbon-based clusters, chemically mediated transfer, electroporation or particle bombardment. Suitable methods for the transformation or transfection of host cells, including plant cells, can be found in Sambrook et al. (Molecular Cloning: A Laboratory Manual, 2nd ed., Cold Spring Harbor Laboratory, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1989) and other laboratory manuals, such as Methods in Molecular Biology, 1995, Vol. 44, Agrobacterium protocols, Ed.: Gartland and Davey, Humana Press, Totowa, New Jersey. Alternatively, a plasmid vector may be introduced by heat shock or electroporation techniques. Should the vector be a virus, it may be packaged in vitro using an appropriate packaging cell line prior to application to host cells.

[0060] Preferably, the vector referred to herein (VC-LJBXXX) is suitable as a cloning vector, i.e. replicable in microbial systems. Such vectors ensure efficient cloning in bacteria and, preferably, yeasts or fungi and make possible the stable transformation of plants. Those which must be mentioned are, in particular, various binary and co-integrated vector systems which are suitable for the T-DNA-mediated transformation. Such vector systems are, as a rule, characterized in that they contain at least the vir genes, which are required for the Agrobacterium-mediated transformation, and the sequences which delimit the T-DNA (T-DNA border). These vector systems, preferably, also comprise further cis-regulatory regions such as promoters and terminators and/or selection markers with which suitable transformed host cells or organisms can be identified. While co-integrated vector systems have vir genes and T-DNA sequences arranged on the same vector, binary systems are based on at least two vectors, one of which bears vir genes, but no T-DNA, while a second one bears T-DNA, but no vir gene. As a consequence, the last-mentioned vectors are relatively small, easy to manipulate and can be replicated both in E. coli and in Agrobacterium. These binary vectors include vectors from the pBIB-HYG, pPZP, pBecks, pGreen series. Preferably used in accordance with the invention are Bin19, pBI101, pBinAR, pGPTV and pCAMBIA. An overview of binary vectors and their use can be found in Hellens et al, Trends in Plant Science (2000) 5, 446- 451. Furthermore, by using appropriate cloning vectors, the polynucleotides can be introduced into host cells or organisms such as plants or animals and, thus, be used in the transformation of plants, such as those which are published, and cited, in: Plant Molecular Biology and Biotechnology (CRC Press, Boca Raton, Florida), chapter 6/7, pp. 71-119 (1993); F.F. White, Vectors for Gene Transfer in Higher Plants; in: Transgenic Plants, vol. 1, Engineering and Utilization, Ed.: Kung and R. Wu, Academic Press, 1993, 15-38; B. Jenes et al., Techniques for Gene Transfer, in: Transgenic Plants, vol. 1, Engineering and Utilization, Ed.: Kung and R. Wu, Academic Press (1993), 128-143; Potrykus 1991, Annu. Rev. Plant Physiol. Plant Molec. Biol. 42, 205-225.

[0061] More preferably, the vector of the present invention is an expression vector. In such an expression vector, i.e. a vector which comprises the polynucleotide of the invention having the nucleic acid sequence operatively linked to an expression control sequence (also called " expression cassette") allowing expression in prokaryotic or eukaryotic cells or isolated fractions thereof. Suitable expression vectors are known in the art such as Okayama-Berg cDNA expression vector pcDV1 (Pharmacia), pCDM8, pRc/CMV, pcDNA1, pcDNA3 (Invitrogene) or pSPORT1 (GIBCO BRL). Further examples of typical fusion expression vectors are pGEX (Pharmacia Biotech Inc; Smith 1988, Gene 67:31-40), pMAL (New England Biolabs, Beverly, MA) and pRIT5 (Pharmacia, Piscataway, NJ), where glutathione S-transferase (GST), maltose E-binding protein and protein A, respectively, are fused with the recombinant target protein. Examples of suitable inducible nonfusion E. coli expression vectors are, inter alia, pTrc (Amann 1988, Gene 69:301-315) and pET 11d (Studier 1990, Methods in Enzymology 185, 60-89). The target gene expression of the pTrc vector is based on the transcription from a hybrid trp-lac fusion promoter by host RNA polymerase. The target gene expression from the pET 11 d vector is based on the transcription of a T7-gn10-lac fusion promoter, which is mediated by a coexpressed viral RNA polymerase (T7 gn1). This viral polymerase is provided by the host strains BL21 (DE3) or HMS174 (DE3) from a resident λ-prophage which harbors a T7 gn1 gene under the transcriptional control of the lacUV 5 promoter. The skilled worker is familiar with other vectors which are suitable in prokaryotic organisms; these vectors are, for example, in E. coli, pLG338, pACYC184, the pBR series such as pBR322, the pUC series such as pUC18 or pUC19, the M113mp series, pKC30, pRep4, pHS1, pHS2, pPLc236, pMBL24, pLG200, pUR290, pIN-III113-B1, λgt11 or pBdCI, in Streptomyces pIJ101, pIJ364, pIJ702 or pIJ361, in Bacillus pUB110, pC194 or pBD214, in Corynebacterium pSA77 or pAJ667. Examples of vectors for expression in the yeast S. cerevisiae comprise pYep Sec1 (Baldari 1987, Embo J. 6:229-234), pMFa (Kurjan 1982, Cell 30:933-943), pJRY88 (Schultz 1987, Gene 54:113-123) and pYES2 (Invitrogen Corporation, San Diego, CA). Vectors and processes for the construction of vectors which are suitable for use in other fungi, such as the filamentous fungi, comprise those which are described in detail in: van den Hondel, C.A.M.J.J., & Punt, P.J. (1991) " Gene transfer systems and vector development for filamentous fungi, in: Applied Molecular Genetics of fungi, J.F. Peberdy et al., Ed., pp. 1-28, Cambridge University Press: Cambridge, or in: More Gene Manipulations in Fungi (J.W. Bennett & L.L. Lasure, Ed., pp. 396-428: Academic Press: San Diego). Further suitable yeast vectors are, for example, pAG-1, YEp6, YEp13 or pEMBLYe23. As an alternative, the polynucleotides of the present invention can be also expressed in insect cells using baculovirus expression vectors. Baculovirus vectors which are available for the expression of proteins in cultured insect cells (for example Sf9 cells) comprise the pAc series (Smith 1983, Mol. Cell Biol. 3:2156-2165) and the pVL series (Lucklow 1989, Virology 170:31-39).

[0062] The abovementioned vectors are only a small overview of vectors to be used in accordance with the present invention. Further vectors are known to the skilled worker and are described, for example, in: Cloning Vectors (Ed., Pouwels, P.H., et al., Elsevier, Amsterdam-New York-Oxford, 1985, ISBN 0 444 904018). For further suitable expression systems for prokaryotic and eukaryotic cells see the chapters 16 and 17 of Sambrook, loc cit.

[0063] It follows from the above that, preferably, said vector is an expression vector. More preferably, the said polynucleotide of the present invention is under the control of a seed-specific promoter in the vector of the present invention. A preferred seed-specific promoter as meant herein is selected from the group consisting of Conlinin 1, Conlinin 2, napin, LuFad3, USP, LeB4, Arc, Fae, ACP, LuPXR, and SBP. For details, see, e.g., US 2003-0159174.

[0064] The polynucleotide of the present invention can be expressed in single-cell plant cells (such as algae), see Falciatore 1999, Marine Biotechnology 1 (3):239-251 and the references cited therein, and plant cells from higher plants (for example Spermatophytes, such as arable crops) by using plant expression vectors. Examples of plant expression vectors comprise those which are described in detail in: Becker 1992, Plant Mol. Biol. 20:1195-1197; Bevan 1984, Nucl. Acids Res. 12:8711-8721; Vectors for Gene Transfer in Higher Plants; in: Transgenic Plants, Vol. 1, Engineering and Utilization, Ed.: Kung and R. Wu, Academic Press, 1993, p. 15-38. A plant expression cassette, preferably, comprises regulatory sequences which are capable of controlling the gene expression in plant cells and which are functionally linked so that each sequence can fulfill its function, such as transcriptional termination, for example polyadenylation signals. Preferred polyadenylation signals are those which are derived from Agrobacterium tumefaciens T-DNA, such as the gene 3 of the Ti plasmid pTiACH5, which is known as octopine synthase (Gielen 1984, EMBO J. 3, 835) or functional equivalents of these, but all other terminators which are functionally active in plants are also suitable. Since plant gene expression is very often not limited to transcriptional levels, a plant expression cassette preferably comprises other functionally linked sequences such as translation enhancers, for example the overdrive sequence, which comprises the 5' -untranslated tobacco mosaic virus leader sequence, which increases the protein/RNA ratio (Gallie 1987, Nucl. Acids Research 15:8693-8711). As described above, plant gene expression must be functionally linked to a suitable promoter which performs the expression of the gene in a timely, cell-specific or tissue-specific manner. Promoters which can be used are constitutive promoters (Benfey 1989, EMBO J. 8:2195-2202) such as those which are derived from plant viruses such as 35S CAMV (Franck 1980, Cell 21:285-294), 19S CaMV (see US 5,352,605 and WO 84/02913) or plant promoters such as the promoter of the Rubisco small subunit, which is described in US 4,962,028. Other preferred sequences for the use in functional linkage in plant gene expression cassettes are targeting sequences which are required for targeting the gene product into its relevant cell compartment (for a review, see Kermode 1996, Crit. Rev. Plant Sci. 15, 4: 285-423 and references cited therein), for example into the vacuole, the nucleus, all types of plastids, such as amyloplasts, chloroplasts, chromoplasts, the extracellular space, the mitochondria, the endoplasmic reticulum, oil bodies, peroxisomes and other compartments of plant cells. As described above, plant gene expression can also be facilitated via a chemically inducible promoter (for a review, see Gatz 1997, Annu. Rev. Plant Physiol. Plant Mol. Biol., 48:89-108). Chemically inducible promoters are particularly suitable if it is desired that genes are expressed in a time-specific manner. Examples of such promoters are a salicylic-acid-inducible promoter (WO 95/19443), a tetracyclin-inducible promoter (Gatz 1992, Plant J. 2, 397-404) and an ethanol-inducible promoter. Promoters which respond to biotic or abiotic stress conditions are also suitable promoters, for example the pathogen-induced PRP1-gene promoter (Ward 1993, Plant Mol. Biol. 22:361-366), the heat-inducible hsp80 promoter from tomato (US 5,187,267), the cold-inducible alpha-amylase promoter from potato (WO 96/12814) or the wound-inducible pinII promoter (EP 0 375 091 A). The promoters which are especially preferred are those which bring about the expression of genes in tissues and organs in which fatty acid, lipid and oil biosynthesis takes place, in seed cells such as the cells of endosperm and of the developing embryo. Suitable promoters are the napin gene promoter from oilseed rape (US 5,608,152), the USP promoter from Vicia faba (Baeumlein 1991, Mol. Gen. Genet. 225 (3):459-67), the oleosin promoter from Arabidopsis (WO 98/45461), the phaseolin promoter from Phaseolus vulgaris (US 5,504,200), the Bce4 promoter from Brassica (WO 91/13980) or the legumin B4 promoter (LeB4; Baeumlein 1992, Plant Journal, 2 (2):233-9), and promoters which bring about the seed-specific expression in monocotyledonous plants such as maize, barley, wheat, rye, rice and the like. Suitable promoters to be taken into consideration are the lpt2 or lpt1 gene promoter from barley (WO 95/15389 and WO 95/23230) or those which are described in WO 99/16890 (promoters from the barley hordein gene, the rice glutelin gene, the rice oryzin gene, the rice prolamin gene, the wheat gliadin gene, wheat glutelin gene, the maize zein gene, the oat glutelin gene, the sorghum kasirin gene, the rye secalin gene). Likewise, especially suitable are promoters which bring about the plastid-specific expression since plastids are the compartment in which the precursors and some end products of lipid biosynthesis are synthesized. Suitable promoters such as the viral RNA-polymerase promoter, are described in WO

95/16783 and WO 97/06250, and the clpP promoter from Arabidopsis, described in WO 99/46394.

[0065] Moreover, the present invention relates to a host cell comprising the polynucleotide or the vector of the present invention. The term " host cell" is also meant as " host cell culture" .

[0066] Preferably, said host cell is a plant cell or plant cell culture and, more preferably, a plant cell obtained from an oilseed crop. More preferably, said oilseed crop is selected from the group consisting of flax (*Linum sp.*), rapeseed (*Brassica sp.*), soybean (*Glycine sp.*), sunflower (*Helianthus sp.*), cotton (*Gossypium sp.*), corn (*Zea mays*), olive (*Olea sp.*), safflower (*Carthamus sp.*), cocoa (*Theobroma cacoa*), peanut (*Arachis sp.*), hemp, camelina, crambe, oil palm, coconuts, groundnuts, sesame seed, castor bean, lesquerella, tallow tree, sheanuts, tungnuts, kapok fruit, poppy seed, jojoba seeds and perilla.

[0067] Also preferably, said host cell is a microorganism. More preferably, said microorganism is a bacterium, a fungus or algae. More preferably, it is selected from the group consisting of *Candida, Cryptococcus, Lipomyces, Rhodosporidium, Yarrowia* and *Schizochytrium.*

[0068] Moreover, a host cell host cell culture according to the present invention may also be an animal cell. Preferably, said animal host cell is a host cell of a fish or a cell line obtained therefrom. More preferably, the fish host cell is from herring, salmon, sardine, redfish, eel, carp, trout, halibut, mackerel, zander or tuna.

[0069] Generally, the controlling steps in the production of LCPUFAs, *i.e.,* the long chain unsaturated fatty acid biosynthetic pathway, are catalyzed by membrane-associated fatty acid desaturases and elongases. Plants and most other eukaryotic organisms have specialized desaturase and elongase systems for the introduction of double bonds and the extension of fatty acids beyond C18 atoms. The elongase reactions have several important features in common with the fatty acid synthase complex (FAS). However, the elongase complex is different from the FAS complex as the complex is localized in the cytosol and membrane bound, ACP is not involved and the elongase 3-keto-acyl-CoA-synthase catalyzes the condensation of malonyl-CoA with an acyl primer. The elongase complex consists of four components with different catalytic functions, the keto-acyl-synthase (condensation reaction of malonyl-CoA to acyl-CoA, creation of a 2 C atom longer keto-acyl-CoA fatty acid), the keto-acyl-reductase (reduction of the 3-keto group to a 3-hydroxy-group), the dehydratase (dehydration results in a 3-enoyl-acyl-CoA fatty acid) and the enoly-CoA-reductase (reduction of the double bond at position 3, release from the complex). For the production of LCPUFAs including ARA, EPA and/or DHA the elongation reactions, beside the desaturation reactions, are essential. Higher plants do not have the necessary enzyme set to produce LCPUFAs (4 or more double bonds, 20 or more C atoms). Therefore the catalytic activities have to be conferred to the plants or plant cells. The polynucleotides of the present invention catalyze the desaturation and elongation activities necessary for the formation of ARA, EPA and/or DHA. By delivering the novel desaturases and elongases increased levels of PUFAs and LCPUFAs are produced.

[0070] However, person skilled in the art knows that dependent on the host cell, further, enzymatic activities may be conferred to the host cells, e.g., by recombinant technologies. Accordingly, the present invention, preferably, envisages a host cell which in addition to the polynucleotide of the present invention comprises polynucleotides encoding such desaturases and/or elongases as required depending on the selected host cell. Preferred desaturases and/or elongases which shall be present in the host cell are at least one enzyme selected from the group consisting of: Δ-4-desaturase, Δ-5-desaturase, Δ-5-elongase, Δ-6-desaturase, Δ12-desaturase, Δ15-desaturase, ω3-desaturase and Δ -6-elongase. Especially prefered are the bifunctional d12d15-Desaturases d12d15Des(Ac) from Acanthamoeba castellanii (WO2007042510), d12d15Des(Cp) from Claviceps purpurea (WO2008006202) and d12d15Des(Lg)1 from Lottia gigantea (WO2009016202), the d12-Desaturases d12Des(Co) from Calendula officinalis (WO200185968), d12Des(Lb) from Laccaria bicolor (WO2009016202), d12Des(Mb) from Monosiga brevicollis (WO2009016202), d12Des(Mg) from Mycosphaerella graminicola (WO2009016202), d12Des(Nh) from Nectria haematococca (WO2009016202), d12Des(Ol) from Ostreococcus lucimarinus (WO2008040787), d12Des(Pb) from Phycomyces blakesleeanus (WO2009016202), d12Des(Ps) from Phytophthora sojae (WO2006100241) and d12Des(Tp) from Thalassiosira pseudonana (WO2006069710), the d15-Desaturases d15Des(Hr) from Helobdella robusta (WO2009016202), d15Des(Mc) from Microcoleus chthonoplastes (WO2009016202), d15Des(Mf) from Mycosphaerella fijiensis (WO2009016202), d15Des(Mg) from Mycosphaerella graminicola (WO2009016202) and d15Des(Nh)2 from Nectria haematococca (WO2009016202), the d4-Desaturases d4Des(Eg) from Euglena gracilis (WO2004090123), d4Des(Tc) from Thraustochytrium sp. (WO2002026946) and d4Des(Tp) from Thalassiosira pseudonana (WO2006069710), the d5-Desaturases d5Des(Ol)2 from Ostreococcus lucimarinus (WO2008040787), d5Des(Pp) from Physcomitrella patens (WO2004057001), d5Des(Pt) from Phaeodactylum tricornutum (WO2002057465), d5Des(Tc) from Thraustochytrium sp. (WO2002026946), d5Des(Tp) from Thalassiosira pseudonana (WO2006069710) and the d6-Desaturases d6Des(Cp) from Ceratodon purpureus (WO2000075341), d6Des(Ol) from Ostreococcus lucimarinus (WO2008040787), d6Des(Ot) from Ostreococcus tauri (WO2006069710), d6Des(Pf) from Primula farinosa (WO2003072784), d6Des(Pir)_BO from Pythium irregulare (WO2002026946), d6Des(Pir) from Pythium irregulare (WO2002026946), d6Des(Plu) from Primula luteola (WO2003072784), d6Des(Pp) from Physcomitrella patens (WO200102591), d6Des(Pt) from Phaeodactylum tricornutum (WO2002057465), d6Des(Pv) from Primula vialii (WO2003072784) and d6Des(Tp) from Thalassiosira pseudonana (WO2006069710), the d8-Desaturases d8Des(Ac) from Acanthamoeba castellanii (EP1790731), d8Des(Eg) from Euglena gracilis (WO200034439) and d8Des(Pm) from Perkinsus marinus (WO2007093776), the o3-Desaturases o3Des(Pi) from Phytophthora infestans (WO2005083053), o3Des(Pir) from Pythium irregulare (WO2008022963), o3Des(Pir)2 from Pythium irregulare (WO2008022963) and o3Des(Ps) from Phytophthora sojae (WO2006100241), the bifunctional d5d6-elongases d5d6Elo(Om)2 from Oncorhynchus mykiss WO2005012316), d5d6Elo(Ta) from Thraustochytrium aureum (WO2005012316) and d5d6Elo(Tc) from Thraustochytrium sp. WO2005012316), the d5-elongases d5Elo(At) from Arabidopsis thaliana WO2005012316), d5Elo(At)2 from Arabidopsis thaliana WO2005012316), d5Elo(Ci) from Ciona intestinalis WO2005012316), d5Elo(Ol) from Ostreococcus lucimarinus (WO2008040787), d5Elo(Ot) from Ostreococcus tauri WO2005012316), d5Elo(Tp) from Thalassiosira pseudonana (WO2005012316) and d5Elo(Xl) from Xenopus laevis WO2005012316), the d6-elongases d6Elo(Ol) from Ostreococcus lucimarinus (WO2008040787), d6Elo(Ot) from Ostreococcus tauri WO2005012316), d6Elo(Pi) from Phytophthora infestans (WO2003064638), d6Elo(Pir) from Pythium irregulare (WO2009016208), d6Elo(Pp) from Physcomitrella patens (WO2001059128), d6Elo(Ps) from Phytophthora sojae (WO2006100241), d6Elo(Ps)2 from Phytophthora sojae (WO2006100241), d6Elo(Ps)3 from Phytophthora sojae (WO2006100241), d6Elo(Pt) from Phaeodactylum tricornutum WO2005012316), d6Elo(Tc) from Thraustochytrium sp. (WO2005012316) and d6Elo(Tp) from Thalassiosira pseudonana WO2005012316), the d9-elongases d9Elo(Ig) from Isochrysis galbana (WO2002077213), d9Elo(Pm) from Perkinsus marinus (WO2007093776) and d9Elo(Ro) from Rhizopus oryzae (WO2009016208). Particularly, if the manufuacture of ARA is envisaged in higher plants, the enzymes recited in Table 3, below (i.e. aditinonally a d6-desaturase, d6-elongase, d5-elongase, d5-desaturase, d12-desaturase, and d6-elongase) or enzymes having essentially the same activity may be combined in a host cell. If the manufacture of EPA is envisaged in higher plants, the enzymes having aditinonally a d6-desaturase, d6-elongase, d5-desaturase, d12-desaturase, d6-elongase, omega 3-desaturase and d15-desaturase, or enzymes having essentially the same activity may be combined in a host cell. If the manufacture of DHA is envisaged in higher plants, the enzymes having aditinonally a d6-desaturase, d6-elongase, d5-desaturase, d12-desaturase, d6-elongase, omega 3-desaturase, d15-desaturase, d5-elongase, and d4-desaturase activity, or enzymes having essentially the same activity may be combined in a host cell.

[0071] The present invention also relates to a cell, preferably a host cell as specified above or a cell of a non-human organism specified elsewhere herein, said cell comprising a polynucleotide which is obtained from the polynucleotide of the present invention by a point mutation, a truncation, an inversion, a deletion, an addition, a substitution and homologous recombination. How to carry out such modifications to a polynucleotide is well known to the skilled artisan and has been described elsewhere in this specification in detail.

[0072] The present invention furthermore pertains to a method for the manufacture of a polypeptide encoded by a polynucleotide of any the present invention comprising

a) cultivating the host cell of the invention under conditions which allow for the production of the said polypeptide; and
b) obtaining the polypeptide from the host cell of step a).

[0073] Suitable conditions which allow for expression of the polynucleotide of the invention comprised by the host cell depend on the host cell as well as the expression control sequence used for governing expression of the said polynucleotide. These conditions and how to select them are very well known to those skilled in the art. The expressed polypeptide may be obtained, for example, by all conventional purification techniques including affinity chromatography, size exclusion chromatography, high pressure liquid chromatography (HPLC) and precipitation techniques including antibody precipitation. It is to be understood that the method may - although preferred -not necessarily yield an essentially pure preparation of the polypeptide. It is to be understood that depending on the host cell which is used for the aforementioned method, the polypeptides produced thereby may become posttranslationally modified or processed otherwise.

[0074] The present invention also encompasses a polypeptide encoded by the polynucleotide of of the present invention or which is obtainable by the aforementioned method.

[0075] The term " polypeptide" as used herein encompasses essentially purified polypeptides or polypeptide preparations comprising other proteins in addition. Further, the term also relates to the fusion proteins or polypeptide fragments being at least partially encoded by the polynucleotide of the present invention referred to above. Moreover, it includes chemically modified polypeptides. Such modifications may be artificial modifications or naturally occurring modifications such as phosphorylation, glycosylation, myristylation and the like (Review in Mann 2003, Nat. Biotechnol. 21, 255- 261, review with focus on plants in Huber 2004, Curr. Opin. Plant Biol. 7, 318-322). Currently, more than 300 posttranslational modifications are known (see full ABFRC Delta mass list at http://www.abrf.org/index.cfm/dm.home). The polypeptides of the present invention shall exhibit the desaturase or elongase activitiy referred to above.

[0076] Moreover, the present invention contemplates a non-human transgenic organism comprising the polynucleotide or the vector of the present invention.

[0077] Preferably, the non-human transgenic organism is a plant or a plant part. Preferred plants to be used for introducing the polynucleotide or the vector of the invention are plants which are capable of synthesizing fatty acids, such as all dicotyledonous or monocotyledonous plants, algae or mosses. It is to be understood that host cells derived from a plant may also be used for producing a plant according to the present invention. Preferred plant parts are seeds from the plants. Preferred plants are selected from the group of the plant families Adelotheciaceae, Anacardiaceae, Asteraceae, Apiaceae, Betulaceae, Boraginaceae, Brassicaceae, Bromeliaceae, Caricaceae, Cannabaceae, Convolvulaceae, Chenopodiaceae, Crypthecodiniaceae, Cucurbitaceae, Ditrichaceae, Elaeagnaceae, Ericaceae, Euphorbiaceae, Fabaceae, Geraniaceae, Gramineae, Juglandaceae, Lauraceae, Leguminosae, Linaceae, Prasinophyceae or vegetable plants or ornamentals such as Tagetes. Examples which may be mentioned are the following plants selected from the group consisting of: Adelotheciaceae such as the genera Physcomitrella, such as the genus and species Physcomitrella patens, Anacardiaceae such as the genera Pistacia, Mangifera, Anacardium, for example the genus and species Pistacia vera [pistachio], Mangifer indica [mango] or Anacardium occidentale [cashew], Asteraceae, such as the genera Calendula, Carthamus, Centaurea, Cichorium, Cynara, Helianthus, Lactuca, Locusta, Tagetes, Valeriana, for example the genus and species Calendula officinalis [common marigold], Carthamus tinctorius [safflower], Centaurea cyanus [cornflower], Cichorium intybus [chicory], Cynara scolymus [artichoke], Helianthus annus [sunflower], Lactuca sativa, Lactuca crispa, Lactuca esculenta, Lactuca scariola L. ssp. sativa, Lactuca scariola L. var. integrata, Lactuca scariola L. var. integrifolia, Lactuca sativa subsp. romana, Locusta communis, Valeriana locusta [salad vegetables], Tagetes lucida, Tagetes erecta or Tagetes tenuifolia [african or french marigold], Apiaceae, such as the genus Daucus, for example the genus and species Daucus carota [carrot], Betulaceae, such as the genus Corylus, for example the genera and species Corylus avellana or Corylus colurna [hazelnut], Boraginaceae, such as the genus Borago, for example the genus and species Borago officinalis [borage], Brassicaceae, such as the genera Brassica, Melanosinapis, Sinapis, Arabadopsis, for example the genera and species Brassica napus, Brassica rapa ssp. [oilseed rape], Sinapis arvensis Brassica juncea, Brassica juncea var. juncea, Brassica juncea var. crispifolia, Brassica juncea var. foliosa, Brassica nigra, Brassica sinapioides, Melanosinapis communis [mustard], Brassica oleracea [fodder beet] or Arabidopsis thaliana, Bromeliaceae, such as the genera Anana, Bromelia (pineapple), for example the genera and species Anana comosus, Ananas ananas or Bromelia comosa [pineapple], Caricaceae, such as the genus Carica, such as the genus and species Carica papaya [pawpaw], Cannabaceae, such as the genus Cannabis, such as the genus and species Cannabis sativa [hemp], Convolvulaceae, such as the genera Ipomea, Convolvulus, for example the genera and species Ipomoea batatus, Ipomoea pandurata, Convolvulus batatas, Convolvulus tiliaceus, Ipomoea fastigiata, Ipomoea tiliacea, Ipomoea triloba or Convolvulus panduratus [sweet potato, batate], Chenopodiaceae, such as the genus Beta, such as the genera and species Beta vulgaris, Beta vulgaris var. altissima, Beta vulgaris var.Vulgaris, Beta maritima, Beta vulgaris var. perennis, Beta vulgaris var. conditiva or Beta vulgaris var. esculenta [sugarbeet], Crypthecodiniaceae, such as the genus Crypthecodinium, for example the genus and species Cryptecodinium cohnii, Cucurbitaceae, such as the genus Cucurbita, for example the genera and species Cucurbita maxima, Cucurbita mixta, Cucurbita pepo or Cucurbita moschata [pumpkin/squash], Cymbellaceae such as the genera Amphora, Cymbella, Okedenia, Phaeodactylum, Reimeria, for example the genus and species Phaeodactylum tricornutum, Ditrichaceae such as the genera Ditrichaceae, Astomiopsis, Ceratodon, Chrysoblastella, Ditrichum, Distichium, Eccremidium, Lophidion, Philibertiella, Pleuridium, Saelania, Trichodon, Skottsbergia, for example the genera and species Ceratodon antarcticus, Ceratodon columbiae, Ceratodon heterophyllus, Ceratodon purpureus, Ceratodon purpureus, Ceratodon purpureus ssp. convolutus, Ceratodon, purpureus spp. stenocarpus, Ceratodon purpureus var. rotundifolius, Ceratodon ratodon, Ceratodon stenocarpus, Chrysoblastella chilensis, Ditrichum ambiguum, Ditrichum brevisetum, Ditrichum crispatissimum, Ditrichum difficile, Ditrichum falcifolium, Ditrichum flexicaule, Ditrichum giganteum, Ditrichum heteromallum, Ditrichum lineare, Ditrichum lineare, Ditrichum montanum, Ditrichum montanum, Ditrichum pallidum, Ditrichum punctulatum, Ditrichum pusillum, Ditrichum pusillum var. tortile, Ditrichum rhynchostegium, Ditrichum schimperi, Ditrichum tortile, Distichium capillaceum, Distichium hagenii, Distichium inclinatum, Distichium macounii, Eccremidium floridanum, Eccremidium whiteleggei, Lophidion strictus, Pleuridium acuminatum, Pleuridium alternifolium, Pleuridium holdridgei, Pleuridium mexicanum, Pleuridium ravenelii, Pleuridium subulatum, Saelania glaucescens, Trichodon borealis, Trichodon cylindricus or Trichodon cylindricus var. oblongus, Elaeagnaceae such as the genus Elaeagnus, for example the genus and species Olea europaea [olive], Ericaceae such as the genus Kalmia, for example the genera and species Kalmia latifolia, Kalmia angustifolia, Kalmia microphylla, Kalmia polifolia, Kalmia occidentalis, Cistus chamaerhodendros or Kalmia lucida [mountain laurel], Euphorbiaceae such as the genera Manihot, Janipha, Jatropha, Ricinus, for example the genera and species Manihot utilissima, Janipha manihot, Jatropha manihot, Manihot aipil, Manihot dulcis, Manihot manihot, Manihot melanobasis, Manihot esculenta [manihot] or Ricinus communis [castor-oil plant], Fabaceae such as the genera Pisum, Albizia, Cathormion, Feuillea, Inga, Pithecolobium, Acacia, Mimosa, Medicajo, Glycine, Dolichos, Phaseolus, Soja, for example the genera and species Pisum sativum, Pisum arvense, Pisum humile [pea], Albizia berteriana, Albizia julibrissin, Albizia lebbeck, Acacia berteriana, Acacia littoralis, Albizia berteriana, Albizzia berteriana, Cathormion berteriana, Feuillea berteriana, Inga fragrans, Pithecellobium berterianum, Pithecellobium fragrans, Pithecolobium berterianum, Pseudalbizzia berteriana, Acacia julibrissin, Acacia nemu, Albizia nemu, Feuilleea julibrissin, Mimosa julibrissin, Mimosa speciosa, Sericanrda julibrissin, Acacia lebbeck, Acacia macrophylla, Albizia lebbek, Feuilleea lebbeck, Mimosa lebbeck, Mimosa speciosa [silk tree], Medicago sativa, Medicago falcata, Medicago varia [alfalfa], Glycine max Dolichos soja, Glycine gracilis, Glycine hispida, Phaseolus max, Soja hispida or Soja max [soybean], Funariaceae such as the genera Aphanorrhegma, Entosthodon, Funaria, Physcomitrella, Physcomitrium, for example the genera and species Aphanorrhegma serratum, Entosthodon attenuatus, Entosthodon bolanderi, Entosthodon bonplandii, Entosthodon californicus, Entosthodon drummondii, Entosthodon jamesonii, Entosthodon leibergii, Entosthodon neoscoticus, Entosthodon rubrisetus, Entosthodon spathulifolius, Entosthodon tucsoni, Funaria americana, Funaria bolanderi, Funaria calcarea, Funaria californica, Funaria calvescens, Funaria convoluta, Funaria flavicans, Funaria groutiana, Funaria hygrometrica, Funaria hygrometrica var. arctica, Funaria hygrometrica var. calvescens, Funaria hygrometrica var. convoluta, Funaria hygrometrica var. muralis, Funaria hygrometrica var. utahensis, Funaria microstoma, Funaria microstoma var. obtusifolia, Funaria muhlenbergii, Funaria orcuttii, Funaria plano-convexa, Funaria polaris, Funaria ravenelii, Funaria rubriseta, Funaria serrata, Funaria sonorae, Funaria sublimbatus, Funaria tucsoni, Physcomitrella californica, Physcomitrella patens, Physcomitrella readeri, Physcomitrium australe, Physcomitrium californicum, Physcomitrium collenchymatum, Physcomitrium coloradense, Physcomitrium cupuliferum, Physcomitrium drummondii, Physcomitrium eurystomum, Physcomitrium flexifolium, Physcomitrium hookeri, Physcomitrium hookeri var. serratum, Physcomitrium immersum, Physcomitrium kellermanii, Physcomitrium megalocarpum, Physcomitrium pyriforme, Physcomitrium pyriforme var. serratum, Physcomitrium rufipes, Physcomitrium sandbergii, Physcomitrium subsphaericum, Physcomitrium washingtoniense, Geraniaceae, such as the genera Pelargonium, Cocos, Oleum, for example the genera and species Cocos nucifera, Pelargonium grossularioides or Oleum cocois [coconut], Gramineae, such as the genus Saccharum, for example the genus and species Saccharum officinarum, Juglandaceae, such as the genera Juglans, Wallia, for example the genera and species Juglans regia, Juglans ailanthifolia, Juglans sieboldiana, Juglans cinerea, Wallia cinerea, Juglans bixbyi, Juglans californica, Juglans hindsii, Juglans intermedia, Juglans jamaicensis, Juglans major, Juglans microcarpa, Juglans nigra or Wallia nigra [walnut], Lauraceae, such as the genera Persea, Laurus, for example the genera and species Laurus nobilis [bay], Persea americana, Persea gratissima or Persea persea [avocado], Leguminosae, such as the genus Arachis, for example the genus and species Arachis hypogaea [peanut], Linaceae, such as the genera Linum, Adenolinum, for example the genera and species Linum usitatissimum, Linum humile, Linum austriacum, Linum bienne, Linum angustifolium, Linum catharticum, Linum flavum, Linum grandiflorum, Adenolinum grandiflorum, Linum lewisii, Linum narbonense, Linum perenne, Linum perenne var. lewisii, Linum pratense or Linum trigynum [linseed], Lythrarieae, such as the genus Punica, for example the genus and species Punica granatum [pomegranate], Malvaceae, such as the genus Gossypium, for example the genera and species Gossypium hirsutum, Gossypium arboreum, Gossypium barbadense, Gossypium herbaceum or Gossypium thurberi [cotton], Marchantiaceae, such as the genus Marchantia, for example the genera and species Marchantia berteroana, Marchantia foliacea, Marchantia macropora, Musaceae, such as the genus Musa, for example the genera and species Musa nana, Musa acuminata, Musa paradisiaca, Musa spp. [banana], Onagraceae, such as the genera Camissonia, Oenothera, for example the genera and species Oenothera biennis or Camissonia brevipes [evening primrose], Palmae, such as the genus Elacis, for example the genus and species Elaeis guineensis [oil palm], Papaveraceae, such as the genus Papaver, for example the genera and species Papaver orientale, Papaver rhoeas, Papaver dubium [poppy], Pedaliaceae, such as the genus Sesamum, for example the genus and species Sesamum indicum [sesame], Piperaceae, such as the genera Piper, Artanthe, Peperomia, Steffensia, for example the genera and species Piper aduncum, Piper amalago, Piper angustifolium, Piper auritum, Piper betel, Piper cubeba, Piper longum, Piper nigrum, Piper retrofractum, Artanthe adunca, Artanthe elongata, Peperomia elongata, Piper elongatum, Steffensia elongata [cayenne pepper], Poaceae, such as the genera Hordeum, Secale, Avena, Sorghum, Andropogon, Holcus, Panicum, Oryza, Zea (maize), Triticum, for example the genera and species Hordeum vulgare, Hordeum jubatum, Hordeum murinum, Hordeum secalinum, Hordeum distichon, Hordeum aegiceras, Hordeum hexastichon, Hordeum hexastichum, Hordeum irregulare, Hordeum sativum, Hordeum secalinum [barley], Secale cereale [rye], Avena sativa, Avena fatua, Avena byzantina, Avena fatua var. sativa, Avena hybrida [oats], Sorghum bicolor, Sorghum halepense, Sorghum saccharatum, Sorghum vulgare, Andropogon drummondii, Holcus bicolor, Holcus sorghum, Sorghum aethiopicum, Sorghum arundinaceum, Sorghum caffrorum, Sorghum cernuum, Sorghum dochna, Sorghum drummondii, Sorghum durra, Sorghum guineense, Sorghum lanceolatum, Sorghum nervosum, Sorghum saccharatum, Sorghum subglabrescens, Sorghum verticilliflorum, Sorghum vulgare, Holcus halepensis, Sorghum miliaceum, Panicum militaceum [millet], Oryza sativa, Oryza latifolia [rice], Zea mays [maize], Triticum aestivum, Triticum durum, Triticum turgidum, Triticum hybernum, Triticum macha, Triticum sativum or Triticum vulgare [wheat], Porphyridiaceae, such as the genera Chroothece, Flintiella, Petrovanella, Porphyridium, Rhodella, Rhodosorus, Vanhoeffenia, for example the genus and species Porphyridium cruentum, Proteaceae, such as the genus Macadamia, for example the genus and species Macadamia intergrifolia [macadamia], Prasinophyceae such as the genera Nephroselmis, Prasinococcus, Scherffelia, Tetraselmis, Mantoniella, Ostreococcus, for example the genera and species Nephroselmis olivacea, Prasinococcus capsulatus, Scherffelia dubia, Tetraselmis chui, Tetraselmis suecica, Mantoniella squamata, Ostreococcus tauri, Rubiaceae such as the genus Cofea, for example the genera and species Cofea spp., Coffea arabica, Coffea canephora or Coffea liberica [coffee], Scrophulariaceae such as the genus Verbascum, for example the genera and species Verbascum blattaria, Verbascum chaixii, Verbascum densiflorum, Verbascum lagurus, Verbascum longifolium, Verbascum lychnitis, Verbascum nigrum, Verbascum olympicum, Verbascum phlomoides, Verbascum phoenicum, Verbascum pulverulentum or Verbascum thapsus [mullein], Solanaceae such as the genera Capsicum, Nicotiana, Solanum, Lycopersicon, for example the genera and species Capsicum annuum, Capsicum annuum var. glabriusculum, Capsicum frutescens [pepper], Capsicum annuum [paprika], Nicotiana tabacum, Nicotiana alata, Nicotiana attenuata, Nicotiana glauca, Nicotiana langsdorffii, Nicotiana obtusifolia, Nicotiana quadrivalvis, Nicotiana repanda, Nicotiana rustica, Nicotiana sylvestris [tobacco], Solanum tuberosum [potato], Solanum melongena [eggplant], Lycopersicon esculentum, Lycopersicon lycopersicum, Lycopersicon pyriforme, Solanum integrifolium or Solanum lycopersicum [tomato], Sterculiaceae, such as the genus Theobroma, for example the genus and species Theobroma cacao [cacao] or Theaceae, such as the genus Camellia, for example the genus and species Camellia sinensis [tea]. In particular preferred plants to be used as transgenic plants in accordance with the present invention are oil fruit crops which comprise large amounts of lipid compounds, such as peanut, oilseed rape, canola, sunflower, safflower, poppy, mustard, hemp, castor-oil plant, olive, sesame, Calendula, Punica, evening primrose, mullein, thistle, wild roses, hazelnut, almond, macadamia, avocado, bay, pumpkin/squash, linseed, soybean, pistachios, borage, trees (oil palm, coconut, walnut) or crops such as maize, wheat, rye, oats, triticale, rice, barley, cotton, cassava, pepper, Tagetes, Solanaceae plants such as potato, tobacco, eggplant and tomato, Vicia species, pea, alfalfa or bushy plants (coffee, cacao, tea), Salix species, and perennial grasses and fodder crops. Preferred plants according to the invention are oil crop plants such as peanut, oilseed rape, canola, sunflower, safflower, poppy, mustard, hemp, castor-oil plant, olive, Calendula, Punica, evening primrose, pumpkin/squash, linseed, soybean, borage, trees (oil palm, coconut). Especially preferred are sunflower, safflower, tobacco, mullein, sesame, cotton, pumpkin/squash, poppy, evening primrose, walnut, linseed, hemp, thistle or safflower. Very especially preferred plants are plants such as safflower, sunflower, poppy, evening primrose, walnut, linseed, or hemp.

[0078] Preferred mosses are Physcomitrella or Ceratodon. Preferred algae are Isochrysis, Mantoniella, Ostreococcus or Crypthecodinium, and algae/diatoms such as Phaeodactylum or Thraustochytrium. More preferably, said algae or mosses are selected from the group consisting of: Emiliana, Shewanella, Physcomitrella, Thraustochytrium, Fusarium, Phytophthora, Ceratodon, Isochrysis, Aleurita, Muscarioides, Mortierella, Phaeodactylum, Cryphthecodinium, specifically from the genera and species Thallasiosira pseudonona, Euglena gracilis, Physcomitrella patens, Phytophtora infestans, Fusarium graminaeum, Cryptocodinium cohnii, Ceratodon purpureus, Isochrysis galbana, Aleurita farinosa, Thraustochytrium sp., Muscarioides viallii, Mortierella alpina, Phaeodactylum tricornutum or Caenorhabditis elegans or especially advantageously Phytophtora infestans, Thallasiosira pseudonona and Cryptocodinium cohnii.

[0079] Transgenic plants may be obtained by transformation techniques as elsewhere in this specification. Preferably, transgenic plants can be obtained by T-DNA-mediated transformation. Such vector systems are, as a rule, characterized in that they contain at least the vir genes, which are required for the Agrobacterium-mediated transformation, and the sequences which delimit the T-DNA (T-DNA border). Suitable vectors are described elsewhere in the specification in detail.

[0080] Also encompassed are transgenic non-human animals comprising the vector or polynucleotide of the present invention. Preferred non-human transgenic animals envisaged by the present invention are fish, such as herring, salmon, sardine, redfish, eel, carp, trout, halibut, mackerel, zander or tuna.

[0081] However, it will be understood that dependent on the non-human transgenic organism specified above, further, enzymatic activities may be conferred to the said organism, e.g., by recombinant technologies. Accordingly, the present invention, preferably, envisages a non-human transgenic organism specified above which in addition to the polynucleotide of the present invention comprises polynucleotides encoding such desaturases and/or elongases as required depending on the selected host cell. Preferred desaturases and/or elongases which shall be present in the organism are at least one enzyme selected from the group of desaturases and/or elongases or the combinations specifically recited elsewhere in this specification (see above and Tables 3, 4 and 5).

[0082] Furthermore, the present invention encompasses a method for the manufacture of polyunsaturated fatty acids comprising:

a) cultivating the host cell of the invention under conditions which allow for the production of polyunsaturated fatty acids in said host cell;
b) obtaining said polyunsaturated fatty acids from the said host cell.

[0083] The term " polyunsaturated fatty acids (PUFA)" as used herein refers to fatty acids comprising at least two, preferably, three, four, five or six, double bonds. Moreover, it is to be understood that such fatty acids comprise, preferably from 18 to 24 carbon atoms in the fatty acid chain. More preferably, the term relates to long chain PUFA (LCPUFA) having from 20 to 24 carbon atoms in the fatty acid chain. Preferred unsaturated fatty acids in the sense of the present invention are selected from the group consisting of DGLA 20:3 (8,11,14), ARA 20:4 (5,8,11,14), iARA 20:4(8,11,14,17), EPA 20:5 (5,8,11,14,17), DPA 22:5 (4,7,10,13,16), DHA 22:6 (4,7,10,13,16,19), 20:4 (8,11,14,17), more preferably, arachidonic acid (ARA) 20:4 (5,8,11,14), eicosapentaenoic acid (EPA) 20:5 (5,8,11,14,17), and docosahexaenoic acid (DHA) 22:6 (4,7,10,13,16,19). Thus, it will be understood that most preferably, the methods provided by the present invention pertaining to the manufacture of ARA, EPA or DHA. Moreover, also encompassed are the intermediates of LCPUFA which occur during synthesis. Such intermediates are, preferably, formed from substrates by the desaturase or elongase activity of the polypeptides of the present invention. Preferably, substrates encompass LA 18:2 (9,12), ALA 18:3(9,12,15), Eicosadienoic acid 20:2 (11,14), Eicosatrienoic acid 20:3 (11,14,17)), DGLA 20:3 (8,11,14), ARA 20:4 (5,8,11,14), eicosatetraenoic acid 20:4 (8,11,14,17), Eicosapentaenoic acid 20:5 (5,8,11,14,17), Docosahexapentanoic acid 22:5 (7,10,13,16,19).

[0084] The term " cultivating" as used herein refers maintaining and growing the host cells under culture conditions which allow the cells to produce the said polyunsaturated fatty acid, i.e. the PUFA and/or LCPUFA referred to above. This implies that the polynucleotide of the present invention is expressed in the host cell so that the desaturase and/or elongase activity is present. Suitable culture conditions for cultivating the host cell are described in more detail below.

[0085] The term " obtaining" as used herein encompasses the provision of the cell culture including the host cells and the culture medium as well as the provision of purified or partially purified preparations thereof comprising the polyunsaturated fatty acids, preferably, ARA, EPA, DHA, in free or in -CoA bound form, as membrane phospholipids or as triacylglyceride estres. More preferably, the PUFA and LCPUFA are to be obtained as triglyceride esters, e.g., in form of an oil. More details on purification techniques can be found elsewhere herein below.

[0086] The host cells to be used in the method of the invention are grown or cultured in the manner with which the skilled worker is familiar, depending on the host organism. Usually, host cells are grown in a liquid medium comprising a carbon source, usually in the form of sugars, a nitrogen source, usually in the form of organic nitrogen sources such as yeast extract or salts such as ammonium sulfate, trace elements such as salts of iron, manganese and magnesium and, if appropriate, vitamins, at temperatures of between 0°C and 100°C, preferably between 10°C and 60°C under oxygen or anaerobic atmosphere depedent on the type of organism. The pH of the liquid medium can either be kept constant, that is to say regulated during the culturing period, or not. The cultures can be grown batchwise, semibatchwise or continuously. Nutrients can be provided at the beginning of the fermentation or administerd semicontinuously or continuously: The produced PUFA or LCPUFA can be isolated from the host cells as described above by processes known to the skilled worker, e.g., by extraction, distillation, crystallization, if appropriate precipitation with salt, and/or chromatography. It might be required to disrupt the host cells prior to purification. To this end, the host cells can be disrupted beforehand. The culture medium to be used must suitably meet the requirements of the host cells in question. Descriptions of culture media for various microorganisms which can be used as host cells according to the present invention can be found in the textbook "Manual of Methods for General Bacteriology" of the American Society for Bacteriology (Washington D.C., USA, 1981). Culture media can also be obtained from various commercial suppliers. All media components are sterilized, either by heat or by filter sterilization. All media components may be present at the start of the cultivation or added continuously or batchwise, as desired. If the polynucleotide or vector of the invention which has been introduced in the host cell further comprises an expressible selection marker, such as an antibiotic resistance gene, it might be necessary to add a selection agent to the culture, such as a antibiotic in order to maintain the stability of the introduced polynucleotide. The culture is continued until formation of the desired product is at a maximum. This is normally achieved within 10 to 160 hours. The fermentation broths can be used directly or can be processed further. The biomass may, according to requirement, be removed completely or partially from the fermentation broth by separation methods such as, for example, centrifugation, filtration, decanting or a combination of these methods or be left completely in said broth. The fatty acid preparations obtained by the method of the invention, e.g., oils, comprising the desired PUFA or LCPUFA as triglyceride esters are also suitable as starting material for the chemical synthesis of further products of interest. For example, they can be used in combination with one another or alone for the preparation of pharmaceutical or cosmetic compositions, foodstuffs, or animal feeds. Chemically pure triglycerides comprising the desired PUFA or LCPUFA can also be manufactured by the methods described above. To this end, the fatty acid preparations are further purified by extraction, distillation, crystallization, chromatography or combinations of these methods. In order to release the fatty acid moieties from the triglycerides, hydrolysis may be also required. The said chemically pure triglycerides or free fatty acids are, in particular, suitable for applications in the food industry or for cosmetic and pharmacological compositions.

[0087] Moreover, the present invention relates to a method for the manufacture of poly-unsaturated fatty acids comprising:

a) cultivating the non-human transgenic organism of the invention under conditions which allow for the production of poly-unsaturated fatty acids in said non-human transgenic organism; and
b) obtaining said poly-unsaturated fatty acids from the said non-human transgenic organism.

[0088] Further, it follows from the above that a method for the manufacture of an oil, lipid or fatty acid composition is also envisaged by the present invention comprising the steps of any one of the aforementioned methods and the further step of formulating PUFA or LCPUFA as oil, lipid or fatty acid composition. Preferably, said oil, lipid or fatty acid composition is to be used for feed, foodstuffs, cosmetics or medicaments. Accordingly, the formulation of the PUFA or LCPUFA shall be carried out according to the GMP standards for the individual envisaged products. For example, an oil may be obtained from plant seeds by an oil mill. However, for product safety reasons, sterilization may be required under the applicable

GMP standard. Similar standards will apply for lipid or fatty acid compositions to be applied in cosmetic or pharmaceutical compositions. All these measures for formulating oil, lipid or fatty acid compositions as products are comprised by the aforementioned manufacture.

[0089] The term " oil" refers to a fatty acid mixture comprising unsaturated and/or saturated fatty acids which are esterified to triglycerides. Preferably, the triglycerides in the oil of the invention comprise PUFA or LCPUFA as referred to above. The amount of esterified PUFA and/or LCPUFA is, preferably, approximately 30%, a content of 50% is more preferred, a content of 60%, 70%, 80% or more is even more preferred. The oil may further comprise free fatty acids, preferably, the PUFA and LCPUFA referred to above. For the analysis, the fatty acid content can be, e.g., determined by GC analysis after converting the fatty acids into the methyl esters by transesterification. The content of the various fatty acids in the oil or fat can vary, in particular depending on the source. The oil, however, shall have a non-naturally occurring composition with respect to the PUFA and/or LCPUFA composition and content. It will be understood that such a unique oil composition and the unique esterification pattern of PUFA and LCPUFA in the triglycerides of the oil shall only be obtainable by applying the methods of the present invention specified above. Moreover, the oil of the invention may comprise other molecular species as well. Specifically, it may comprise minor impurities of the polynucleotide or vector of the invention. Such impurities, however, can be detected only by highly sensitive techniques such as PCR.

[0090] Another embodiment is the use of the polynucleotide comprising NEENA or the recombinant vector comprising the polynucleotide with NEENA as defined above for enhancing expression of at least one enzyme of the polyunsaturated fatty acid biosynthetic pathway as defined in plants or parts thereof, in a more preferably embodiment the polynucleotide comprising NEENA or the recombinant vector comprising the polynucleotide with NEENA as defined above for enhancing expression of at least one enzyme of the polyunsaturated fatty acid biosynthetic pathway is used in plant seeds.

[0091] Another preferred embodiment is the use of a host cell or a host cell culture or of a non-human transgenic organism, transgenic plant, plant parts or plant seeds derived from the transgenic non-human organism or plant as decribed above for the production of foodstuffs, animal feeds, seeds, pharmaceuticals or fine chemicals.

DEFINITIONS

[0092] Abbreviations: NEENA - nucleic acid expression enhancing nucleic acid, GFP - green fluorescence protein, GUS - beta-Glucuronidase, BAP - 6-benzylaminopurine; MS - Murashige and Skoog medium; Kan: Kanamycin sulfate; GA3 - Gibberellic acid; microl: Microliter.

[0093] It is to be understood that this invention is not limited to the particular methodology or protocols. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention which will be limited only by the appended claims. It must be noted that as used herein and in the appended claims, the singular forms "a," "and," and "the" include plural reference unless the context clearly dictates otherwise. Thus, for example, reference to "a vector" is a reference to one or more vectors and includes equivalents thereof known to those skilled in the art, and so forth. The term "about" is used herein to mean approximately, roughly, around, or in the region of. When the term "about" is used in conjunction with a numerical range, it modifies that range by extending the boundaries above and below the numerical values set forth. In general, the term "about" is used herein to modify a numerical value above and below the stated value by a variance of 20 percent, preferably 10 percent up or down (higher or lower). As used herein, the word "or" means any one member of a particular list and also includes any combination of members of that list. The words "comprise," "comprising," "include," "including," and "includes" when used in this specification and in the following claims are intended to specify the presence of one or more stated features, integers, components, or steps, but they do not preclude the presence or addition of one or more other features, integers, components, steps, or groups thereof. For clarity, certain terms used in the specification are defined and used as follows:

Antiparallel: "Antiparallel" refers herein to two nucleotide sequences paired through hydrogen bonds between complementary base residues with phosphodiester bonds running in the 5'-3' direction in one nucleotide sequence and in the 3'-5' direction in the other nucleotide sequence.

[0094] Antisense: The term "antisense" refers to a nucleotide sequence that is inverted relative to its normal orientation for transcription or function and so expresses an RNA transcript that is complementary to a target gene mRNA molecule expressed within the host cell (e.g., it can hybridize to the target gene mRNA molecule or single stranded genomic DNA through Watson-Crick base pairing) or that is complementary to a target DNA molecule such as, for example genomic DNA present in the host cell.

[0095] Coding region: As used herein the term "coding region" when used in reference to a structural gene refers to the nucleotide sequences which encode the amino acids found in the nascent polypeptide as a result of translation of a mRNA molecule. The coding region is bounded, in eukaryotes, on the 5'-side by the nucleotide triplet "ATG" which encodes the initiator methionine and on the 3'-side by one of the three triplets which specify stop codons (i.e., TAA, TAG, TGA). In addition to containing introns, genomic forms of a gene may also include sequences located on both the 5'- and 3'-end of the sequences which are present on the RNA transcript. These sequences are referred to as "flanking" sequences or regions (these flanking sequences are located 5' or 3' to the non-translated sequences present on the mRNA transcript). The 5'-flanking region may contain regulatory sequences such as promoters and enhancers which control or influence the transcription of the gene. The 3'-flanking region may contain sequences which direct the termination of transcription, post-transcriptional cleavage and polyadenylation.

[0096] Complementary: "Complementary" or "complementarity" refers to two nucleotide sequences which comprise antiparallel nucleotide sequences capable of pairing with one another (by the base-pairing rules) upon formation of hydrogen bonds between the complementary base residues in the antiparallel nucleotide sequences. For example, the sequence 5'-AGT-3' is complementary to the sequence 5'-ACT-3'. Complementarity can be "partial" or "total." "Partial" complementarity is where one or more nucleic acid bases are not matched according to the base pairing rules. "Total" or "complete" complementarity between nucleic acid molecules is where each and every nucleic acid base is matched with another base under the base pairing rules. The degree of complementarity between nucleic acid molecule strands has significant effects on the efficiency and strength of hybridization between nucleic acid molecule strands. A "complement" of a nucleic acid sequence as used herein refers to a nucleotide sequence whose nucleic acid molecules show total complementarity to the nucleic acid molecules of the nucleic acid sequence.

[0097] Double-stranded RNA: A "double-stranded RNA" molecule or " dsRNA" molecule comprises a sense RNA fragment of a nucleotide sequence and an antisense RNA fragment of the nucleotide sequence, which both comprise nucleotide sequences complementary to one another, thereby allowing the sense and antisense RNA fragments to pair and form a double-stranded RNA molecule.

[0098] Endogenous: An "endogenous" nucleotide sequence refers to a nucleotide sequence, which is present in the genome of the untransformed plant cell.

[0099] Enhanced expression: " enhance" or " increase" the expression of a nucleic acid molecule in a plant cell are used equivalently herein and mean that the level of expression of the nucleic acid molecule in a plant, part of a plant or plant cell after applying a method of the present invention is higher than its expression in the plant, part of the plant or plant cell before applying the method, or compared to a reference plant lacking a recombinant nucleic acid molecule of the invention. For example, the reference plant is comprising the same construct which is only lacking the respective NEENA. The term "enhanced" or " increased" as used herein are synonymous and means herein higher, preferably significantly higher expression of the nucleic acid molecule to be expressed. As used herein, an " enhancement" or " increase" of the level of an agent such as a protein, mRNA or RNA means that the level is increased relative to a substantially identical plant, part of a plant or plant cell grown under substantially identical conditions, lacking a recombinant nucleic acid molecule of the invention, for example lacking the NEENA molecule, the recombinant construct or recombinant vector of the invetion. As used herein, " enhancement" or " increase" of the level of an agent, such as for example a preRNA, mRNA, rRNA, tRNA, snoRNA, snRNA expressed by the target gene and/or of the protein product encoded by it, means that the level is increased 50% or more, for example 100% or more, preferably 200% or more, more preferably 5 fold or more, even more preferably 10 fold or more, most preferably 20 fold or more for example 50 fold relative to a cell or organism lacking a recombinant nucleic acid molecule of the invention. The enhancement or increase can be determined by methods with which the skilled worker is familiar. Thus, the enhancement or increase of the nucleic acid or protein quantity can be determined for example by an immunological detection of the protein. Moreover, techniques such as protein assay, fluorescence, Northern hybridization, nuclease protection assay, reverse transcription (quantitative RT-PCR), ELISA (enzyme-linked immunosorbent assay), Western blotting, radioimmunoassay (RIA) or other immunoassays and fluorescence-activated cell analysis (FACS) can be employed to measure a specific protein or RNA in a plant or plant cell. Depending on the type of the induced protein product, its activity or the effect on the phenotype of the organism or the cell may also be determined. Methods for determining the protein quantity are known to the skilled worker. Examples, which may be mentioned, are: the micro-Biuret method (Goa J (1953) Scand J Clin Lab Invest 5:218-222), the Folin-Ciocalteau method (Lowry OH et al. (1951) J Biol Chem 193:265-275) or measuring the absorption of CBB G-250 (Bradford MM (1976) Analyt Biochem 72:248-254). As one example for quantifying the activity of a protein, the detection of luciferase activity is described in the Examples below.

[0100] Expression: "Expression" refers to the biosynthesis of a gene product, preferably to the transcription and/or translation of a nucleotide sequence, for example an endogenous gene or a heterologous gene, in a cell. For example, in the case of a structural gene, expression involves transcription of the structural gene into mRNA and - optionally - the subsequent translation of mRNA into one or more polypeptides. In other cases, expression may refer only to the transcription of the DNA harboring an RNA molecule.

[0101] Expression construct: "Expression construct" as used herein mean a DNA sequence capable of directing expression of a particular nucleotide sequence in an appropriate part of a plant or plant cell, comprising a promoter functional in said part of a plant or plant cell into which it will be introduced, operatively linked to the nucleotide sequence of interest which is - optionally - operatively linked to termination signals. If translation is required, it also typically comprises sequences required for proper translation of the nucleotide sequence. The coding region may code for a protein of interest but may also code for a functional RNA of interest, for example RNAa, siRNA, snoRNA, snRNA, microRNA, ta-siRNA or any other noncoding regulatory RNA, in the sense or antisense direction. The expression construct comprising the nucleotide sequence of interest may be chimeric, meaning that one or more of its components is heterologous with respect to one or more of its other components. The expression construct may also be one, which is naturally occurring but has been obtained in a recombinant form useful for heterologous expression. Typically, however, the expression construct is heterologous with respect to the host, i.e., the particular DNA sequence of the expression construct does not occur naturally in the host cell and must have been introduced into the host cell or an ancestor of the host cell by a transformation event. The expression of the nucleotide sequence in the expression construct may be under the control of a seed-specific promoter or of an inducible promoter, which initiates transcription only when the host cell is exposed to some particular external stimulus. In the case of a plant, the promoter can also be specific to a particular tissue or organ or stage of development.

[0102] Foreign: The term "foreign" refers to any nucleic acid molecule (e.g., gene sequence) which is introduced into the genome of a cell by experimental manipulations and may include sequences found in that cell so long as the introduced sequence contains some modification (e.g., a point mutation, the presence of a selectable marker gene, etc.) and is therefore distinct relative to the naturally-occurring sequence.

[0103] Functional linkage: The term "functional linkage" or "functionally linked" is to be understood as meaning, for example, the sequential arrangement of a regulatory element (e.g. a promoter) with a nucleic acid sequence to be expressed and, if appropriate, further regulatory elements (such as e.g., a terminator or a NEENA) in such a way that each of the regulatory elements can fulfill its intended function to allow, modify, facilitate or otherwise influence expression of said nucleic acid sequence. As a synonym the wording " operable linkage" or " operably linked" may be used. The expression may result depending on the arrangement of the nucleic acid sequences in relation to sense or antisense RNA. To this end, direct linkage in the chemical sense is not necessarily required. Genetic control sequences such as, for example, enhancer sequences, can also exert their function on the target sequence from positions which are further away, or indeed from other DNA molecules. Preferred arrangements are those in which the nucleic acid sequence to be expressed recombinantly is positioned behind the sequence acting as promoter, so that the two sequences are linked covalently to each other. The distance between the promoter sequence and the nucleic acid sequence to be expressed recombinantly is preferably less than 200 base pairs, especially preferably less than 100 base pairs, very especially preferably less than 50 base pairs. In a preferred embodiment, the nucleic acid sequence to be transcribed is located behind the promoter in such a way that the transcription start is identical with the desired beginning of the chimeric RNA of the invention. Functional linkage, and an expression construct, can be generated by means of customary recombination and cloning techniques as described (e.g., in Maniatis T, Fritsch EF and Sambrook J (1989) Molecular Cloning: A Laboratory Manual, 2nd Ed., Cold Spring Harbor Laboratory, Cold Spring Harbor (NY); Silhavy et al. (1984) Experiments with Gene Fusions, Cold Spring Harbor Laboratory, Cold Spring Harbor (NY); Ausubel et al. (1987) Current Protocols in Molecular Biology, Greene Publishing Assoc. and Wiley Interscience; Gelvin et al. (Eds) (1990) Plant Molecular Biology Manual; Kluwer Academic Publisher, Dordrecht, The Netherlands). However, further sequences, which, for example, act as a linker with specific cleavage sites for restriction enzymes, or as a signal peptide, may also be positioned between the two sequences. The insertion of sequences may also lead to the expression of fusion proteins. Preferably, the expression construct, consisting of a linkage of a regulatory region for example a promoter and nucleic acid sequence to be expressed, can exist in a vector-integrated form and be inserted into a plant genome, for example by transformation.

[0104] Gene: The term "gene" refers to a region operably joined to appropriate regulatory sequences capable of regulating the expression of the gene product (e.g., a polypeptide or a functional RNA) in some manner. A gene includes untranslated regulatory regions of DNA (e.g., promoters, enhancers, repressors, etc.) preceding (up-stream) and following (downstream) the coding region (open reading frame, ORF) as well as, where applicable, intervening sequences (i.e., introns) between individual coding regions (i.e., exons). The term "structural gene" as used herein is intended to mean a DNA sequence that is transcribed into mRNA which is then translated into a sequence of amino acids characteristic of a specific polypeptide.

[0105] Genome and genomic DNA: The terms " genome" or " genomic DNA" is referring to the heritable genetic information of a host organism. Said genomic DNA comprises the DNA of the nucleus (also referred to as chromosomal DNA) but also the DNA of the plastids (e.g., chloroplasts) and other cellular organelles (e.g., mitochondria). Preferably the terms genome or genomic DNA is referring to the chromosomal DNA of the nucleus.

[0106] Heterologous: The term "heterologous" with respect to a nucleic acid molecule or DNA refers to a nucleic acid molecule which is operably linked to, or is manipulated to become operably linked to, a second nucleic acid molecule to which it is not operably linked in nature, or to which it is operably linked at a different location in nature. A heterologous expression construct comprising a nucleic acid molecule and one or more regulatory nucleic acid molecule (such as a promoter or a transcription termination signal) linked thereto for example is a constructs originating by experimental manipulations in which either a) said nucleic acid molecule, or b) said regulatory nucleic acid molecule or c) both (i.e. (a) and (b)) is not located in its natural (native) genetic environment or has been modified by experimental manipulations, an example of a modification being a substitution, addition, deletion, inversion or insertion of one or more nucleotide residues. Natural genetic environment refers to the natural chromosomal locus in the organism of origin, or to the presence in a genomic library. In the case of a genomic library, the natural genetic environment of the sequence of the nucleic acid molecule is preferably retained, at least in part. The environment flanks the nucleic acid sequence at least at one side and has a sequence of at least 50 bp, preferably at least 500 bp, especially preferably at least 1,000 bp, very especially preferably at least 5,000 bp, in length. A naturally occurring expression construct - for example the naturally occurring combination of a promoter with the corresponding gene - becomes a transgenic expression construct when it is modified by non-natural, synthetic " artificial" methods such as, for example, mutagenization. Such methods have been described (US 5,565,350; WO 00/15815). For example a protein encoding nucleic acid molecule operably linked to a promoter, which is not the native promoter of this molecule, is considered to be heterologous with respect to the promoter. Preferably, heterologous DNA is not endogenous to or not naturally associated with the cell into which it is introduced, but has been obtained from another cell or has been synthesized. Heterologous DNA also includes an endogenous DNA sequence, which contains some modification, non-naturally occurring, multiple copies of an endogenous DNA sequence, or a DNA sequence which is not naturally associated with another DNA sequence physically linked thereto. Generally, although not necessarily, heterologous DNA encodes RNA or proteins that are not normally produced by the cell into which it is expressed.

[0107] High expression seed-specific promoter: A " high expression seed-specific promoter" as used herein means a promoter causing seed-specific or seed-preferential expression in a plant or part thereof wherein the accumulation or rate of synthesis of RNA or stability of RNA derived from the nucleic acid molecule under the control of the respective promoter is higher, preferably significantly higher than the expression caused by the promoter lacking the NEENA of the invention. Preferably the amount of RNA and/or the rate of RNA synthesis and/or stability of RNA is increased 50% or more, for example 100% or more, preferably 200% or more, more preferably 5 fold or more, even more preferably 10 fold or more, most preferably 20 fold or more for example 50 fold relative to a seed-specific or a seed-preferential promoter lacking a NEENA of the invention.

[0108] Hybridization: The term "hybridization" as used herein includes "any process by which a strand of nucleic acid molecule joins with a complementary strand through base pairing." (J. Coombs (1994) Dictionary of Biotechnology, Stockton Press, New York). Hybridization and the strength of hybridization (i.e., the strength of the association between the nucleic acid molecules) is impacted by such factors as the degree of complementarity between the nucleic acid molecules, stringency of the conditions involved, the Tm of the formed hybrid, and the G:C ratio within the nucleic acid molecules. As used herein, the term "Tm" is used in reference to the "melting temperature." The melting temperature is the temperature at which a population of double-stranded nucleic acid molecules becomes half dissociated into single strands. The equation for calculating the Tm of nucleic acid molecules is well known in the art. As indicated by standard references, a simple estimate of the Tm value may be calculated by the equation: Tm=81.5+0.41(% G+C), when a nucleic acid molecule is in aqueous solution at 1 M NaCl [see e.g., Anderson and Young, Quantitative Filter Hybridization, in Nucleic Acid Hybridization (1985)]. Other references include more sophisticated computations, which take structural as well as sequence characteristics into account for the calculation of Tm. Stringent conditions, are known to those skilled in the art and can be found in Current Protocols in Molecular Biology, John Wiley & Sons, N.Y. (1989), 6.3.1-6.3.6.

[0109] " Identity" : " Identity" when used in respect to the comparison of two or more nucleic acid or amino acid molecules means that the sequences of said molecules share a certain degree of sequence similarity, the sequences being partially identical.

[0110] To determine the percentage identity (homology is herein used interchangeably) of two amino acid sequences or of two nucleic acid molecules, the sequences are written one underneath the other for an optimal comparison (for example gaps may be inserted into the sequence of a protein or of a nucleic acid in order to generate an optimal alignment with the other protein or the other nucleic acid).

[0111] The amino acid residues or nucleic acid molecules at the corresponding amino acid positions or nucleotide positions are then compared. If a position in one sequence is occupied by the same amino acid residue or the same nucleic acid molecule as the corresponding position in the other sequence, the molecules are homologous at this position (i.e. amino acid or nucleic acid " homology" as used in the present context corresponds to amino acid or nucleic acid " identity" . The percentage homology between the two sequences is a function of the number of identical positions shared by the sequences (i.e. % homology = number of identical positions/total number of positions x 100). The terms " homology" and identity" are thus to be considered as synonyms.

[0112] For the determination of the percentage identity of two or more amino acids or of two or more nucleotide sequences several computer software programs have been developed. The identity of two or more sequences can be calculated with for example the software fasta, which presently has been used in the version fasta 3 (W. R. Pearson and D. J. Lipman, PNAS 85, 2444(1988); W. R. Pearson, Methods in Enzymology 183, 63 (1990); W. R. Pearson and D. J. Lipman, PNAS 85, 2444 (1988); W. R. Pearson, Enzymology 183, 63 (1990)). Another useful program for the calculation of identities of different sequences is the standard blast program, which is included in the Biomax pedant software (Biomax, Munich, Federal Republic of Germany). This leads unfortunately sometimes to suboptimal results since blast does not always include complete sequences of the subject and the query. Nevertheless as this program is very efficient it can be used for the comparison of a huge number of sequences. The following settings are typically used for such a comparisons of sequences:

Intron: refers to sections of DNA (intervening sequences) within a gene that do not encode part of the protein that the gene produces, and that is spliced out of the mRNA that is transcribed from the gene before it is exported from the cell nucleus. Intron sequence refers to the nucleic acid sequence of an intron. Thus, introns are those regions of DNA sequences that are transcribed along with the coding sequence (exons) but are removed during the formation of mature mRNA. Introns can be positioned within the actual coding region or in either the 5' or 3' untranslated leaders of the pre-mRNA (unspliced mRNA). Introns in the primary transcript are excised and the coding sequences are simultaneously and precisely ligated to form the mature mRNA. The junctions of introns and exons form the splice site. The sequence of an intron begins with GU and ends with AG. Furthermore, in plants, two examples of AU-AC introns have been described: the fourteenth intron of the RecA-like protein gene and the seventh intron of the G5 gene from Arabidopsis thaliana are AT-AC introns. Pre-mRNAs containing introns have three short sequences that are - beside other sequences- essential for the intron to be accurately spliced. These sequences are the 5' splice-site, the 3' splice-site, and the branchpoint. mRNA splicing is the removal of intervening sequences (introns) present in primary mRNA transcripts and joining or ligation of exon sequences. This is also known as cis-splicing which joins two exons on the same RNA with the removal of the intervening sequence (intron). The functional elements of an intron is comprising sequences that are recognized and bound by the specific protein components of the spliceosome (e.g. splicing consensus sequences at the ends of introns). The interaction of the functional elements with the spliceosome results in the removal of the intron sequence from the premature mRNA and the rejoining of the exon sequences. Introns have three short sequences that are essential -although not sufficient- for the intron to be accurately spliced. These sequences are the 5' splice site, the 3' splice site and the branch point. The branchpoint sequence is important in splicing and splice-site selection in plants. The branchpoint sequence is usually located 10-60 nucleotides upstream of the 3' splice site.

[0113] Isolated: The term "isolated" as used herein means that a material has been removed by the hand of man and exists apart from its original, native environment and is therefore not a product of nature. An isolated material or molecule (such as a DNA molecule or enzyme) may exist in a purified form or may exist in a non-native environment such as, for example, in a transgenic host cell. For example, a naturally occurring polynucleotide or polypeptide present in a living plant is not isolated, but the same polynucleotide or polypeptide, separated from some or all of the coexisting materials in the natural system, is isolated. Such polynucleotides can be part of a vector and/or such polynucleotides or polypeptides could be part of a composition, and would be isolated in that such a vector or composition is not part of its original environment. Preferably, the term "isolated" when used in relation to a nucleic acid molecule, as in "an isolated nucleic acid sequence" refers to a nucleic acid sequence that is identified and separated from at least one contaminant nucleic acid molecule with which it is ordinarily associated in its natural source. Isolated nucleic acid molecule is nucleic acid molecule present in a form or setting that is different from that in which it is found in nature. In contrast, non-isolated nucleic acid molecules are nucleic acid molecules such as DNA and RNA, which are found in the state they exist in nature. For example, a given DNA sequence (e.g., a gene) is found on the host cell chromosome in proximity to neighboring genes; RNA sequences, such as a specific mRNA sequence encoding a specific protein, are found in the cell as a mixture with numerous other mRNAs, which encode a multitude of proteins. However, an isolated nucleic acid sequence comprising for example SEQ ID NO: 1 includes, by way of example, such nucleic acid sequences in cells which ordinarily contain SEQ ID NO:1 where the nucleic acid sequence is in a chromosomal or extrachromosomal location different from that of natural cells, or is otherwise flanked by a different nucleic acid sequence than that found in nature. The isolated nucleic acid sequence may be present in single-stranded or double-stranded form. When an isolated nucleic acid sequence is to be utilized to express a protein, the nucleic acid sequence will contain at a minimum at least a portion of the sense or coding strand (i.e., the nucleic acid sequence may be single-stranded). Alternatively, it may contain both the sense and anti-sense strands (i.e., the nucleic acid sequence may be double-stranded).

[0114] Minimal Promoter: promoter elements, particularly a TATA element, that are inactive or that have greatly reduced promoter activity in the absence of upstream activation. In the presence of a suitable transcription factor, the minimal promoter functions to permit transcription.

[0115] NEENA: see " Nucleic acid expression enhancing nucleic acid" .

[0116] Nucleic acid expression enhancing nucleic acid (NEENA): The term " nucleic acid expression enhancing nucleic acid" refers to a sequence and/or a nucleic acid molecule of a specific sequence having the intrinsic property to enhance expression of a nucleic acid under the control of a promoter to which the NEENA is functionally linked. Unlike promoter sequences, the NEENA as such is not able to drive expression. In order to fulfill the function of enhancing expression of a nucleic acid molecule functionally linked to the NEENA, the NEENA itself has to be functionally linked to a promoter. In distinction to enhancer sequences known in the art, the NEENA is acting in cis but not in trans and has to be located close to the transcription start site of the nucleic acid to be expressed.

[0117] Nucleic acids and nucleotides: The terms "Nucleic Acids" and "Nucleotides" refer to naturally occurring or synthetic or artificial nucleic acid or nucleotides. The terms " nucleic acids" and "nucleotides" comprise deoxyribonucleotides or ribonucleotides or any nucleotide analogue and polymers or hybrids thereof in either single- or double-stranded, sense or antisense form. Unless otherwise indicated, a particular nucleic acid sequence also implicitly encompasses conservatively modified variants thereof (e.g., degenerate codon substitutions) and complementary sequences, as well as the sequence explicitly indicated. The term "nucleic acid" is used inter-changeably herein with "gene", "cDNA, "mRNA", "oligonucleotide," and "polynucleotide". Nucleotide analogues include nucleotides having modifications in the chemical structure of the base, sugar and/or phosphate, including, but not limited to, 5-position pyrimidine modifications, 8-position purine modifications, modifications at cytosine exocyclic amines, substitution of 5-bromo-uracil, and the like; and 2'-position sugar modifications, including but not limited to, sugar-modified ribonucleotides in which the 2'-OH is replaced by a group selected from H, OR, R, halo, SH, SR, NH2, NHR, NR2, or CN. Short hairpin RNAs (shRNAs) also can comprise non-natural elements such as non-natural bases, e.g., ionosin and xanthine, non-natural sugars, e.g., 2'-methoxy ribose, or non-natural phosphodiester linkages, e.g., methylphosphonates, phosphorothioates and peptides.

[0118] Nucleic acid sequence: The phrase "nucleic acid sequence" refers to a single or double-stranded polymer of deoxyribonucleotide or ribonucleotide bases read from the 5'- to the 3'-end. It includes chromosomal DNA, self-replicating plasmids, infectious polymers of DNA or RNA and DNA or RNA that performs a primarily structural role. "Nucleic acid sequence" also refers to a consecutive list of abbreviations, letters, characters or words, which represent nucleotides. In one embodiment, a nucleic acid can be a "probe" which is a relatively short nucleic acid, usually less than 100 nucleotides in length. Often a nucleic acid probe is from about 50 nucleotides in length to about 10 nucleotides in length. A "target region" of a nucleic acid is a portion of a nucleic acid that is identified to be of interest.

[0119] Oligonucleotide: The term "oligonucleotide" refers to an oligomer or polymer of ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) or mimetics thereof, as well as oligonucleotides having non-naturally-occurring portions which function similarly. Such modified or substituted oligonucleotides are often preferred over native forms because of desirable properties such as, for example, enhanced cellular uptake, enhanced affinity for nucleic acid target and increased stability in the presence of nucleases. An oligonucleotide preferably includes two or more nucleomonomers covalently coupled to each other by linkages (e.g., phosphodiesters) or substitute linkages.

[0120] Plant: is generally understood as meaning any eukaryotic single-or multi-celled organism or a cell, tissue, organ, part or propagation material (such as seeds or fruit) of same which is capable of photosynthesis. Included for the purpose of the invention are all genera and species of higher and lower plants of the Plant Kingdom. Annual, perennial, monocotyledonous and dicotyledonous plants are preferred. The term includes the mature plants, seed, shoots and seedlings and their derived parts, propagation material (such as seeds or microspores), plant organs, tissue, protoplasts, callus and other cultures, for example cell cultures, and any other type of plant cell grouping to give functional or structural units. Mature plants refer to plants at any desired developmental stage beyond that of the seedling. Seedling refers to a young immature plant at an early developmental stage. Annual, biennial, monocotyledonous and dicotyledonous plants are preferred host organisms for the generation of transgenic plants. The expression of genes is furthermore advantageous in all ornamental plants, useful or ornamental trees, flowers, cut flowers, shrubs or lawns. Plants which may be mentioned by way of example but not by limitation are angiosperms, bryophytes such as, for example, Hepaticae (liverworts) and Musci (mosses); Pteridophytes such as ferns, horsetail and club mosses; gymnosperms such as conifers, cycads, ginkgo and Gnetatae; algae such as Chlorophyceae, Phaeophpyceae, Rhodophyceae, Myxophyceae, Xanthophyceae, Bacillariophyceae (diatoms), and Euglenophyceae. Preferred are plants which are used for food or feed purpose such as the families of the Leguminosae such as pea, alfalfa and soya; Gramineae such as rice, maize, wheat, barley, sorghum, millet, rye, triticale, or oats; the family of the Umbelliferae, especially the genus Daucus, very especially the species carota (carrot) and Apium, very especially the species Graveolens dulce (celery) and many others; the family of the Solanaceae, especially the genus Lycopersicon, very especially the species esculentum (tomato) and the genus Solanum, very especially the species tuberosum (potato) and melongena (egg plant), and many others (such as tobacco); and the genus Capsicum, very especially the species annuum (peppers) and many others; the family of the Leguminosae, especially the genus Glycine, very especially the species max (soybean), alfalfa, pea, lucerne, beans or peanut and many others; and the family of the Cruciferae (Brassicacae), especially the genus Brassica, very especially the species napus (oil seed rape), campestris (beet), oleracea cv Tastie (cabbage), oleracea cv Snowball Y (cauliflower) and oleracea cv Emperor (broccoli); and of the genus Arabidopsis, very especially the species thaliana and many others; the family of the Compositae, especially the genus Lactuca, very especially the species sativa (lettuce) and many others; the family of the Asteraceae such as sunflower, Tagetes, lettuce or Calendula and many other; the family of the Cucurbitaceae such as melon, pumpkin/squash or zucchini, and linseed. Further preferred are cotton, sugar cane, hemp, flax, chillies, and the various tree, nut and wine species.

[0121] Polypeptide: The terms "polypeptide", "peptide", "oligopeptide", "polypeptide", "gene product", "expression product" and "protein" are used interchangeably herein to refer to a polymer or oligomer of consecutive amino acid residues.

[0122] Primary transcript: The term " primary transcript" as used herein refers to a premature RNA transcript of a gene. A " primary transcript" for example still comprises introns and/or is not yet comprising a polyA tail or a cap structure and/or is missing other modifications necessary for its correct function as transcript such as for example trimming or editing.

[0123] Promoter: The terms "promoter", or "promoter sequence" are equivalents and as used herein, refer to a DNA sequence which when ligated to a nucleotide sequence of interest is capable of controlling the transcription of the nucleotide sequence of interest into RNA. Such promoters can for example be found in the following public databases http://www.grassius.org/grasspromdb.html, http://mendel.cs.rhul.ac.uk/mendel.php?topic=plantprom, http://ppdb.gene.nagoya-u.ac.jp/cgi-bin/index.cgi. Promoters listed there may be addressed with the methods of the invention and are herewith included by reference. A promoter is located 5' (i.e., upstream), proximal to the transcriptional start site of a nucleotide sequence of interest whose transcription into mRNA it controls, and provides a site for specific binding by RNA polymerase and other transcription factors for initiation of transcription. Said promoter comprises for example the at least 10 kb, for example 5 kb or 2 kb proximal to the transcription start site. It may also comprise the at least 1500 bp proximal to the transcriptional start site, preferably the at least 1000 bp, more preferably the at least 500 bp, even more preferably the at least 400 bp, the at least 300 bp, the at least 200 bp or the at least 100 bp. In a further preferred embodiment, the promoter comprises the at least 50 bp proximal to the transcription start site, for example, at least 25 bp. The promoter does not comprise exon and/or intron regions or 5' untranslated regions. The promoter may for example be heterologous or homologous to the respective plant. A polynucleotide sequence is "heterologous to" an organism or a second polynucleotide sequence if it originates from a foreign species, or, if from the same species, is modified from its original form. For example, a promoter operably linked to a heterologous coding sequence refers to a coding sequence from a species different from that from which the promoter was derived, or, if from the same species, a coding sequence which is not naturally associated with the promoter (e.g. a genetically engineered coding sequence or an allele from a different ecotype or variety). Suitable promoters can be derived from genes of the host cells where expression should occur or from pathogens for this host cells (e.g., plants or plant pathogens like plant viruses). A plant specific promoter is a promoter suitable for regulating expression in a plant. It may be derived from a plant but also from plant pathogens or it might be a synthetic promoter designed by man. If a promoter is an inducible promoter, then the rate of transcription increases in response to an inducing agent. Also, the promoter may be regulated in a tissue-specific or tissue preferred manner such that it is only or predominantly active in transcribing the associated coding region in a specific tissue type(s) such as leaves, roots or meristem. The term "tissue specific" as it applies to a promoter refers to a promoter that is capable of directing selective expression of a nucleotide sequence of interest to a specific type of tissue (e.g., petals) in the relative absence of expression of the same nucleotide sequence of interest in a different type of tissue (e.g., roots). Tissue specificity of a promoter may be evaluated by, for example, operably linking a reporter gene to the promoter sequence to generate a reporter construct, introducing the reporter construct into the genome of a plant such that the reporter construct is integrated into every tissue of the resulting transgenic plant, and detecting the expression of the reporter gene (e.g., detecting mRNA, protein, or the activity of a protein encoded by the reporter gene) in different tissues of the transgenic plant. The detection of a greater level of expression of the reporter gene in one or more tissues relative to the level of expression of the reporter gene in other tissues shows that the promoter is specific for the tissues in which greater levels of expression are detected. The term "cell type specific" as applied to a promoter refers to a promoter, which is capable of directing selective expression of a nucleotide sequence of interest in a specific type of cell in the relative absence of expression of the same nucleotide sequence of interest in a different type of cell within the same tissue. The term "cell type specific" when applied to a promoter also means a promoter capable of promoting selective expression of a nucleotide sequence of interest in a region within a single tissue. Cell type specificity of a promoter may be assessed using methods well known in the art, e.g., GUS activity staining, GFP protein or immunohistochemical staining. The term "constitutive" when made in reference to a promoter or the expression derived from a promoter means that the promoter is capable of directing transcription of an operably linked nucleic acid molecule in the absence of a stimulus (e.g., heat shock, chemicals, light, etc.) in the majority of plant tissues and cells throughout substantially the entire lifespan of a plant or part of a plant. Typically, constitutive promoters are capable of directing expression of a transgene in substantially any cell and any tissue.

[0124] Promoter specificity: The term " specificity" when referring to a promoter means the pattern of expression conferred by the respective promoter. The specificity describes the tissues and/or developmental status of a plant or part thereof, in which the promoter is conferring expression of the nucleic acid molecule under the control of the respective promoter. Specificity of a promoter may also comprise the environmental conditions, under which the promoter may be activated or down-regulated such as induction or repression by biological or environmental stresses such as cold, drought, wounding or infection.

[0125] Purified: As used herein, the term "purified" refers to molecules, either nucleic or amino acid sequences that are removed from their natural environment, isolated or separated. "Substantially purified" molecules are at least 60% free, preferably at least 75% free, and more preferably at least 90% free from other components with which they are naturally associated. A purified nucleic acid sequence may be an isolated nucleic acid sequence.

[0126] Recombinant: The term "recombinant" with respect to nucleic acid molecules refers to nucleic acid molecules produced by recombinant DNA techniques. Recombinant nucleic acid molecules may also comprise molecules, which as such does not exist in nature but are modified, changed, mutated or otherwise manipulated by man. Preferably, a "recombinant nucleic acid molecule" is a non-naturally occurring nucleic acid molecule that differs in sequence from a naturally occurring nucleic acid molecule by at least one nucleic acid. A " recombinant nucleic acid molecule" may also comprise a " recombinant construct" which comprises, preferably operably linked, a sequence of nucleic acid molecules not naturally occurring in that order. Preferred methods for producing said recombinant nucleic acid molecule may comprise cloning techniques, directed or non-directed mutagenesis, synthesis or recombination techniques.

[0127] "Seed-specific promoter" in the context of this invention means a promoter which is regulating transcription of a nucleic acid molecule under control of the respective promoter in seeds wherein the transcription in any tissue or cell of the seeds contribute to more than 90%, preferably more than 95%, more preferably more than 99% of the entire quantity of the RNA transcribed from said nucleic acid sequence in the entire plant during any of its developmental stage. The term " seed-specific expression" and " seed-specific NEENA" are to be understood accordingly. Hence a " seed-specific NEENA" enhances the transcription of a seed-specific or seed-preferential promoter in a way, that the transcription in seeds derived from said promoter functionally linked to a respective NEENA contribute to more than 90%, preferably more than 95%, more preferably more than 99% of the entire quantity of the RNA transcribed from the respective promoter functionally linked to a NEENA in the entire plant during any of its developmental stage.

[0128] "Seed-preferential promoter" in the context of this invention means a promoter which is regulating transcription of a nucleic acid molecule under control of the respective promoter in seeds wherein the transcription in any tissue or cell of the seeds contribute to more than 50%, preferably more than 70%, more preferably more than 80% of the entire quantity of the RNA transcribed from said nucleic acid sequence in the entire plant during any of its developmental stage. The term " seed-preferential expression" and " seed-preferential NEENA" are to be understood accordingly. Hence a " seed-preferential NEENA" enhances the transcription of a seed-specific or seed-preferential promoter in a way, that the transcription in seeds derived from said promoter functionally linked to a respective NEENA contribute to more than 50%, preferably more than 70%, more preferably more than 80% of the entire quantity of the RNA transcribed from the respective promoter functionally linked to a NEENA in the entire plant during any of its developmental stage.

[0129] Sense: The term "sense" is understood to mean a nucleic acid molecule having a sequence which is complementary or identical to a target sequence, for example a sequence which binds to a protein transcription factor and which is involved in the expression of a given gene. According to a preferred embodiment, the nucleic acid molecule comprises a gene of interest and elements allowing the expression of the said gene of interest.

[0130] Significant increase or decrease: An increase or decrease, for example in enzymatic activity or in gene expression, that is larger than the margin of error inherent in the measurement technique, preferably an increase or decrease by about 2-fold or greater of the activity of the control enzyme or expression in the control cell, more preferably an increase or decrease by about 5-fold or greater, and most preferably an increase or decrease by about 10-fold or greater.

[0131] Substantially complementary: In its broadest sense, the term "substantially complementary", when used herein with respect to a nucleotide sequence in relation to a reference or target nucleotide sequence, means a nucleotide sequence having a percentage of identity between the substantially complementary nucleotide sequence and the exact complementary sequence of said reference or target nucleotide sequence of at least 60%, more desirably at least 70%, more desirably at least 80% or 85%, preferably at least 90%, more preferably at least 93%, still more preferably at least 95% or 96%, yet still more preferably at least 97% or 98%, yet still more preferably at least 99% or most preferably 100% (the later being equivalent to the term " identical" in this context). Preferably identity is assessed over a length of at least 19 nucleotides, preferably at least 50 nucleotides, more preferably the entire length of the nucleic acid sequence to said reference sequence (if not specified otherwise below). Sequence comparisons are carried out using default GAP analysis with the University of Wisconsin GCG, SEQWEB application of GAP, based on the algorithm of Needleman and Wunsch (Needleman and Wunsch (1970) J Mol. Biol. 48: 443-453; as defined above). A nucleotide sequence "substantially complementary " to a reference nucleotide sequence hybridizes to the reference nucleotide sequence under low stringency conditions, preferably medium stringency conditions, most preferably high stringency conditions (as defined above).

[0132] Transgene: The term "transgene" as used herein refers to any nucleic acid sequence, which is introduced into the genome of a cell by experimental manipulations. A transgene may be an "endogenous DNA sequence," or a "heterologous DNA sequence" (i.e., "foreign DNA"). The term "endogenous DNA sequence" refers to a nucleotide sequence, which is naturally found in the cell into which it is introduced so long as it does not contain some modification (e.g., a point mutation, the presence of a selectable marker gene, etc.) relative to the naturally-occurring sequence.

[0133] Transgenic: The term transgenic when referring to an organism means transformed, preferably stably transformed, with a recombinant DNA molecule that preferably comprises a suitable promoter operatively linked to a DNA sequence of interest.

[0134] Vector: As used herein, the term "vector" refers to a nucleic acid molecule capable of transporting another nucleic acid molecule to which it has been linked. One type of vector is a genomic integrated vector, or "integrated vector", which can become integrated into the chromosomal DNA of the host cell. Another type of vector is an episomal vector, i.e., a nucleic acid molecule capable of extra-chromosomal replication. Vectors capable of directing the expression of genes to which they are operatively linked are referred to herein as "expression vectors". In the present specification, "plasmid" and "vector" are used interchangeably unless otherwise clear from the context. Expression vectors designed to produce RNAs as described herein in vitro or in vivo may contain sequences recognized by any RNA polymerase, including mitochondrial RNA polymerase, RNA pol I, RNA pol II, and RNA pol III. These vectors can be used to transcribe the desired RNA molecule in the cell according to this invention. A plant transformation vector is to be understood as a vector suitable in the process of plant transformation.

[0135] Wild-type: The term "wild-type", "natural" or "natural origin" means with respect to an organism, polypeptide, or nucleic acid sequence, that said organism is naturally occurring or available in at least one naturally occurring organism which is not changed, mutated, or otherwise manipulated by man.

[0136] The contents of all references cited throughout this application are herewith incorporated by reference in general and with respect to their specific disclosure content referred to above.

FIGURES

[0137]

Figure 1: Schematical figure of the different enzymatic activities leading to the production of ARA, EPA and DHA.

Figure 2 Strategy employed for stepwise buildup of plant expression plasmids of the invention. A detailed description is given in example 4. Abreviations: *Nco* I, *Pac* I, *Kas* I, *Sfo* I, *Fse* I, *Sbf* I, *Xma* I, *Not* I indicate restriction endonucleases used for cloning; *att*Lx and *att*Rx-where x are numbers from 1 to 4-designate attachment sites for site specific recombination of the Multisite Gateway™ System (Invitrogen); pENTR_A, pENTR_B, pENTR_C are Multisite Gateway™ System-Entry-vectors; Kan (Kanaycin) and Strep (Streptinomycin) designate antibiotic selection markers used for cloning; ori-origin of replication.

Figure 3 Orientation and combination of the functional elements (promoter, NEENA, gene, terminator) of the plant expression vecotrs VC-LJB913-1qcz (SEQ-ID 38), VC-LJB1327-1qcz (SEQ-ID 39), VC-LJB2003-1qcz (SEQ-ID 40) and VC-LJB2197-1qcz (SEQ-ID 146).

EXAMPLES

Example 1: General cloning methods

[0138] Cloning methods as e.g. use of restriction endonucleases to cut double stranded DNA at specific sites, agarose gel electrophoreses, purification of DNA fragments, transfer of nucleic aicds onto nitrocellulose and nylon memebranes, joining of DNA-fragments, transformation of E.coli cells and culture of bacteria where perforemed as described in Sambrook et al. (1989) (Cold Spring Harbor Laboratory Press: ISBN 0-87965-309-6). Polymerase chain reaction was performed using Phusion™ High-Fidelity DNA Polymerase (NEB, Frankfurt, Germany) according to the manufactures instrucions. In general, primers used in PCR were designed such, that at least 20 nucleotides of the 3' end of the primer anneal perfectly with the template to amplify. Restriction site were added by attaching the corresponing nucleotides of the recognition sites to the 5' end of the primer. Fusion PCR, for example described by K. Heckman and L. R. Pease, Nature Protocols (2207) 2, 924- 932 was used as an alternative method to join two fragments of interest, e.g. a promoter to a gene or a gene to a terminator.

Example 2: Sequence Analysis of recombinant DNA

[0139] Sequencing of recombinant DNA-molecules was performed using a laser-fluorescence DNA sequencer (Applied Biosystems Inc, USA) employing the sanger method (Sanger et al. (1977) Proc. Natl. Acad. Sci. USA 74, 5463-5467). Expression constructs harboring fragments obtained by polymerase chain reactions (PCR) were subjected to sequencing to confirm the correctness of expression cassettes consisting of promoter, nulceic acid molecule to be expressed and terminator to avoid mutations that might result from handling of the DNA during cloning, e.g. due to incorrect primers, mutations from exposure to UV-light or errors of polymerases.

Example 3: Identification of Nucleic Acid Expression Enhancing Nucleic Acids (NEENA) from genes with seed preferred expression

3.1 Identification of NEENA molecules from A *thaliana* genes

[0140] Using publicly available genomic DNA sequences (e.g. http://www.ncbi.nlm.nih.gov/genomes/PLANTS/PlantList.html) and transcript expression data (e.g. http://www.weigelworld.org/resources/microarray/AtGenExpress/), a set of 19 NEENA candidates deriving from *Arabidopsis thaliana* transcripts with seed preferred expression was selected for detailed analyses. The candidates were named as follows:

Table 1: seed specific NEENA candidates (NEENAss).

NEENA name	Locus	Annotation	SEQ ID No
NEENAss1	At1g62290	aspartyl protease family protein	6
NEENAss2	At1g65090	expressed protein	7
NEENAss15	At2g27040	PAZ domain-containing protein	9
NEENAss18	At1g01170	ozone-responsive stress-related protein, putative	10
NEENAss14	At5g63190	MA3 domain-containing protein	8
NEENAss4	At5g07830	glycosyl hydrolase family 79 N-terminal domain-containing protein similar to beta-glucuronidase AtGUS2	11
NEENAss13	At2g04520	eukaryotic translation initiation factor 1A, putative / eIF-1A	12
NEENAss3	At5g60760	2-phosphoglycerate kinase-related	13
NEENAss5	At1g11170	expressed protein contains Pfam profile PF05212	14
NEENAss11	At4g37050	PLA V/PLP4 (Patatin-like protein 4)	15
NEENAss8	At1g56170	HAP5B (Heme activator protein (yeast) homolog 5B)	16
NEENAss16	At1g54100	aldehyde dehydrogenase, putative / antiquitin	17
NEENAss9	At3g12670	CTP synthase, putative / UTP--ammonia ligase, putative	18
NEENAss20	At4g04460	aspartyl protease family protein	19
NEENAss10	At1g04120	ATMRP5 (Arabidopsis thaliana multidrug resistance-associated protein 5)	20
NEENAss6	At2g41070	basic leucine zipper transcription factor (BZIP12)	21
NEENAss12	At1g05450	protease inhibitor/seed storage/lipid transfer protein (LTP)-related	22
NEENAss7	At4g03050	2-oxoglutarate-dependent dioxygenase, putative (AOP3)	23
NEENAss17	At3g12490	cysteine protease inhibitor, putative / cystatin	24

3.2 Isolation of the NEENA candidates

[0141] Genomic DNA was extracted from *A. thaliana* green tissue using the Qiagen DNeasy Plant Mini Kit (Qiagen, Hilden, Germany). Genomic DNA fragments containing NEENA molecules were isolated by conventional polymerase chain reaction (PCR). Primers were designed on the basis of the *A. thaliana* genome sequence with a multitude of NEENA candidates. The reaction comprised 19 sets of primers (Table 2) and followed the protocol outlined by Phusion High Fidelity DNA Polymerase (Cat No F-540L, New England Biolabs, Ipswich, MA, USA). The isolated DNA was used as template DNA in a PCR amplification using the following primers:

Table 2: Primer sequences for isolation of NEENAs

Primer name	Sequence	SEQ ID No	PCR yielding SEQ ID No
NEENAss1_for NEENAss1_rev	tggtgcttaaacactctggtgagt tttgacctacaaaatcaaagcagtca	42 43	6

(continued)

Primer name	Sequence	SEQ ID No	PCR yielding SEQ ID No
NEENAss2_for NEENAss2_rev	agttctttgctttcgaagttgc tactacgtactgttttcaattct	44 45	7
NEENAss3_for NEENAss3_rev	atttccacacgctttctatcatttc ttatctctctctaaaaaataaaaacgaatc	46 47	13
NEENAss4_for NEENAss4_rev	gtccagaattttctccattga tcttcactatccaaagctctca	48 49	11
NEENAss5_for NEENAss5_rev	gtctactttcattacagtgactctg ttatattttacctgcaacacaattcaa	50 51	14
NEENAss6_for NEENAss6_rev	cactcgaatactgcatgcaa ttatgtagcctttacacagaaaacaa	52 53	21
NEENAss7 for NEENAss7_rev	aacaactatggcctgagggt ttatcttactgtttttaaccaaaaaataaaat	54 55	23
NEENAss8_for NEENAss8_rev	atcttagggtttcgcgagatctca tgctaagctatctctgttaatataaaattg	56 57	16
NEENAss9_for NEENAss9_rev	atttttgttggtgaaaggtaga ttacgtttttgtctctgcttcttct	58 59	18
NEENAss10_for NEENAss10_rev	tctgggaaatatcgattttgatct tctcaccacatcccaaagctc	60 61	20
NEENAss11_for NEENAss11_rev	gcacaatcttagcttaccttgaa ttatttaatccacaagccttgcctc	62 63	15
NEENAss12_for NEENAss12_rev	tgtcggagaagtgggcg agaagtgggcggacg	64 65	22
NEENAss13_for NEENAss13_rev	tagcttaatctcagattcgaatcgt tagtatctacataccaatcatacaaatg	66 67	12
NEENAss14_for	tttcacgatttggaatttga	68	8
NEENAss14_rev	tctacaacattaaaacgaccatta	69	
NEENAss15_for NEENAss15_rev	agggtttcgtttttgtttca ttatctcctgctcaaagaaacca	70 71	9
NEENAss16_for NEENAss16_rev	agaagctcatttcttcgatac tctctgcgcaaaaattcacc	72 73	17
NEENAss17_for NEENAss17_rev	tctaaaaatacagggcacc ttactcttcgttgcagaagccta	74 75	24
NEENAss18_for NEENAss18_rev	actgtttaagcttcactgtct tttcttctaaagctgaaagt	76 77	10
NEENAss20_for NEENAss20_rev	ttaagcttttaagaatctctactcaca ttaaattttacctgtcatcaaaaacaaca	78 79	19

[0142] Amplification during the PCR was carried out with the following composition (50 microl):

3,00 microl *A. thaliana* genomic DNA
10,00 microl 5x Phusion HF Buffer
4,00 microl dNTP (2,5 mM)
2,50 microl for Primer (10 microM)
2,50 microl rev Primer (10 microM)

0,50 microl Phusion HF DNA Polymerase (2U/microl)

[0143] A touch-down approach was employed for the PCR with the following parameters: 98,0°C for 30 sec (1 cycle), 98,0°C for 30 sec, 56,0°C for 30 sec and 72,0°C for 60 sec (4 cycles), 4 additional cycles each for 54,0°C, 51,0°C and 49,0°C annealing temperature, followed by 20 cycles with 98,0°C for 30 sec, 46,0°C for 30 sec and 72,0°C for 60 sec (4 cycles) and 72,0°C for 5 min. The amplification products was loaded on a 2 % (w/v) agarose gel and separated at 80V. The PCR products were excised from the gel and purified with the Qiagen Gel Extraction Kit (Qiagen, Hilden, Germany). The purified PCR prudcts were cloned into the pCR2.1 TOPO (Invitrogen) vector according to the manufacturer' s manual and subsequently sequenced. These plasmids served as source for further cloning steps or as template for further PCR, e.g. fusion PCR for fusion with promotors as described in example 4.

Example 4: Assembly of genes requiered for PUFA synthesis within a **T-plasmid**

[0144] For synthesis of LC-PUFA in Brassica napus seeds, the set of genes encoding the proteins of the metabolic LC-PUFA pathway (table 3) was combined with expression elements (promoter, terminators, NEENAs, table 5) and transfered into binary t-plasmids that were used for agrobacteria mediated transformation of plants as described in example 5. To this end, the general cloning strategy depicted in figure 2 was employed: Genes listed in table 3 were PCR-amplified using Phusion™ High-Fidelity DNA Polymerase (NEB, Frankfurt, Germany) according to the manufactures instrucions from cDNA using primer introducing a *Nco* I and/or *Asc* I restriction site at the 5' terminus, and a *Pac* I restriction site at the 3' terminus (figure 2A). Promoter-terminator modules or promoter-NEENA-terminator modules were created by joinging the corresponding expression elements listed in table 2 using fusion PCR as described in example 1 and cloning the PCR-product into the TOPO-vector pCR2.1 (Invitrogen) according to the manufactures instructions (figure 2B). As a non limiting example, primer combinations are listed in table 6 were used to create fusions of promoter-NEENAs harbored by the plasmid VC-LJB2003-1qcz (SEQ-ID 40) and VC-LJB2197-1qcz (SEQ-ID 146) containing the required set of pathway genes to synthesize arachidonic acid in seeds of rapeseed. While joining terminator sequences to promoter sequences or promoter-NEENA sequences using fusion PCR, primers were designed such, that recognition sequences for the restriction endonucleases depicted in figure 2 were added to either side of the modules, and the recognition sites for the restriction endonucleases *Nco* I, *Asc* I and *Pac* I were introduced between promoter and terminator or between NEENA and terminator (see figure 2B). To obtain the final expression modules, PCR-amplified genes were cloned between promoter and terminator or NEENA and terminator via Nco I and/or Pac I restriction sites (figure 2C). Employing the custom multiple cloning site (MCS) SEQ-ID 41, up to three of those expression modules were combined as desired to expression cassettes harbored by either one of pENTR/A, pENTR/B or pENTR/C (figure 2D). Deviating from the strategy depicted in figure 2, some elements or joined elements were synthezied by a service provider or cloned using blunt-end ligation. Finally, the Multisite Gateway™ System (Invitrogen) was used to combine three expression cassette harbored by pENTR/A, pENTR/B and pENTR/C (figure 2E) to obtain the final binary pSUN T-plasmids VC-LJB913-1qcz (SEQ-ID 38), VC-LJB1327-1qcz (SEQ-ID 39) and VC-LJB2003-1qcz (SEQ-ID 40) and VC-LJB2197-1qcz (SEQ-ID 146).. The orientation and combination of the functional elements (promoter, NEENA, gene, terminator) is depicted in figure 3A, 3B, 3C and 3D. An overview of binary vectors and their usage is given by Hellens et al, Trends in Plant Science (2000) 5: 446- 451.

Table 3: Genes used for synthesis of 20:4n-6 (ARA) in rapeseed.

Gene	Source Organism	Activity	SEQ-ID
d12Des(Ps_GA)	*Phytophtora sojae*	Δ 12-Desaturase	95
d6Des(Ot-febit)	*Ostreococcus tauri*	Δ 6-Desaturase	96
d6Des(Ot_GA2)	*Ostreococcus tauri*	Δ 6-Desaturase	97
d6Des(Pir_GAI)	*Pythium irregulare*	Δ 6-Desaturase	98
d6Elo(Pp_GA2)	*Physcomitrella patens*	Δ 6-Elongase	99
d6Elo(Tp_GA2)	*Thalassiosira pseudonana*	Δ 6-Elongase	100
d5Des(Tc_GA2)	*Thraustochytrium ssp.*	Δ 5-Desaturase	101

Table 4: Genes used in addition to genes listed in table 1 for synthesis of 22:6n-3 (DHA) in rapeseed.

Gene	Source Organism	Activity	SEQ-ID
d5Elo(Ot_GA3)	*Ostreococcus tauri*	Δ 5-Elongase	102
d4Des(Tc_GA3)	*Traustochytrium ssp.*	Δ 4-Desaturase	103

Table 5: Expression elements used for synthesis of 20:4n-6 (ARA) or 22:6n-3 (DHA) in rapeseed

Element	Source Organism	Function	SEQ-ID
p-VfSBP-NEENAss1	*Vicia faba*; Arabidopsis	Promotor+NEENA	1
p-BnNapin-NEENAss2	*Brassica napus*; Arabidopsis	Promotor+NEENA	2
p-LuCnl-NEENAss14	*Linum usitatissimum*; Arabidopsis	Promotor+NEENA	3
p-LuPxr-NEENAss15	*Linum usitatissimum*; Arabidopsis	Promotor+NEENA	4
p-VfUSP-NEENAss18	*Vicia faba*; Arabidopsis	Promotor+NEENA	5
p-VfSBP-NEENAss2	*Vicia faba*, Arabidopsis	Promoter+NEENA	147
p-LuPxr-NEENAss1	*Linum usitatissimum*, Arabidopsis	Promoter+NEENA	148
p-BnNapin-NEENAss14	*Brassica napus,* Arabidopsis	Promoter+NEENA	149
NEENAss1	Arabidopsis	NEENA from locus At1g62290 (aspartyl protease family protein)	6
NEENAss2	Arabidopsis	NEENA from locus At1g65090 (expressed protein)	7
NEENAss14	Arabidopsis	NEENA from locus At5g63190 (MA3 domain-containing protein)	8
NEENAss15	Arabidopsis	NEENA from locus At2g27040 (PAZ domain-containing protein)	9
NEENAss18	Arabidopsis	NEENAfrom locus At1g01170 (ozone-responsive stress-related protein, putative)	10
NEENAss4	Arabidopsis	NEENA from locus At5g07830 (glycosyl hydrolase family 79 N-terminal domain-containing	11
		protein similar to beta-glucuronidase AtGUS2)	
NEENAss13	Arabidopsis	NEENA from locus At2g04520 (eukaryotic translation initiation factor 1A, putative / eIF-1A)	12
NEENAss3	Arabidopsis	NEENA from locus At5g60760 (2-phosphoglycerate kinase-related)	13

(continued)

Element	Source Organism	Function	SEQ-ID
NEENAss5	Arabidopsis	NEENA from locus At1g11170 (expressed protein contains Pfam profile PF05212)	14
NEENAss11	Arabidopsis	NEENA from locus At4g37050 (PLA V/PLP4 (Patatin-like protein 4))	15
NEENAss8	Arabidopsis	NEENA from locus At1 g56170 (HAP5B (Heme activator protein (yeast) homolog 5B))	16
NEENAss16	Arabidopsis	NEENA from locus At1g54100 (aldehyde dehydrogenase, putative / antiquitin)	17
NEENAss9	Arabidopsis	NEENA from locus At3g12670 (CTP synthase, putative / UTP-ammonia ligase, putative)	18
NEENAss20	Arabidopsis	NEENA from locus At4g04460 (aspartyl protease family protein)	19
NEENAss10	Arabidopsis	NEENA from locus At1g04120 (ATMRP5 (Arabidopsis thaliana multidrug resistance-associated protein 5))	20
NEENAss6	Arabidopsis	NEENA from locus At2g41070 (basic leucine zipper transcription factor (BZIP12))	21
NEENAss12	Arabidopsis	NEENA from locus At1g05450 (protease inhibitor/seed storage/lipid transfer protein (LTP)-related)	22
NEENAss7	Arabidopsis	NEENA from locus At4g03050 (2-oxoglutarate-dependent dioxygenase, putative (AOP3))	23
NEENAss17	Arabidopsis	NEENA from locus At3g12490 (cysteine protease inhibitor, putative / cystatin)	24
p-BnNapin	*Brassica napus*	Promotor	25
p-LuCnl	*Linum usitatissimum*	Promotor	26
p-LuPXR	*Linum usitatissimum*	Promotor	27
p-VfSBP	*Vicia faba*	Promotor	28
p-VfUSP	*Vicia faba*	Promotor	29
p-VfLeB4	*Vicia faba*	Promotor	30
t-AtPXR	Arabidopsis	Terminator	31
t-CaMV35S	CaMV	Terminator	32
t-E9	*Pisum sativum*	Terminator	33
t-AgrOCS	*Agrobacterium tumefaciens*	Terminator	34
t-PvArc	*Phaseolus vulgaris*	Terminator	35
t-StCat	*Solanum tuberosum*	Terminator	36
t-VfLeB3	*Vicia faba*	Terminator	37

Table 6: Primers used for creation of fusions between promotor and NEENA elements using fusion PCR as described in example 1.

Promoter/NEENA cassette	Primer pair 1. PCR Promoter	Primer pair 1. PCR NEENA	Primer pair 2. PCR Promotor-NEENA
p-VfSBP-NEENAss1	Forw: tcgacggcccggactgta tccaac (SEQ-ID No:80) Rev: actcaccagagtgtttaag caccagttcagcttgatcg ctctattaat (SEQ-ID No:81)	Forw: attaatagagcgatcaag ctgaactggtgcttaaaca ctctggtgagt (SEQ-ID No:82) Rev: tttgacctacaaaatcaaa gcagtca (SEQ-ID No:43)	Forw: tcgacggcccggactgta tccaac (SEQ-ID No:80) Rev: tttgacctacaaaatcaaa gcagtca (SEQ-ID No:43)
p-BnNapin-NEENAss2	Forw: taaggatgacctacccatt cttga (SEQ-ID No:83) Rev: gcaacttcgaaagcaaa gaacttgtttttaatcttgtttg tattga (SEQ-ID No:84)	Forw: tcaatacaaacaagatta aaaacaagttctttgctttc gaagttgc (SEQ-ID No:85) Rev: tactacgtactgttttcaatt ct (SEQ-ID No:45)	Forw: taaggatgacctacccatt cttga (SEQ-ID No:83) Rev: tactacgtactgttttcaatt ct (SEQ-ID No:45)
p-LuCnl-NEENAss14	Forw: ttagcagatatttggtgtcta aat (SEQ-ID No:86) Rev:	Forw: aaagaaccaatcaccac caaaaaatttcacgatttg gaatttga (SEQ-ID No:88)	Forw: ttagcagatatttggtgtcta aat (SEQ-ID No:86) Rev:

(continued)

Promoter/NEENA cassette	Primer pair 1. PCR Promoter	Primer pair 1. PCR NEENA	Primer pair 2. PCR Promotor-NEENA
	tcaaattccaaatcgtgaa atttttggtggtgattggttc ttt (SEQ-ID No:87)	Rev: tctacaacattaaaacga ccatta (SEQ-ID No:69)	tctacaacattaaaacga ccatta (SEQ-ID No:69)
p-LuPxr-NEENAss15	Forw: cacgggcaggacatagg gactact (SEQ-ID No:89) Rev: tgaaacaaaaacgaaac c ctgatttatgataaaaatgt cggttt (SEQ-ID No:90)	Forw: aaaccgacatttttatcata aatcagggtttcgtttttgttt ca (SEQ-ID No:91) Rev: ttatctcctgctcaaagaa acca (SEQ-ID No:71)	Forw: cacgggcaggacatagg gactact (SEQ-ID No:89) Rev: ttatctcctgctcaaagaa acca (SEQ-ID No:71)
p-VfUSP-NEENAss18	Forw: ctgcagcaaatttacacat tgcca (SEQ-ID No:92) Rev:	Forw: gattataatttcttcatagcc agtactgtttaagcttcact gtct (SEQ-ID No:94) Rev:	Forw: ctgcagcaaatttacacat tgcca (SEQ-ID No:92) Rev:

(continued)

Promoter/NEENA cassette	Primer pair 1. PCR Promoter	Primer pair 1. PCR NEENA	Primer pair 2. PCR Promotor-NEENA
	agacagtgaagcttaaac agtactggctatgaagaa attataatc (SEQ-ID No:93)	tttcttctaaagctgaaagt (SEQ-ID No:77)	tttcttctaaagctgaaagt (SEQ-ID No:77)
p-VfSBP-NEENAss2	Forw: Tcgacggcccggactgt atccaac (SEQ-ID No:80) Rev: Gcaacttcgaaagcaaa gaactgttcagcttgatcg ctctattaat (SEQ_ID No:150)	Forw: Attaatagagcgatcaag ctgaacagttctttgctttcg aagttgc (SEQ-ID No:151) Rev: Tactacgtactgttttcaatt ct (SEQ-ID No:45)	Forw: Tcgacggcccggactgt atccaac (SEQ-ID No:80) Rev: Tactacgtactgttttcaatt ct (SEQ-ID No:45)
p-LuPxr-NEENAss1	Forw: Cacgggcaggacatag ggactact (SEQ-ID No:89) Rev: Actcaccagagtgtttaag caccagatttatgataaaa atgtcggttt (SEQ_ID No:152)	Forw: aaaccgacatttttatcata aatctggtgcttaaacact ctggtgagt (SEQ-ID No:153) Rev: tggtgcttaaacactctggt gagt (SEQ-ID No:42)	Forw: Cacgggcaggacatag ggactact (SEQ-ID No:89) Rev: tggtgcttaaacactctggt gagt (SEQ-ID No:42)
p-BnNapin-NEENAss14	Forw: taaggatgacctacccatt cttga (SEQ-ID No:83)	Forw: tcaatacaaacaagatta aaaacatttcacgatttgg aatttga (SEQ-ID No:155)	Forw: taaggatgacctacccatt cttga (SEQ-ID No:83)

(continued)

Promoter/NEENA cassette	Primer pair 1. PCR Promoter	Primer pair 1. PCR NEENA	Primer pair 2. PCR Promotor-NEENA
	Rev: tcaaattccaaatcgtgaa atgtttttaatcttgtttgtatt ga (SEQ_ID No:154)	Rev: tctacaacattaaaacga ccatta (SEQ_ID No:69)	Rev: tctacaacattaaaacga ccatta (SEQ_ID No:69)

[0145] Binary T-plasmids harboring functional expression modules for synthesis of docosahexaenoic acid (DHA) in rapeseed can be obtained in a similar manner. To this end, in addition to the functional modules (promotor-gene-terminator and/or promotor-NEENA-gene-terminator) described for synthesis ARA, constructs also contain functional modules required for the expression of the genes listed in table 4. Promotors used in those expression modules can be SEQ-ID No. 25, 26, 27, 28, 29 and/or 30, NEENAs can be any or none of SEQ-ID No. 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, and(or 24,, and terminators can be SEQ-ID No. 31, 32, 33, 34, 35, 36 and 37.

Example 5: Production of transgenic plants

a) Generation of transgenic rape seed plants (amended protocol according to Moloney et al. 1992, Plant Cell Reports, 8:238-242)

[0146] For the generation of transgenic rapeseed plants, the binary vectors described in example 3 were transformed into Agrobacterium tumefaciens C58C1:pGV2260 (Deblaere et al. 1984, Nucl. Acids. Res. 13: 4777-4788). For the transformation of rapeseed plants (cv. Kumily,) a 1:50 dilution of an overnight culture of positive transformed acrobacteria colonies grown in Murashige-Skoog Medium (Murashige and Skoog 1962 Physiol. Plant. 15, 473) supplemented by 3% saccharose (3MS-Medium) was used. Petiols or Hypocotyledones of sterial rapeseed plants were incubated in a petri dish with a 1:50 acrobacterial dilusion for 5-10 minutes. This was followed by a tree day co-incubation in darkness at 25°C on 3MS-Medium with 0.8% bacto-Agar. After three days the culture was put on to 16 hours light/8 hours darkness weekly on MS-medium containing 500mg/l Claforan (Cefotaxime-Natrium), 100 nM Imazetapyr, 20 mikroM Benzylaminopurin (BAP) and 1,6g/l Glucose. Growing sprouts were transferred to MS-Medium containing 2% saccharose, 250mg/l Claforan and 0.8%Bacto-Agar. Even after three weeks no root formation was observed, a growth hormone 2-Indolbutyl acid was added to the medium for enhancing root formation.

[0147] Regenerated sprouts have been obtained on 2MS-Medium with Imazetapyr and Claforan and were transferred to the green house for sprouting. After flowering, the mature seeds were harvested and analysed for expression of the Desaturase gene via lipid analysis as described in Qui et al. 2001, J. Biol. Chem. 276, 31561-31566.

b) Production of transgenic flax plants

[0148] The production of transgenic flax plants can be carried out according to the method of Bell et al., 1999, In Vitro Cell. Dev. Biol. Plant 35(6):456-465 using particle bombardment. Acrobacterial transformation could be carried out according to Mlynarova et al. (1994), Plant Cell Report 13: 282-285.

Example 6: Lipid extraction and lipid analysis of plant oils

[0149] The results of genetic modifications in plants or on the production of a desired molecule, e.g. a certain fatty acid, can be determined by growing the plant under suitable conditions, e.g. as described below, and analysing the growth media and/or the cellular components for enhanced production of the desired molecule, e.g. lipids or a certain fatty acid. Lipids can be extracted as described in the standard literature including Ullman, Encyclopedia of Industrial Chemistry, Bd. A2, S. 89-90 und S. 443-613, VCH: Weinheim (1985); Fallon, A., et al., (1987)" Applications of HPLC in Biochemistry" in: Laboratory Techniques in Biochemistry and Molecular Biology, Bd. 17; Rehm et al. (1993) Biotechnology, Bd. 3, Kapitel III:" Product recovery and purification" , S. 469-714, VCH: Weinheim; Belter, P.A., et al. (1988) Bioseparations: downstream processing for Biotechnology, John Wiley and Sons; Kennedy, J.F., und Cabral, J.M.S. (1992) Recovery processes for biological Materials, John Wiley and Sons; Shaeiwitz, J.A., und Henry, J.D. (1988) Biochemical Separations, in: Ullmann' s Encyclopedia of Industrial Chemistry, Bd. B3; Kapitel 11, S. 1-27, VCH: Weinheim; und Dechow, F.J. (1989) Separation and purification techniques in biotechnology, Noyes Publications.

[0150] Alternatively, extraction will be carried out as described in Cahoon et al. (1999) Proc. Natl. Acad. Sci. USA 96 (22):12935-12940, und Browse et al. (1986) Analytic Biochemistry 152:141-145. Quantitative and qualitative analysis of lipids or fatty acids are described in Christie, William W., Advances in Lipid Methodology, Ayr/Scotland: Oily Press (Oily Press Lipid Library; 2); Christie, William W., Gas Chromatography and Lipids. A Practical Guide-Ayr, Scotland: Oily Press, 1989, Repr. 1992, IX, 307 S. (Oily Press Lipid Library; 1);" Progress in Lipid Research, Oxford: Pergamon Press, 1 (1952) - 16 (1977) u.d.T.: Progress in the Chemistry of Fats and Other Lipids CODEN.

[0151] The binary T-plasmids described in example 4 were transformed into rapeseed (Brassica napus) as described in example 5. After selection of transgenic plants using PCR, plats were grown until development of mature seeds (Day/night cycle: 16h at 200mE and 21°C, 8h at darkness and 19°C). Fatty acids from harvested seeds were extracted and analysed using gas chromatography. Based on the analysed lipids, the effect of the NEENAs on expression of desaturases and elongases can be determined since the lipid pattern of successfully transformed plant seeds will differ from the pattern of control plant seeds, e.g. of plants expressing a set of desaturases and elongases without the enhancing

effect of NEENAs.
Table 7 shows results of single seed measurements of the five best performing transgenic lines obtained for each binary T-plasmid. Table 8 shows the nomenclature for the fatty acids listed in the header of table 3.

[0152] Surprisingly, transgenic plants obtained from transformations with construct VC-VC-LJB1327-1qcz (SEQ-ID 39) VC-LJB2003-1qcz (SEQ-ID 40) and VC-LJB2197-1qcz (SEQ-ID 146) showed a much higher ARA to GLA ratio compared to plants transformed with VC-LJB913-1qcz (SEQ-ID 38) and was highest for plants transformed with VC-LJB2003-1qcz (ARA:GLA ratio of up to 53.3). Such a ratio is benefitial if GLA is not desired. Even more surprising was that plants of contructs VC-LJB2003-1qcz and VC-LJB2197-1qcz (incorporating NEENAs) reached higher ARA levels than VC-LJB913-1qcz and VC-LJB1327-1qcz (maximal for VC-LJB913-1qcz: 25.6 %; VC-LJB1327-1 qcz: 22 %, VC-LJB2003-1qcz: 28.7 % and for VC-LJBV2197-1qcz: 33.1 %), despite removal of the expression module expressing the enzyme d6Des(Pir_GAI) compared to VC-LJB913-1qcz transformed plants.

Table 7: Gaschromatographical anaylsis of the fatty acid composition of seedoil from transgenic rapeseed plants.

Sample name	16:0	16:1 n-7	16:3 n-3	18:0	18:1 n-9	18:2 n-9	18:2 n-6	18:3 n-6	18:3 n-3	18:4 n-3	20:0	20:1 n-9	20:2 n-6	20:3 n-6	20:3 n-3	20:4 n-6 (ARA)	20:4 n-3	20:5 n-3	22:0	Ratio ARA:GLA	Ratio ARA:DGLA	Ratio LA:ALA	Ratio ARA:EPA
LJB2197_169_37	2,9	0,0	0,0	2,0	17,9	0,9	25,1	1,2	3,8	0,0	0,5	0,7	2,5	3,0	0,0	33,1	0,5	5,9	0,0	27,0	11,2	6,7	5,6
LJB2197_169_5	3,2	0,0	0,0	2,0	16,3	1,2	25,8	2,1	4,5	0,2	0,6	0,6	1,5	2,8	0,0	32,1	0,5	6,7	0,0	15,2	11,5	5,8	4,8
LJB2197_169_11	3,0	0,0	0,0	2,1	17,5	0,9	27,6	1,6	4,1	0,0	0,6	0,6	1,5	3,3	0,0	31,2	0,5	5,5	0,0	19,9	9,4	6,7	5,7
LJB2197_169_51	3,1	0,0	0,0	2,2	17,5	0,9	27,6	1,6	4,1	0,0	0,6	0,6	1,5	3,3	0,0	31,1	0,5	5,5	0,0	19,8	9,3	6,7	5,7
LJB2197_169_9	3,4	0,0	0,0	2,2	18,3	1,9	25,9	3,1	4,0	0,2	0,6	0,6	1,1	2,0	0,0	30,2	0,4	5,7	0,3	9,9	14,9	6,5	5,3
LJB2197_169_22	3,2	0,0	0,0	2,4	17,7	0,7	28,5	1,7	3,6	0,2	0,7	0,8	0,8	3,8	0,0	29,8	0,6	5,3	0,4	18,0	7,9	8,0	5,7
LJB2197_169_36	3,5	0,0	0,0	2,3	17,1	0,6	29,5	1,5	3,8	0,2	0,7	0,8	1,0	3,2	0,0	29,5	0,5	5,5	0,4	19,8	9,3	7,8	5,4
LJB2197_169_40	3,4	0,0	0,0	2,4	18,2	1,2	28,6	2,8	3,4	0,2	0,7	0,7	0,8	2,6	0,0	29,2	0,4	5,0	0,3	10,2	11,4	8,4	5,8
LJB2197_169_42	3,5	0,0	0,0	2,1	18,4	0,7	27,2	1,5	4,3	0,2	0,6	0,8	1,0	3,3	0,0	29,1	0,6	6,6	0,3	19,1	8,9	6,4	4,4
LJB2197_169_26	3,7	0,0	0,0	2,3	19,3	1,3	27,4	2,7	4,0	0,3	0,7	0,7	0,6	2,1	0,0	29,0	0,4	5,5	0,0	10,6	13,5	6,9	5,3
LJB2197_169_61	3,7	0,0	0,0	2,7	20,1	1,1	28,5	2,2	3,2	0,2	0,8	0,9	1,1	3,0	0,0	27,4	0,4	4,6	0,3	12,5	9,3	9,0	6,0
LJB2197_169_14	3,3	0,0	0,0	1,7	18,0	0,7	30,9	1,5	4,9	0,2	0,6	0,7	1,1	3,1	0,0	26,8	0,6	5,7	0,4	18,4	8,7	6,4	4,7
LJB2197_169_16	3,3	0,0	0,0	2,2	20,3	0,7	28,3	1,2	4,5	0,1	0,7	0,8	0,8	3,0	0,0	26,6	0,6	6,3	0,4	21,5	8,8	6,2	4,2
LJB2197_169_65	3,7	0,1	0,0	2,7	20,1	1,2	29,1	2,3	3,8	0,2	0,7	0,7	0,8	1,8	0,0	26,6	0,3	5,5	0,3	11,5	14,4	7,7	4,8
LJB2197_169_7	3,1	0,0	0,0	2,3	18,6	0,5	30,1	1,1	4,1	0,1	0,7	0,9	1,8	4,1	0,0	26,5	0,7	5,1	0,4	24,6	6,5	7,4	5,2
LJB2197_169_34	3,3	0,0	0,0	2,5	20,9	0,8	28,8	1,3	4,2	0,2	0,8	0,8	0,8	2,9	0,0	26,5	0,5	5,4	0,4	19,8	9,2	6,9	4,9
LJB2197_169_47	3,2	0,0	0,0	2,1	18,0	0,9	33,4	1,7	3,9	0,1	0,7	0,7	0,7	2,7	0,0	26,3	0,4	4,6	0,4	15,2	9,8	8,7	5,7
LJB2197_169_24	3,2	0,0	0,0	2,2	18,6	0,5	30,0	1,2	4,4	0,1	0,7	0,8	1,5	3,9	0,0	26,2	0,7	5,6	0,3	22,7	6,8	6,7	4,7
LJB2197_169_31	3,2	0,0	0,0	1,8	19,4	0,6	31,1	1,4	4,2	0,1	0,6	0,8	1,3	3,5	0,0	26,0	0,6	5,0	0,4	18,6	7,5	7,4	5,2
LJB2197_169_73	3,7	0,0	0,0	2,9	18,7	0,8	31,2	1,7	4,5	0,0	0,8	0,7	0,7	2,4	0,0	26,0	0,4	5,4	0,0	15,1	10,8	6,9	4,8
LJB2197_169_21	3,3	0,0	0,0	2,4	19,5	0,7	30,5	1,3	4,2	0,1	0,7	0,8	0,9	3,6	0,0	25,9	0,6	5,0	0,4	19,3	7,2	7,2	5,2
LJB2197_169_29	3,2	0,0	0,0	2,2	19,6	0,6	29,7	1,3	4,0	0,1	0,7	0,9	1,5	4,0	0,0	25,8	0,7	5,1	0,4	19,4	6,5	7,4	5,0
LJB2003_110_11	3,0	0,0	0,0	2,6	15,7	0,2	32,1	0,6	2,8	0,0	0,7	1,0	4,8	3,0	0,3	28,7	0,3	3,7	0,3	48,9	9,7	11,4	7,8
LJB2003_110_17	3,3	0,0	0,0	2,7	16,5	0,1	31,4	0,5	2,7	0,0	0,7	1,1	5,6	2,5	0,4	28,1	0,3	3,6	0,3	53,3	11,2	11,5	7,7
LJB2003_110_16	3,3	0,1	0,0	3,2	17,4	0,2	32,6	0,5	2,6	0,0	0,8	1,1	5,1	2,7	0,4	26,1	0,3	3,2	0,3	50,1	9,6	12,6	8,1
LJB2003_8_54	3,5	0,1	0,0	2,5	19,4	0,8	36,2	2,3	3,3	0,2	0,8	0,7	0,4	2,0	0,0	24,2	0,2	3,0	0,4	10,5	12,2	11,0	8,1
LJB2003_8_7	3,3	0,1	0,0	2,8	19,4	0,8	35,1	2,3	3,7	0,2	0,8	0,8	0,5	1,8	0,0	24,0	0,3	3,7	0,4	10,2	13,6	9,5	6,5
LJB2003_53_11	2,7	0,0	0,0	2,1	14,0	0,3	38,0	0,7	5,3	0,0	0,7	0,7	1,6	4,3	0,0	23,9	0,7	4,7	0,4	33,1	5,6	7,2	5,1

Sample name	16:0	16:1n-7	16:3 n-3	18:0	18:1 n-9	18:2n-9	18:2 n-6	18:3 n-6	18:3 n-3	18:4 n-3	20:0	20:1n-9	20:2 n-6	20:3 n-6	20:3 n-3	20:4n-6 (ARA)	20:4 n-3	20:5 n-3	22:0	Ratio ARA:GLA	Ratio ARA:DGLA	Ratio LA:ALA	Ratio ARA:EPA
LJB2003_110_49	3,9	0,0	0,0	3,4	18,6	0,3	34,9	0,5	2,5	0,0	0,8	1,1	4,4	2,4	0,5	23,6	0,2	2,7	0,3	45,1	9,9	13,9	8,7
LJB2003_53_37	3,2	0,0	0,0	3,4	16,0	0,4	36,4	1,0	3,5	0,0	0,8	0,7	1,3	5,2	0,0	23,5	0,7	3,4	0,4	23,6	4,5	10,3	6,8
LJB2003_8_49	3,4	0,1	0,0	2,7	20,0	0,9	37,1	2,1	3,4	0,1	0,8	0,7	0,5	1,7	0,0	22,8	0,2	2,9	0,4	11,1	13,1	11,0	7,9
LJB2003_8_23	3,6	0,1	0,0	3,0	20,7	1,0	33,6	2,9	4,0	0,3	0,8	0,8	0,5	1,4	0,0	22,8	0,2	3,8	0,4	7,8	16,5	8,4	6,1
LJB2003_8_42	3,6	0,1	0,0	2,6	20,7	0,8	35,3	2,4	3,8	0,2	0,7	0,7	0,5	1,6	0,0	22,6	0,2	3,7	0,4	9,6	14,1	9,3	6,0
LJB2003_8_57	3,7	0,1	0,0	3,0	20,8	1,0	36,0	2,3	3,1	0,2	0,9	0,7	0,4	1,8	0,0	22,6	0,2	2,8	0,5	9,8	12,6	11,8	8,0
LJB2003_53_34	2,8	0,0	0,0	2,6	16,4	0,3	39,3	0,8	4,2	0,0	0,7	0,7	1,7	4,1	0,0	22,5	0,5	3,1	0,4	28,5	5,5	9,4	7,2
LJB2003_54_13	3,7	0,1	0,0	2,3	17,9	0,5	39,5	1,3	4,0	0,1	0,8	0,7	0,8	1,9	0,0	22,4	0,2	3,2	0,5	17,4	11,9	9,8	6,9
LJB2003_8_58	3,7	0,1	0,0	2,5	23,6	0,9	34,1	2,1	3,5	0,2	0,7	0,8	0,3	1,4	0,0	22,3	0,2	3,4	0,3	10,7	16,3	9,9	6,5
LJB2003_8_62	3,7	0,1	0,0	2,5	21,3	0,8	35,6	2,2	3,9	0,2	0,7	0,7	0,4	1,4	0,0	22,2	0,2	3,6	0,4	10,2	15,4	9,1	6,3
LJB2003_110_25	3,2	0,0	0,0	3,2	20,1	0,2	34,7	0,4	2,9	0,0	0,9	1,1	3,9	3,2	0,4	22,2	0,4	3,0	0,3	49,8	7,0	12,1	7,5
LJB2003_54_17	3,4	0,2	0,0	2,4	18,2	0,4	39,5	1,1	4,2	0,1	0,8	0,7	1,0	2,1	0,0	21,9	0,3	3,4	0,4	20,5	10,7	9,5	6,5
LJB2003_8_19	3,6	0,1	0,0	3,1	20,6	0,9	36,9	2,5	3,1	0,2	0,8	0,8	0,4	1,5	0,0	21,9	0,2	2,9	0,4	8,7	14,6	11,7	7,6
LJB2003_53_23	3,4	0,2	0,0	2,3	18,0	0,2	37,0	0,7	4,3	0,1	0,6	0,8	2,0	3,6	0,2	21,9	0,6	3,8	0,4	31,0	6,1	8,5	5,7
LJB2003_8_68	3,5	0,1	0,0	2,8	20,8	0,8	36,4	2,2	3,7	0,2	0,8	0,7	0,4	1,7	0,0	21,8	0,2	3,4	0,4	9,9	13,1	9,9	6,4
LJB1327_305_31	3,7	0,1	0,0	2,8	21,0	1,3	35,3	3,4	3,1	0,2	0,9	0,7	0,2	1,5	0,9	22,0	0,1	2,2	0,5	6,4	15,1	11,4	9,8
LJB1327_305_48	4,3	0,1	0,0	2,2	19,5	0,9	37,5	1,9	4,2	0,1	0,7	0,6	0,2	2,1	0,7	21,6	0,2	2,8	0,5	11,5	10,4	8,9	7,8
LJB1327_305_32	4,0	0,0	0,0	2,1	18,8	0,7	39,2	1,8	4,2	0,1	0,8	0,6	0,2	1,7	1,2	21,4	0,2	2,5	0,6	11,7	12,9	9,3	8,7
LJB1327_458_92	3,3	0,0	0,0	2,0	17,8	0,9	39,1	2,1	4,6	0,2	0,8	0,7	0,2	2,0	1,4	21,2	0,2	3,1	0,6	10,2	10,4	8,6	6,9
LJB1327_305_38	4,0	0,1	0,0	2,7	19,7	1,0	36,9	2,9	4,1	0,3	0,9	0,6	0,2	1,7	0,6	20,9	0,2	2,8	0,6	7,2	12,6	9,0	7,5
LJB1327_305_43	4,0	0,1	0,0	2,6	19,2	1,0	37,2	2,2	4,0	0,1	0,9	0,6	0,2	3,1	0,8	20,8	0,3	2,4	0,6	9,5	6,8	9,3	8,7
LJB1327_305_45	3,9	0,1	0,0	2,7	19,9	0,9	37,3	2,4	4,3	0,2	0,9	0,6	0,2	1,7	0,9	20,7	0,2	2,7	0,6	8,6	12,0	8,7	7,7
LJB1327_305_30	3,9	0,1	0,0	2,7	22,0	1,0	36,4	2,5	3,5	0,2	0,9	0,7	0,2	1,6	0,6	20,6	0,2	2,5	0,5	8,3	13,1	10,3	8,3
LJB1327_305_35	4,2	0,1	0,0	2,7	20,3	1,0	38,0	2,2	3,7	0,2	0,9	0,6	0,2	1,5	0,8	20,6	0,2	2,3	0,5	9,3	14,1	10,4	9,0
LJB1327_305_37	4,3	0,0	0,0	3,0	19,7	1,1	38,8	2,6	3,2	0,2	1,1	0,6	0,2	1,4	0,7	20,5	0,1	1,9	0,6	7,9	14,9	12,2	10,9
LJB1327_305_47	4,1	0,1	0,0	2,4	20,4	1,1	38,3	2,4	3,8	0,2	0,8	0,6	0,2	1,4	0,7	20,4	0,1	2,2	0,5	8,5	14,4	10,0	9,3
LJB1327_305_34	3,9	0,0	0,0	2,8	18,9	1,0	39,0	2,6	3,6	0,2	1,1	0,6	0,1	1,7	1,2	20,4	0,2	2,1	0,7	8,0	11,7	10,7	9,9
LJB1327_305_44	4,1	0,1	0,0	2,9	20,3	0,9	38,0	2,3	4,3	0,2	0,9	0,6	0,2	1,4	0,7	19,9	0,1	2,5	0,6	8,5	14,2	8,9	8,0
LJB1327_458_94	4,0	0,0	0,0	2,1	18,8	0,8	37,1	2,2	5,9	0,3	0,8	0,6	0,2	2,2	1,5	19,3	0,3	3,5	0,5	8,7	8,9	6,3	5,5
LJB1327_305_50	4,0	0,0	0,0	2,4	19,6	0,8	40,3	2,2	4,2	0,2	0,9	0,6	0,2	1,5	0,7	19,2	0,2	2,4	0,6	8,8	12,6	9,7	8,0
LJB1327_305_42	3,7	0,1	0,0	2,5	23,6	1,1	37,0	2,4	3,8	0,2	0,8	0,7	0,2	1,1	0,7	19,2	0,2	2,4	0,5	8,1	16,8	9,7	8,0

Sample name	16:0	16:1n-7	16:3 n-3	18:0	18:1 n-9	18:2n-9	18:2 n-6	18:3 n-6	18:3 n-3	18:4 n-3	20:0	20:1n-9	20:2 n-6	20:3 n-6	20:3 n-3	20:4n-6 (ARA)	20:4 n-3	20:5 n-3	22:0	Ratio ARA:GLA	Ratio ARA:DGLA	Ratio LA:ALA	Ratio ARA:EPA
LJB1327_305_54	4,4	0,1	0,0	3,4	21,5	1,4	37,4	2,8	2,7	0,1	1,3	0,8	0,6	1,5	0,7	19,1	0,0	1,6	0,6	6,8	12,9	13,9	11,8
LJB1327_305_41	4,2	0,1	0,0	2,5	22,4	1,0	38,6	2,0	3,6	0,1	0,8	0,6	0,2	1,3	0,7	19,1	0,2	2,3	0,5	9,6	14,6	10,7	8,3
LJB1327_305_40	3,9	0,0	0,0	2,5	21,1	0,9	39,4	2,0	4,3	0,2	0,8	0,6	0,2	1,3	0,7	18,8	0,2	2,6	0,5	9,2	14,5	9,1	7,1
LJB1327_305_55	4,5	0,1	0,0	3,3	21,9	1,3	37,7	2,0	3,3	0,2	1,2	0,7	0,7	1,4	0,9	18,6	0,0	1,7	0,5	9,3	13,7	11,3	11,1
LJB1327_305_33	4,2	0,1	0,0	2,7	23,8	1,1	37,0	2,1	3,7	0,2	0,9	0,7	0,2	1,3	0,8	18,6	0,1	2,1	0,6	8,9	14,6	10,1	8,8
LJB913_64-13a	4,4	0,0	0,0	3,9	11,3	0,0	21,7	11,7	3,7	0,7	1,1	0,9	3,7	6,7	0,0	25,6	0,7	3,8	0,0	2,2	3,8	5,9	6,7
LJB913_64_9	3,8	0,0	0,2	2,7	9,8	0,0	21,8	12,7	4,3	0,8	0,9	1,0	4,5	8,7	0,6	23,6	1,0	3,8	0,0	1,8	2,7	5,1	6,1
LJB913_64_3	4,2	0,1	0,2	3,6	12,0	0,0	22,4	11,7	3,5	0,7	1,0	1,2	5,7	6,5	0,7	22,0	0,7	3,5	0,5	1,9	3,4	6,5	6,4
LJB913_64_20	3,5	0,2	0,1	3,3	14,1	0,1	25,9	8,7	3,0	0,5	0,9	1,2	5,0	7,4	0,5	21,2	0,8	3,2	0,4	2,4	2,9	8,5	6,6
LJB913_64_8	3,7	0,1	0,2	3,0	13,9	0,2	24,1	16,4	3,7	1,1	0,9	0,8	2,0	5,8	0,0	20,4	0,7	3,1	0,0	1,2	3,5	6,6	6,6
LJB913_91_5	3,5	0,1	0,1	2,8	15,7	0,1	27,1	9,0	4,9	0,5	0,8	0,9	3,1	6,0	0,4	20,3	0,7	3,5	0,4	2,2	3,4	5,5	5,8
LJB913_64_22	4,8	0,2	0,1	4,0	13,4	0,0	25,9	9,3	3,9	0,7	1,2	1,0	4,3	6,0	0,6	19,8	0,8	3,3	0,7	2,1	3,3	6,6	6,0
LJB913_64_23	4,5	0,1	0,1	3,9	13,4	0,0	25,0	9,9	3,9	0,7	1,1	1,1	5,2	6,1	0,7	19,5	0,8	3,4	0,5	2,0	3,2	6,4	5,8
LJB913_64-07a	4,2	0,0	0,0	4,5	13,7	0,0	25,9	7,3	4,4	0,0	1,3	1,4	7,6	6,2	1,0	19,4	0,0	3,1	0,0	2,7	3,1	5,9	6,3
LJB913_91_4	4,1	0,2	0,2	3,7	16,2	0,2	32,4	5,2	6,1	0,4	1,0	0,7	1,7	4,7	0,0	19,4	0,6	3,4	0,0	3,7	4,1	5,3	5,7
LJB913_64-05a	4,2	0,0	0,0	4,8	14,0	0,0	25,3	8,0	4,8	0,5	1,3	1,3	5,8	7,0	0,0	19,1	0,8	3,2	0,0	2,4	2,7	5,2	6,0
LJB913_64_10	3,9	0,0	0,1	4,6	15,0	0,0	27,3	6,0	4,5	0,3	1,2	1,3	6,2	6,4	0,7	18,9	0,6	2,5	0,5	3,2	3,0	6,0	7,6
LJB913_64_13	3,9	0,1	0,1	3,5	15,0	0,1	25,1	9,4	4,5	0,5	0,9	1,1	4,5	7,8	0,6	18,7	1,0	3,1	0,0	2,0	2,4	5,6	6,0
LJB913_91_14	3,6	0,0	0,2	3,5	17,0	0,1	26,6	9,3	5,1	0,5	0,9	0,9	2,8	6,5	0,4	18,7	0,7	3,1	0,0	2,0	2,9	5,2	6,0
LJB913_64-12a	4,8	0,0	0,0	4,8	13,9	0,0	24,1	7,1	5,0	0,0	1,4	1,3	7,7	6,5	1,2	18,5	0,0	3,5	0,0	2,6	2,8	4,8	5,2
LJB913_91_28	4,2	0,0	0,2	4,0	17,1	0,0	27,4	7,5	5,9	0,4	1,1	0,9	2,9	6,5	0,0	18,4	0,7	2,9	0,0	2,4	2,8	4,7	6,3
LJB913_91_20	3,2	0,1	0,1	3,0	18,7	0,1	28,9	7,2	4,7	0,3	0,7	0,9	2,5	7,1	0,3	18,3	0,8	2,9	0,0	2,5	2,6	6,1	6,3
LJB913_64_17	4,7	0,1	0,1	4,3	14,3	0,0	27,0	9,6	3,8	0,5	1,1	1,0	4,0	6,5	0,5	18,2	0,7	2,9	0,6	1,9	2,8	7,1	6,2
LJB913_91_18	3,6	0,0	0,1	4,0	17,8	0,1	31,0	6,1	4,6	0,3	1,0	0,9	2,5	5,6	0,3	18,2	0,6	2,8	0,5	3,0	3,2	6,8	6,6
LJB913_64_14	4,0	0,0	0,3	4,2	14,9	0,0	26,2	8,9	5,5	0,7	1,1	1,0	3,9	6,5	0,6	17,8	0,9	3,5	0,0	2,0	2,7	4,7	5,1
LJB913_91_3	3,8	0,1	0,2	3,1	18,1	0,0	29,7	6,5	6,8	0,5	0,9	0,8	1,9	5,3	0,0	17,7	0,8	3,7	0,0	2,7	3,3	4,4	4,8

Table 8: Used Nomenclature

Fatty acid	Nomenclature	
Oleic acid	18:1Δ9	18:1n-9
Linoleic acid	18:2Δ6,12	18:2n-6
α-Linolenic acid	18:3Δ9,12,15	α18:3n-3
γ-Linolenic acid	18:3Δ6,9,12	γ18:3n-6
Stearidonic acid	18:4Δ6,9,12,15	18:4n-3
Dihomo-γ-linolenic acid	20:3Δ8,11,14	20:3n-6
Eicosatrienoic acid	20:3Δ11,14,17	20:3n-3
iso-Arachidonic acid	20:4Δ8,11,14,17	20:4n-3
Arachidonic acid	20:4Δ5,8,11,14	20:4n-6
Eicosapentaenoic acid	20:5Δ5,8,11,14,17	20:5n-3

SEQUENCE LISTING

<110> BASF Plant Science GmbH

<120> Regulatory nucleic acid molecules for enhancing seed-specific and/or seed-preferential gene expression in plants promoting enhanced polyunsaturated fatty acid synthesis

<130> PF 62524

<160> 155

<170> PatentIn version 3.4

<210> 1
<211> 2646
<212> DNA
<213> Vicia faba; Arabidopsis

<400> 1
tcgacggccc ggactgtatc caacttctga tctttgaatc tctctgttcc aacatgttct 60

gaaggagttc taagactttt cagaaagctt gtaacatgct ttgtagactt tctttgaatt 120

actcttgcaa actctgattg aacctacgtg aaaactgctc cagaagttct aaccaaattc 180

cgtcttggga aggcccaaaa tttattgagt acttcagttt catggacgtg tcttcaaaga 240

tttataactt gaaatcccat catttttaag agaagttctg ttccgcaatg tcttagatct 300

cattgaaatc tacaactctt gtgtcagaag ttcttccaga atcaacttgc atcatggtga 360

aaatctggcc agaagttctg aacttgtcat atttcttaac agttagaaaa atttctaagt 420

gtttagaatt ttgacttttc caaagcaaac ttgacttttg actttcttaa taaaacaaac 480

ttcatattct aacatgtctt gatgaaatgt gattcttgaa atttgatgtt gatgcaaaag 540

tcaaagtttg acttttcagt gtgcaattga ccattttgct cttgtgccaa ttccaaacct 600

aaattgatgt atcagtgctg caaacttgat gtcatggaag atcttatgag aaaattcttg 660

aagactgaga ggaaaaattt tgtagtacaa cacaaagaat cctgtttttc atagtcggac 720

tagacacatt aacataaaac accacttcat tcgaagagtg attgaagaag gaaatgtgca 780

gttacctttc tgcagttcat aagagcaact tacagacact tttactaaaa tactacaaag 840

aggaagattt taacaactta gagaagtaat gggagttaaa gagcaacaca ttaaggggga 900

gtgttaaaat taatgtgttg taaccaccac tacctttagt aagtattata agaaaattgt 960

aatcatcaca ttataattat tgtccttatt taaaattatg ataaagttgt atcattaaga 1020

ttgagaaaac caaatagtcc tcgtcttgat ttttgaatta ttgttttcta tgttactttt 1080

cttcaagcct atataaaaac tttgtaatgc taaattgtat gctggaaaaa aatgtgtaat 1140

gaattgaata gaaattatgg tatttcaaag tccaaaatcc atcaatagaa atttagtaca 1200

aaacgtaact caaaaatatt ctcttatttt aaattttaca acaatataaa aatattctct 1260

tattttaaat tttacaataa tataatttat cacctgtcac ctttagaata ccaccaacaa 1320

```
tattaatact tagatatttt attcttaata attttgagat ctctcaatat atctgatatt   1380
tattttatat ttgtgtcata ttttcttatg ttttagagtt aacccttata tcttggtcaa   1440
actagtaatt caatatatga gtttgtgaag gacacattga catcttgaaa cattggtttt   1500
aaccttgttg gaatgttaaa ggtaataaaa cattcagaat tatgaccatc tattaatata   1560
cttcctttgt cttttaaaaa agtgtgcatg aaaatgctct atggtaagct agagtgtctt   1620
gctggcctgt gtatatcaat tccatttcca gatggtagaa actgccacta cgaataatta   1680
gtcataagac acgtatgtta acacacgtcc ccttgcatgt tttttgccat atattccgtc   1740
tctttctttt tcttcacgta taaaacaatg aactaattaa tagagcgatc aagctgaact   1800
ggtgcttaaa cactctggtg agttctagta cttctgctat gatcgatctc attaccattt   1860
cttaaatttc tctccctaaa tattccgagt tcttgatttt tgataacttc aggttttctc   1920
tttttgataa atctggtctt tccatttttt tttttttgtg gttaatttag tttcctatgt   1980
tcttcgattg tattatgcat gatctgtgtt tggattctgt tagattatgt attggtgaat   2040
atgtatgtgt ttttgcatgt ctggttttgg tcttaaaaat gttcaaatct gatgatttga   2100
ttgaagcttt tttagtgttg gtttgattct tctcaaaact actgttaatt tactatcatg   2160
ttttccaact ttgattcatg atgacacttt tgttctgctt tgttataaaa ttttggttgg   2220
tttgattttg taattatagt gtaattttgt taggaatgaa catgttttaa tactctgttt   2280
tcgatttgtc acacattcga attattaatc gataatttaa ctgaaaattc atggttctag   2340
atcttgttgt catcagatta tttgtttcga taattcatca aatatgtagt ccttttgctg   2400
atttgcgact gtttcatttt ttctcaaaat tgttttttgt taagtttatc taacagttat   2460
cgttgtcaaa agtctctttc attttgcaaa atcttctttt tttttttgtt tgtaactttg   2520
tttttaagc tacacattta gtctgtaaaa tagcatcgag gaacagttgt cttagtagac   2580
ttgcatgttc ttgtaacttc tatttgtttc agtttgttga tgactgcttt gattttgtag   2640
gtcaaa                                                              2646
```

<210> 2
<211> 1119
<212> DNA
<213> Brassica napus; Arabidopsis

<400> 2

```
taaggatgac ctacccattc ttgagacaaa tgttacattt tagtatcaga gtaaaatgtg     60
tacctataac tcaaattcga ttgacatgta tccattcaac ataaaattaa accagcctgc    120
acctgcatcc acatttcaag tattttcaaa ccgttcggct cctatccacc gggtgtaaca    180
agacggattc cgaatttgga agattttgac tcaaattccc aatttatatt gaccgtgact    240
aaatcaactt taacttctat aattctgatt aagctcccaa tttatattcc caacggcact    300
```

acctccaaaa tttatagact ctcatcccct tttaaaccaa cttagtaaac gttttttttt 360

taattttatg aagttaagtt tttaccttgt ttttaaaaag aatcgttcat aagatgccat 420

gccagaacat tagctacacg ttacacatag catgcagccg cggagaattg tttttcttcg 480

ccacttgtca ctcccttcaa acacctaaga gcttctctct cacagcacac acatacaatc 540

acatgcgtgc atgcattatt acacgtgatc gccatgcaaa tctcctttat agcctataaa 600

ttaactcatc ggcttcactc tttactcaaa ccaaaactca tcaatacaaa caagattaaa 660

aacaagttct ttgctttcga agttgccgca acctaaacag gtttttcctt cttctttctt 720

cttattaact acgaccttgt cctttgccta tgtaaaatta ctaggttttc atcagttaca 780

ctgattaagt tcgttatagt ggaagataaa atgccctcaa agcattttgc aggatatctt 840

tgatttttca aagatatgga actgtagagt ttgatagtgt tcttgaatgt ggttgcatga 900

agttttttttg gtctgcatgt tattttttcc tcgaaatatg ttttgagtcc aacaagtgat 960

tcacttggga ttcagaaagt tgttttctca atatgtaaca gttttttttct atggagaaaa 1020

atcataggga ccgttggttt tggcttcttt aattttgagc tcagattaaa cccattttac 1080

ccggtgttct tggcagaatt gaaaacagta cgtagtacc 1119

<210> 3
<211> 1441
<212> DNA
<213> Linum usitatissimum; Arabidopsis

<400> 3
ttagcagata tttggtgtct aaatgtttat tttgtgatat gttcatgttt gaaatggtgg 60

tttcgaaacc agggacaacg ttgggatctg atagggtgtc aaagagtatt atggattggg 120

acaatttcgg tcatgagttg caaattcaag tatatcgttc gattatgaaa attttcgaag 180

aatatcccat ttgagagagt ctttacctca ttaatgtttt tagattatga aattttatca 240

tagttcatcg tagtcttttt ggtgtaaagg ctgtaaaaag aaattgttca cttttgtttt 300

cgtttatgtg aaggctgtaa aagattgtaa aagactattt tggtgttttg gataaaatga 360

tagtttttat agattctttt gcttttagaa gaaatacatt tgaaattttt tccatgttga 420

gtataaaata ccgaaatcga ttgaagatca tagaaatatt ttaactgaaa acaaatttat 480

aactgattca attctctcca tttttatacc tatttaaccg taatcgattc taatagatga 540

tcgatttttt atataatcct aattaaccaa cggcatgtat tggataatta accgatcaac 600

tctcacccct aatagaatca gtattttcct tcgacgttaa ttgatcctac actatgtagg 660

tcatatccat cgttttaatt tttggccacc attcaattct gtcttgcctt tagggatgtg 720

aatatgaacg gccaaggtaa gagaataaaa ataatccaaa ttaaagcaag agaggccaag 780

taagataatc caaatgtaca cttgtcattg ccaaaattag taaaatactc ggcatattgt 840 attcccacac attattaaaa taccgtatat gtattggctg catttgcatg aataatacta 900

cgtgtaagcc caaaagaacc cacgtgtagc ccatgcaaag ttaacactca cgaccccatt 960

cctcagtctc cactatataa acccaccatc cccaatctca ccaaacccac cacacaactc 1020

acaactcact ctcacacctt aaagaaccaa tcaccaccaa aaaatttcac gatttggaat 1080

ttgattcctg cgatcacagg tatgacaggt tagattttgt tttgtatagt tgtatacata 1140

cttctttgtg atgttttgtt tacttaatcg aatttttgga gtgttttaag gtctctcgtt 1200

tagaaatcgt ggaaaatatc actgtgtgtg tgttcttatg attcacagtg tttatgggtt 1260

tcatgttctt tgttttatca ttgaatggga agaaatttcg ttgggataca aatttctcat 1320

gttcttactg atcgttatta ggagtttggg gaaaaaggaa gagttttttt ggttggttcg 1380

agtgattatg aggttatttc tgtatttgat ttatgagtta atggtcgttt taatgttgta 1440

g 1441

<210> 4
<211> 2485
<212> DNA
<213> Linum usitatissimum; Arabidopsis

<400> 4
cacgggcagg acatagggac tactacaagc atagtatgct tcagacaaag agctaggaaa 60

gaactcttga tggaggttaa gagaaaaaag tgctagaggg gcatagtaat caaacttgtc 120

aaaaccgtca tcatgatgag ggatgacata atataaaaag ttgactaagg tcttggtagt 180

actctttgat tagtattata tattggtgag aacatgagtc aagaggagac aagaaaccga 240

ggaaccatag tttagcaaca agatggaagt tgcaaagttg agctagccgc tcgattagtt 300

acatctccta agcagtacta caaggaatgg tctctatact ttcatgttta gcacatggta 360

gtgcggattg acaagttaga aacagtgctt aggagacaaa gagtcagtaa aggtattgaa 420

agagtgaagt tgatgctcga caggtcagga gaagtccctc cgccagatgg tgactaccaa 480

ggggttggta tcagctgaga cccaaataag attcttcggt tgaaccagtg gttcgaccga 540

gactcttagg gtgggatttc actgtaagat ttgtgcattt tgttgaatat aaattgacaa 600

tttttttat ttaattatag attatttaga atgaattaca tatttagttt ctaacaagga 660

tagcaatgga tgggtatggg tacaggttaa acatatctat tacccaccca tctagtcgtc 720

gggttttaca cgtacccacc cgtttacata aaccagaccg gaattttaaa ccgtacccgt 780

ccgttagcgg gtttcagatt tacccgttta atcgggtaaa acctgattac taaatatata 840

ttttttattt gataaacaaa acaaaaatgt taatattttc atattggatg caattttaag 900

aaacacatat tcataaattt ccatatttgt aggaaaataa aaagaaaaat atattcaaga 960

acacaaattt caccgacatg acttttatta cagagttgga attagatcta acaattgaaa 1020 aattaaaatt aagatagaat atgttgagga acatgacata gtataatgct gggttacccg 1080

tcgggtaggt atcgaggcgg atactactaa atccatccca ctcgctatcc gataatcact 1140

ggtttcgggt atacccattc ccgtcaacag gcctttttaa ccggataatt tcaacttata 1200

gtgaatgaat tttgaataaa tagttagaat accaaaatcc tggattgcat ttgcaatcaa 1260

attttgtgaa ccgttaaatt ttgcatgtac ttgggataga tataatagaa ccgaattttc 1320

attagtttaa tttataactt actttgttca aagaaaaaaa atatctatcc aatttactta 1380

taataaaaaa taatctatcc aagttactta ttataatcaa cttgtaaaaa ggtaagaata 1440

caaatgtggt agcgtacgtg tgattatatg tgacgaaatg ttatatctaa caaaagtcca 1500

aattcccatg gtaaaaaaaa tcaaaatgca tggcaggctg tttgtaacct tggaataaga 1560

tgttggccaa ttctggagcc gccacgtacg caagactcag ggccacgttc tcttcatgca 1620

aggatagtag aacaccactc cacccacctc ctatattaga cctttgccca accctcccca 1680

actttcccat cccatccaca aagaaaccga catttttatc ataaatcagg gtttcgtttt 1740

tgtttcatcg ataaactcaa aggtgatgat tttagggtct tgtgagtgtg ctttttttgtt 1800

tgattctact gtagggttta tgttctttag ctcataggtt ttgtgtattt cttagaaatg 1860

tggcttcttt aatctctggg tttgtgactt tttgtgtggt ttctgtgttt ttcatatcaa 1920

aaacctattt tttccgagtt tttttttaca aattcttact ctcaagcttg aatacttcac 1980

atgcagtgtt cttttgtaga ttttagagtt aatgtgttaa aaagtttgga tttttcttgc 2040

ttatagagct tcttcacttt gattttgtgg gtttttttgt tttaaaggtg agatttttga 2100

tgaggttttt gcttcaaaga tgtcaccttt ctgggtttgt cttttgaata aagctatgaa 2160

ctgtcacatg gctgacgcaa ttttgttact atgtcatgaa agctgacgtt tttccgtgtt 2220

atacatgttt gcttacactt gcatgcgtca aaaaaattgg ggctttttag ttttagtcaa 2280

agattttact tctcttttgg gatttatgaa ggaaagttgc aaactttctc aaattttacc 2340

atttttgctt tgatgtttgt ttagattgcg acagaacaaa ctcatatatg ttgaaatttt 2400

tgcttggttt tgtataggat tgtgtctttt gcttataaat gttgaaatct gaactttttt 2460

tttgtttggt ttctttgagc aggag 2485

<210> 5
<211> 936
<212> DNA
<213> Vicia faba; Arabidopsis

<400> 5
ctgcagcaaa tttacacatt gccactaaac gtctaaaccc ttgtaatttg tttttgtttt 60

actatgtgtg ttatgtattt gatttgcgat aaatttttat atttggtact aaatttataa 120

caccttttat gctaacgttt gccaacactt agcaatttgc aagttgatta attgattcta 180 aattattttt gtcttctaaa tacatatact aatcaactgg aaatgtaaat atttgctaat 240

atttctacta taggagaatt aaagtgagtg aatatggtac cacaaggttt ggagatttaa 300

ttgttgcaat gctgcatgga tggcatatac accaaacatt caataattct tgaggataat 360

aatggtacca cacaagattt gaggtgcatg aacgtcacgt ggacaaaagg tttagtaatt 420

tttcaagaca acaatgttac cacacacaag ttttgaggtg catgcatgga tgccctgtgg 480

aaagtttaaa aatattttgg aaatgatttg catggaagcc atgtgtaaaa ccatgacatc 540

cacttggagg atgcaataat gaagaaaact acaaatttac atgcaactag ttatgcatgt 600

agtctatata atgaggattt tgcaatactt tcattcatac acactcacta agttttacac 660

gattataatt tcttcatagc cagtactgtt taagcttcac tgtctctgaa tcggcaaagg 720

taaacgtatc aattattcta caaacccttt tatttttctt ttgaattacc gtcttcattg 780

gttatatgat aacttgataa gtaaagcttc aataattgaa tttgatctgt gtttttttgg 840

ccttaatact aaatccttac ataagctttg ttgcttctcc tcttgtgagt tgagtgttaa 900

gttgtaataa tggttcactt tcagctttag aagaaa 936

<210> 6
<211> 847
<212> DNA
<213> Arabidopsis

<400> 6
tggtgcttaa acactctggt gagttctagt acttctgcta tgatcgatct cattaccatt 60

tcttaaattt ctctccctaa atattccgag ttcttgattt ttgataactt caggttttct 120

ctttttgata aatctggtct ttccattttt tttttttgt ggttaattta gtttcctatg 180

ttcttcgatt gtattatgca tgatctgtgt ttggattctg ttagattatg tattggtgaa 240

tatgtatgtg tttttgcatg tctggttttg gtcttaaaaa tgttcaaatc tgatgatttg 300

attgaagctt ttttagtgtt ggtttgattc ttctcaaaac tactgttaat ttactatcat 360

gttttccaac tttgattcat gatgacactt ttgttctgct ttgttataaa attttggttg 420

gtttgatttt gtaattatag tgtaattttg ttaggaatga acatgtttta atactctgtt 480

ttcgatttgt cacacattcg aattattaat cgataattta actgaaaatt catggttcta 540

gatcttgttg tcatcagatt atttgtttcg ataattcatc aaatatgtag tccttttgct 600

gatttgcgac tgtttcattt tttctcaaaa ttgtttttg ttaagtttat ctaacagtta 660

tcgttgtcaa aagtctcttt catttgcaa aatcttcttt tttttttgt ttgtaacttt 720

gtttttaag ctacacattt agtctgtaaa atagcatcga ggaacagttg tcttagtaga 780

cttgcatgtt cttgtaactt ctatttgttt cagtttgttg atgactgctt tgattttgta 840

ggtcaaa 847

<210> 7
<211> 455
<212> DNA
<213> Arabidopsis

<400> 7
agttctttgc tttcgaagtt gccgcaacct aaacaggttt ttccttcttc tttcttctta 60

ttaactacga ccttgtcctt tgcctatgta aaattactag gttttcatca gttacactga 120

ttaagttcgt tatagtggaa gataaaatgc cctcaaagca ttttgcagga tatctttgat 180

ttttcaaaga tatggaactg tagagtttga tagtgttctt gaatgtggtt gcatgaagtt 240

tttttggtct gcatgttatt ttttcctcga aatatgtttt gagtccaaca agtgattcac 300

ttgggattca gaaagttgtt ttctcaatat gtaacagttt ttttctatgg agaaaaatca 360

tagggaccgt tggttttggc ttctttaatt ttgagctcag attaaaccca ttttacccgg 420

tgttcttggc agaattgaaa acagtacgta gtacc 455

<210> 8
<211> 377
<212> DNA
<213> Arabidopsis

<400> 8
tttcacgatt tggaatttga ttcctgcgat cacaggtatg acaggttaga ttttgttttg 60

tatagttgta tacatacttc tttgtgatgt tttgtttact taatcgaatt tttggagtgt 120

tttaaggtct ctcgtttaga aatcgtggaa aatatcactg tgtgtgtgtt cttatgattc 180

acagtgttta tgggtttcat gttctttgtt ttatcattga atgggaagaa atttcgttgg 240

gatacaaatt tctcatgttc ttactgatcg ttattaggag tttggggaaa aaggaagagt 300

ttttttggtt ggttcgagtg attatgaggt tatttctgta tttgatttat gagttaatgg 360

tcgttttaat gttgtag 377

<210> 9
<211> 758
<212> DNA
<213> Arabidopsis

<400> 9
agggtttcgt ttttgtttca tcgataaact caaaggtgat gattttaggg tcttgtgagt 60

gtgctttttt gtttgattct actgtagggt ttatgttctt tagctcatag gttttgtgta 120

tttcttagaa atgtggcttc tttaatctct gggtttgtga ctttttgtgt ggtttctgtg 180

tttttcatat caaaaaccta ttttttccga gttttttttt acaaattctt actctcaagc 240

ttgaatactt cacatgcagt gttcttttgt agattttaga gttaatgtgt taaaaagttt 300

ggatttttct tgcttataga gcttcttcac tttgattttg tgggtttttt tgttttaaag 360 gtgagatttt tgatgaggtt tttgcttcaa agatgtcacc tttctgggtt tgtcttttga 420

ataaagctat gaactgtcac atggctgacg caattttgtt actatgtcat gaaagctgac 480

gtttttccgt gttatacatg tttgcttaca cttgcatgcg tcaaaaaaat tggggctttt 540

tagttttagt caaagatttt acttctcttt tgggatttat gaaggaaagt tgcaaacttt 600

ctcaaatttt accatttttg ctttgatgtt tgtttagatt gcgacagaac aaactcatat 660

atgttgaaat ttttgcttgg ttttgtatag gattgtgtct tttgcttata aatgttgaaa 720

tctgaacttt ttttttgttt ggtttctttg agcaggag 758

<210> 10
<211> 252
<212> DNA
<213> Arabidopsis

<400> 10
actgtttaag cttcactgtc tctgaatcgg caaaggtaaa cgtatcaatt attctacaaa 60

cccttttatt tttcttttga attaccgtct tcattggtta tatgataact tgataagtaa 120

agcttcaata attgaatttg atctgtgttt ttttggcctt aatactaaat ccttacataa 180

gctttgttgc ttctcctctt gtgagttgag tgttaagttg taataatggt tcactttcag 240

ctttagaaga aa 252

<210> 11
<211> 718
<212> DNA
<213> Arabidopsis

<400> 11
gtccagaatt ttctccattg aagctggatt ctaaggtcag ttcttacttc tttatctcaa 60

tctgatgatt ccatatcgaa agtcttactt tttcacttca atttcaatct gatgattcta 120

agatctttga ttcgaggtcg atctctgata gttactacat gtttctgggt ttatttattt 180

ttaatccata tagtaattaa aaactcttat gaggtttaat tatggttact tgagaatttg 240

caatcgtcat ctttctttga ctcctatcca ttttttggtt tttcctttgt ttaatttctg 300

tttcataatt gtaattgtaa attaaccaaa acaaattgat cagaaacctt tttcctatgg 360

aatatttatc acacgcaagc ctgtgagttg tgactctgta atcacttcct tgttctggta 420

atttcagtgg ttaaggctct cctttttttct gatgttgtca gcaaaagtta gtttttcttc 480

ttctttaatg ggttaattac acctaaatct ctggttatta aacaatccag aaagaaaaaa 540

agtttattcc ttcctctatg tatatagttt cacatgcaag catcacttgt ttgttctgac 600

aaattgcaga gttttgagtt ctgttttttt ttttttctaa tgttttgtct ttaagaaagt 660

tctgtttttt tttctgcagg aaagttatca aaagttttga gagctttgga tagtgaag 718

<210> 12
<211> 495
<212> DNA
<213> Arabidopsis

<400> 12
ctagcttaat ctcagattcg aatcgttcca tagtggtgag cttcgtgttc ttctttcgtc 60

tcttactcct gattctcgat tttagggttt tcagtaattg cgtcggcggc gaaagtcttt 120

atcgccgatc gatcttcctt atctagaaat tattgatcag aaactgttgg gttttgtttg 180

attcttgtca agttttgatt tttcatgcga aattgctcaa tcccaattca aagttacgat 240

ttttattgaa aaccctagat tggtttcttc aagtttgtca ctttgattca atctaatagc 300

ttagcttaat cgttaagtct ctttttggt tttaggtttc atttgcgatt taaaggttct 360

tgttttggta tttgttttgc tttggtcctt taagtttgag aggcttatgt agattataag 420

agagaagagt attgctttgc atgtttaaag gaagaacttt taactgaaca tttgtatgat 480

tggtatgtag atact 495

<210> 13
<211> 139
<212> DNA
<213> Arabidopsis

<400> 13
atttccacac gctttctatc atttccaccc aaaaggtaac gcgcttttta tttcctttcc 60

tgcattcata aatttgtctc ctgcatgttg aaaaaaaaaa atttacatcg agattcgttt 120

ttatttttta gagagagat 139

<210> 14
<211> 889
<212> DNA
<213> Arabidopsis

<400> 14
gtctactttc attacagtga ctctgcatgc ttcaggtctc gtctaattct tgaattctct 60

tcttttctgt tccgtaattt actttctagg gtctctagat ttgtgtctcc tctaacaaaa 120

gatcctatct ttcgacaaat ttaatttcat cattgacctt tgtcgattcc attctctctc 180

tatctctctg tttcttcgaa aacctagagg ttttgaattt aatgattcct ttttatgtca 240

ataaatttgc aatcaatggg agctttttaa aatcatcgtt atatctataa acaaaaaaac 300

agtaattact cttcttagat ctaaaacaat taataaatct ttcccttttt tctcatcata 360

attttttcgt atttaactct tgtaaaaatt tgcttagccg tttcgctttc tcaggcccca 420

ggtgattcgt gtcttctagg tcagcttgtg aaacctgaga gaagccatct tttgtttgcg 480

gttacaaact ttgccgcttc aatatttcat tgctgttttc tgggaaaacc tttttctagt 540 tttttcggct tattatgcct tttaactttt tgtgcattta acatttattg ttagtgcttt 600

gcttagtgta aagtagtagt tctctttgta atattaccat aaggttcaga agtaaatttt 660

tctaaaattg ttttcttgtg ggaaattcag actgatttca gcaacatgca tgggcttaaa 720

atcagcttct aagactgaga tttagtgacc agtgtggtgg tgtcttgttc tctgttcttg 780

ggagaacaca aaggcagtgt ggagtctggt gagttttctg attcttgaaa agatttataa 840

atttcttgc aaaattagtc tttatgttga attgtgttgc aggtaaaat 889

<210> 15
<211> 433
<212> DNA
<213> Arabidopsis

<400> 15
gcacaatctt agcttacctt gaatcacaac ttcaggtata tgtaactgat tctaaattga 60

agattgtgtg caaatcttat atccattttt tattattaaa tttattgaaa aagctagcgg 120

tgtaaattaa tgtcacaaaa tcagtatatt gttagttttt gtttttttg aagttttatg 180

caaatcttca aaaagtatat tcagtgttgt aattgacaaa tagagactct agttcttttt 240

ttttttttct tttttttaac atctgactct tatagagact ctagttcatg tacacttttt 300

ttaatggaaa aacaaatttg aaactgaata tcttatttcc acgtagattg tatattagtt 360

taatttgatt gttatatttg taaatgtcta ctaaacagga attggatggt gaggaggcaa 420

ggcttgtgga tta 433

<210> 16
<211> 354
<212> DNA
<213> Arabidopsis

<400> 16
atcttagggt ttcgcgagat ctcactctca ctggtatgtc tgtgtttctt cttccatttt 60

ctgtttctat tggaaacttc tctctccaat ttcgttttct tcacttcttt gatcctttag 120

ctttgacaaa accgtagtaa aggatcaaaa gttatcatct ttggtccatg ttgtgaatcg 180

tgctctgctt gggtcgtgac tcccaaatcc ggatttgaaa ccagcatatc tgagcttaat 240

tcgagcatgc atgcgcttct ttttttctga tttttttag actttggttc taaatccctt 300

aactttggat taactgtcaa tctacaattt tatattaaca gagatagctt agca 354

<210> 17
<211> 143
<212> DNA
<213> Arabidopsis

<400> 17
cagaagctca tttcttcgat acgatcaacc attaggtgat ttttttctct gatcttcgag 60

ttctgataat tgctcttttt tctctggctt tgttatcgat aatttctctg gattttcttt 120

ctggggtgaa tttttgcgca gag 143

<210> 18
<211> 182
<212> DNA
<213> Arabidopsis

<400> 18
atttttgttg gtgaaaggta gaattcgtaa atttcttctg ctcactttat tgtttcgact 60

catacccgat aatctcttct atgtttggta gagatatctt ctcaaagtct tatctttcct 120

taccgtgttc tgtgtttttt gatgatttag gtgaagaaga agaagcagag acaaaaacga 180

tt 182

<210> 19
<211> 665
<212> DNA
<213> Arabidopsis

<400> 19
ttaagctttt aagaatctct actcacattt tctctgtgag tgttctttta tacttctttg 60

ttatttccaa tttttctttc tttcctctaa aaattttagg aactattgaa tcatttaatt 120

tctgtttgtt gataaaattt cgatcaactg ttctcggctt accgatgcat tttttgtaaa 180

accgtctttt tttggtgaat aaaattttaa attcatacaa aaaaaaaaca tatttgatac 240

tattttagct ccattgtatc tgaatcttca tttgttaatt tttttgtttc ctctgttctc 300

acttgaattt tggaatattt tctctaggtt ttaccttata ttcttcactt taagaactat 360

atgaagattt gattggaagt aataatattc ggtgatagaa tctgagtttg tttgattctg 420

gtgtggggct tatatctaac ttttttcttt gtaccaatac attttcaatt ttacattttt 480

gattagctta aaatgtgaag gataccttgt aaataactat tacactattg cttgtcttag 540

tctaatagtc ttcactaata ttttgtgcag tagaagtaaa tattataaag agttgttgtt 600

tgattataga gagttgttgt ctattcttta acttgatgtg atgttgtttt tgatgacagg 660

taaaa 665

<210> 20
<211> 252
<212> DNA
<213> Arabidopsis

<400> 20
tctgggaaat atcgattttg atctattaag agctggtgag agccaaagtt tcctttttgt 60

ttgtttgttt gtttgtttgt tgtttgtatt tttgtatctc tgtgatcgct tctacgtgtt 120

gggtcatgca gagaaactca ttttgttttg atttgcaatg tgtcaattcc actttgaaat 180 ataagattca tcgcctctct ctcctttgtt ttttttcttc ttctgcagct acgagctttg 240

ggatgtggtg ag 252

<210> 21
<211> 186
<212> DNA
<213> Arabidopsis

<400> 21
tattcacaat ctcctgccac ctctcatttc tctagttgag ttgttatctg cgtttttaag 60

cactcgaata ctgcatgcaa attccctgat tgtttgttag taccttagag attctcgatt 120

ttttagttgt ttagattgaa ccaggattac taaattgtta ttgttttctg tgtaaaggct 180

acatat 186

<210> 22
<211> 345
<212> DNA
<213> Arabidopsis

<400> 22
ctttgcagct tctgcagcac ctctccctac tccaggtact tatgtttttg ataattttat 60

tgatagactc tttacaatta tacttaagct tgttactttt tattgttacc aacaaaagct 120

aatgtatagt tcataactca caggtcctgc gtctttcggt ccgaccactt ctcctacaga 180

ttcgcaaact tctgatcctg aaggtactcg cgaacttttt actgcaactt ctagttctaa 240

ctccaaaaca ttttgttcag aatttgtttc taaaagattt tcgggtttgt tgacgtcaca 300

taactcgcag ggtctgcttc tttccgtccg cccacttctc cgaca 345

<210> 23
<211> 285
<212> DNA
<213> Arabidopsis

<400> 23
aacaactatg gcctgagggt aacaagagta tcaggtatat gtgaaaactc tacttttgaa 60

gtttaccaaa aaaaatactc tacttttgga aagacattgc tcctaaaatc ttattagttg 120

tatataattt actaaaacac atagttcttg aattcttgtt aatgagcatg ttaccttgga 180

caagtgaccc tttttctaca ttttgttttt ctatcacacg tcatgcgttt tgattgtttc 240

cttacgagtt ttaattttat tttttggtta aaaacagtaa gataa 285

<210> 24
<211> 137
<212> DNA
<213> Arabidopsis

<400> 24
tctaaaaata cagggcaccg aaccaaataa aggtgagaat gatgagaagc cgtttcttac 60

tcttcattgt tttcttctct ctatccctct tcatttcctc tctgatcgcc agtgatttag 120

gcttctgcaa cgaagag 137

<210> 25
<211> 664
<212> DNA
<213> Brassica napus

<400> 25
taaggatgac ctacccattc ttgagacaaa tgttacattt tagtatcaga gtaaaatgtg 60

tacctataac tcaaattcga ttgacatgta tccattcaac ataaaattaa accagcctgc 120

acctgcatcc acatttcaag tattttcaaa ccgttcggct cctatccacc gggtgtaaca 180

agacggattc cgaatttgga agattttgac tcaaattccc aatttatatt gaccgtgact 240

aaatcaactt taacttctat aattctgatt aagctcccaa tttatattcc caacggcact 300

acctccaaaa tttatagact ctcatcccct tttaaaccaa cttagtaaac gttttttttt 360

taattttatg aagttaagtt tttaccttgt ttttaaaaag aatcgttcat aagatgccat 420

gccagaacat tagctacacg ttacacatag catgcagccg cggagaattg tttttcttcg 480

ccacttgtca ctcccttcaa acacctaaga gcttctctct cacagcacac acatacaatc 540

acatgcgtgc atgcattatt acacgtgatc gccatgcaaa tctcctttat agcctataaa 600

ttaactcatc ggcttcactc tttactcaaa ccaaaactca tcaatacaaa caagattaaa 660

aaca 664

<210> 26
<211> 1064
<212> DNA
<213> Linum usitatissimum

<400> 26
ttagcagata tttggtgtct aaatgtttat tttgtgatat gttcatgttt gaaatggtgg 60

tttcgaaacc agggacaacg ttgggatctg atagggtgtc aaagagtatt atggattggg 120

acaatttcgg tcatgagttg caaattcaag tatatcgttc gattatgaaa attttcgaag 180

aatatcccat ttgagagagt ctttacctca ttaatgtttt tagattatga aattttatca 240

tagttcatcg tagtcttttt ggtgtaaagg ctgtaaaaag aaattgttca cttttgtttt 300

cgtttatgtg aaggctgtaa aagattgtaa aagactattt tggtgttttg gataaaatga 360

tagtttttat agattctttt gcttttagaa gaaatacatt tgaaattttt tccatgttga 420

gtataaaata ccgaaatcga ttgaagatca tagaaatatt ttaactgaaa acaaatttat 480

aactgattca attctctcca tttttatacc tatttaaccg taatcgattc taatagatga 540

tcgatttttt atataatcct aattaaccaa cggcatgtat tggataatta accgatcaac 600 tctcacccct aatagaatca gtattttcct tcgacgttaa ttgatcctac actatgtagg 660

tcatatccat cgttttaatt tttggccacc attcaattct gtcttgcctt tagggatgtg 720

aatatgaacg gccaaggtaa gagaataaaa ataatccaaa ttaaagcaag agaggccaag 780

taagataatc caaatgtaca cttgtcattg ccaaaattag taaaatactc ggcatattgt 840

attcccacac attattaaaa taccgtatat gtattggctg catttgcatg aataatacta 900

cgtgtaagcc caaaagaacc cacgtgtagc ccatgcaaag ttaacactca cgaccccatt 960

cctcagtctc cactatataa acccaccatc cccaatctca ccaaacccac cacacaactc 1020

acaactcact ctcacacctt aaagaaccaa tcaccaccaa aaaa 1064

<210> 27
<211> 1727
<212> DNA
<213> Linum usitatissimum

<400> 27
cacgggcagg acatagggac tactacaagc atagtatgct tcagacaaag agctaggaaa 60

gaactcttga tggaggttaa gagaaaaaag tgctagaggg gcatagtaat caaacttgtc 120

aaaaccgtca tcatgatgag ggatgacata atataaaaag ttgactaagg tcttggtagt 180

actctttgat tagtattata tattggtgag aacatgagtc aagaggagac aagaaaccga 240

ggaaccatag tttagcaaca agatggaagt tgcaaagttg agctagccgc tcgattagtt 300

acatctccta agcagtacta caaggaatgg tctctatact ttcatgttta gcacatggta 360

gtgcggattg acaagttaga aacagtgctt aggagacaaa gagtcagtaa aggtattgaa 420

agagtgaagt tgatgctcga caggtcagga gaagtccctc cgccagatgg tgactaccaa 480

ggggttggta tcagctgaga cccaaataag attcttcggt tgaaccagtg gttcgaccga 540

gactcttagg gtgggatttc actgtaagat ttgtgcattt tgttgaatat aaattgacaa 600

tttttttat ttaattatag attatttaga atgaattaca tatttagttt ctaacaagga 660

tagcaatgga tgggtatggg tacaggttaa acatatctat tacccaccca tctagtcgtc 720

gggttttaca cgtacccacc cgtttacata aaccagaccg gaattttaaa ccgtacccgt 780

ccgttagcgg gtttcagatt tacccgttta atcgggtaaa acctgattac taaatatata 840

ttttttattt gataaacaaa acaaaaatgt taatattttc atattggatg caattttaag 900

aaacacatat tcataaattt ccatatttgt aggaaaataa aaagaaaaat atattcaaga 960

acacaaattt caccgacatg acttttatta cagagttgga attagatcta acaattgaaa 1020

aattaaaatt aagatagaat atgttgagga acatgacata gtataatgct gggttacccg 1080

tcgggtaggt atcgaggcgg atactactaa atccatccca ctcgctatcc gataatcact 1140

ggtttcgggt atacccattc ccgtcaacag gcctttttaa ccggataatt tcaacttata 1200 gtgaatgaat tttgaataaa tagttagaat accaaaatcc tggattgcat ttgcaatcaa 1260

attttgtgaa ccgttaaatt ttgcatgtac ttgggataga tataatagaa ccgaattttc 1320

attagtttaa tttataactt actttgttca aagaaaaaaa atatctatcc aatttactta 1380

taataaaaaa taatctatcc aagttactta ttataatcaa cttgtaaaaa ggtaagaata 1440

caaatgtggt agcgtacgtg tgattatatg tgacgaaatg ttatatctaa caaaagtcca 1500

aattcccatg gtaaaaaaaa tcaaaatgca tggcaggctg tttgtaacct tggaataaga 1560

tgttggccaa ttctggagcc gccacgtacg caagactcag ggccacgttc tcttcatgca 1620

aggatagtag aacaccactc cacccacctc ctatattaga cctttgccca accctcccca 1680

actttcccat cccatccaca aagaaaccga catttttatc ataaatc 1727

<210> 28
<211> 1799
<212> DNA
<213> Vicia faba

<400> 28
tcgacggccc ggactgtatc caacttctga tctttgaatc tctctgttcc aacatgttct 60

gaaggagttc taagactttt cagaaagctt gtaacatgct ttgtagactt tctttgaatt 120

actcttgcaa actctgattg aacctacgtg aaaactgctc cagaagttct aaccaaattc 180

cgtcttggga aggcccaaaa tttattgagt acttcagttt catggacgtg tcttcaaaga 240

tttataactt gaaatcccat catttttaag agaagttctg ttccgcaatg tcttagatct 300

cattgaaatc tacaactctt gtgtcagaag ttcttccaga atcaacttgc atcatggtga 360

aaatctggcc agaagttctg aacttgtcat atttcttaac agttagaaaa atttctaagt 420

gtttagaatt ttgacttttc caaagcaaac ttgacttttg actttcttaa taaaacaaac 480

ttcatattct aacatgtctt gatgaaatgt gattcttgaa atttgatgtt gatgcaaaag 540

tcaaagtttg acttttcagt gtgcaattga ccattttgct cttgtgccaa ttccaaacct 600

aaattgatgt atcagtgctg caaacttgat gtcatggaag atcttatgag aaaattcttg 660

aagactgaga ggaaaaattt tgtagtacaa cacaaagaat cctgttttc atagtcggac 720

tagacacatt aacataaaac accacttcat tcgaagagtg attgaagaag gaaatgtgca 780

gttacctttc tgcagttcat aagagcaact tacagacact tttactaaaa tactacaaag 840

aggaagattt taacaactta gagaagtaat gggagttaaa gagcaacaca ttaaggggga 900

gtgttaaaat taatgtgttg taaccaccac tacctttagt aagtattata agaaaattgt 960

aatcatcaca ttataattat tgtccttatt taaaattatg ataaagttgt atcattaaga 1020

ttgagaaaac caaatagtcc tcgtcttgat ttttgaatta ttgttttcta tgttactttt 1080

cttcaagcct atataaaaac tttgtaatgc taaattgtat gctggaaaaa aatgtgtaat 1140 gaattgaata gaaattatgg tatttcaaag tccaaaatcc atcaatagaa atttagtaca 1200

aaacgtaact caaaaatatt ctcttatttt aaattttaca acaatataaa aatattctct 1260

tattttaaat tttacaataa tataatttat cacctgtcac ctttagaata ccaccaacaa 1320

tattaatact tagatatttt attcttaata attttgagat ctctcaatat atctgatatt 1380

tattttatat ttgtgtcata ttttcttatg ttttagagtt aacccttata tcttggtcaa 1440

actagtaatt caatatatga gtttgtgaag gacacattga catcttgaaa cattggtttt 1500

aaccttgttg gaatgttaaa ggtaataaaa cattcagaat tatgaccatc tattaatata 1560

cttcctttgt cttttaaaaa agtgtgcatg aaaatgctct atggtaagct agagtgtctt 1620

gctggcctgt gtatatcaat tccatttcca gatggtagaa actgccacta cgaataatta 1680

gtcataagac acgtatgtta acacacgtcc ccttgcatgt tttttgccat atattccgtc 1740

tctttctttt tcttcacgta taaaacaatg aactaattaa tagagcgatc aagctgaac 1799

<210> 29
<211> 684
<212> DNA
<213> Vicia faba

<400> 29
ctgcagcaaa tttacacatt gccactaaac gtctaaaccc ttgtaatttg tttttgtttt 60

actatgtgtg ttatgtattt gatttgcgat aaatttttat atttggtact aaatttataa 120

caccttttat gctaacgttt gccaacactt agcaatttgc aagttgatta attgattcta 180

aattattttt gtcttctaaa tacatatact aatcaactgg aaatgtaaat atttgctaat 240

atttctacta taggagaatt aaagtgagtg aatatggtac cacaaggttt ggagatttaa 300

ttgttgcaat gctgcatgga tggcatatac accaaacatt caataattct tgaggataat 360

aatggtacca cacaagattt gaggtgcatg aacgtcacgt ggacaaaagg tttagtaatt 420

tttcaagaca acaatgttac cacacacaag ttttgaggtg catgcatgga tgccctgtgg 480

aaagtttaaa aatattttgg aaatgatttg catggaagcc atgtgtaaaa ccatgacatc 540

cacttggagg atgcaataat gaagaaaact acaaatttac atgcaactag ttatgcatgt 600

agtctatata atgaggattt tgcaatactt tcattcatac acactcacta agttttacac 660

gattataatt tcttcatagc cagt 684

<210> 30
<211> 2742
<212> DNA
<213> Vicia faba

<400> 30
gtcgtctcaa actcattcat cagaaccttc ttgaacttag ttatctcttg ttcagagctt 60

cctgttagca atatgtcatc aacatataaa catgtcccag aagccagaag atagaagttg 120

gatgatagaa gtaaagtaat gttactggtg gagtaccaca atacaagttc atacaaactt 180
tattgtccag aaactaacaa agttgagttc agcatagatg aaagacaaaa agaatatatt 240
aaatgacggc tgcaaaataa ggagtaatga atacattgac ctacctacta ctaggctatt 300
tatacacaat attagggtat aataaaatat taaaataccc tctatcagac ttagtcaata 360
agacattcct aaaatataaa ttatttccaa caataatttg tctcaaataa aatatagagg 420
tgcaaaagtt aaactaagag tgcaaagtaa aattttgaga gggctcaaaa ttgaatataa 480
taacaatatt agtgtagttt aagaaaactc aggggatgca gttgaactcc ctcaactgta 540
cgtagctcct cccctggatg cagtgtaaag atttgaagat atattttagt actttggata 600
ttgtaggcca gagggtgttg aagataaagg ttcaggaact aacacattca tccacaactt 660
ctatgtgtcc atcgtcagtg aaatacatgc caaatagggg agttaagaag agtagaaagg 720
gtcaagatag tgatgtgcat cgtgatcctt cataatggga gtgtggtgag ggctcgcatg 780
ggagtcatac tacaaagaga tcatgcataa aaccaactag aagtcaactg tcaagtatga 840
cggctgacaa ttaaccgtcc accaaatctt ccagacatgt ttacttgtcc cagttttctg 900
atttcttata tccatacatt gatgacatta ttgatgttgg tggcgatgga gattggggtt 960
ttcatgctat tacagcttta cttggatggg gtgaagagtc atagcctttg attcagacgc 1020
agttagatac tcaagttcat caacaccctc aattgttttt taagttgttt tgtgacacga 1080
tctctacagt tagaaatgcg ttacgagtag aacacttggc tgtgcagggt atagataaat 1140
gaatgacgat ttatgatatg ggttacccta ttgcttctag atacaatgtc gtatttgtct 1200
cccttccaaa agacttaaca tcacgttttt tcctcttgcc ttatctccac ctatgtatac 1260
aagcaggcat aaaatcattg ttgttggttt tgtcaacaac aatcattgag tttaggtaaa 1320
gttgaaactt gattgtccat tacctcttgt cactgactgt tgaagacaga attgtactga 1380
ctgtatatat caacatatgc gagacgcgtt aggcagtgga aagacgtagt taggatgtca 1440
tcataatttg tttcgtattt ttatatgtag cacagttttt atatgtatat attttatcgg 1500
gtagtttttt atcgattcag ttatttgaga aaaagtaatg cagacaaaaa gtggaaaaga 1560
caatctgact gtacataaga aatttccaat ttttgaaatt tttttataat tatcagaaat 1620
tttaaaattt ccgataaaaa catacatgta tagatcgaaa atttcaaatt tctagtactt 1680
tcaaatttct tgcagtaaaa gttgtaattt tttaaaaatt tacgataatt tacagtattt 1740
aaaaaaaaat ccaatcttaa ataaagggta taagaataaa agcactcatg tggagtggca 1800
ggtttcgtca caccctaaga acatccctaa atacaccaca tatgtataag tattaagtga 1860
ttgatgttaa gtgaaacgaa aatatttata tgtgaaattt aatattcagc ttacttgatt 1920
aaactccata gtgacccaat aagtgctaac ttttactgtc tttaccttta aatgttatat 1980

tgatttattt atgcatttct ttttcctgca tctcaatagt atatagggta tcaaatagtg 2040

attatccaaa cttaaataag ttagaggaaa caccaagata tgccatatac tctcaaattt 2100

gacactatga ttcaaagttg cacttgcata aaacttatta attcaatagt aaaaccaaac 2160

ttgtgcgtga tacagttaaa atgactaaac tactaattaa ggtccctccc attagtaaat 2220

aagttatttt tttagaaaaa gaaaataata aaaagaatga cgagtctatc taaatcatat 2280

taacaagtaa tacatattga ttcattcgat ggaggaggcc aataattgta gtaaacaagc 2340

agtgccgagg ttaatatatg ctcaagacag taaataatct aaatgaatta agacagtgat 2400

ttgcaaagag tagatgcaga gaagagaact aaagatttgc tgctacacgt atataagaat 2460

agcaacagat attcattctg tctctttgtg gaatatggat atctactaat catcatctat 2520

ctgtgaagaa taaaagaagc ggccacaagc gcagcgtcgc acatatgatg tgtatcaaat 2580

taggactcca tagccatgca tgctgaagaa tgtcacacac gttctgtcac acgtgttact 2640

ctctcactgt tctcctcttc ctataaatca ccgcgccaca gcttctccac ttcaccactt 2700

caccacttca ctcacaatcc ttcattagtt gtttactatc ac 2742

<210> 31
<211> 445
<212> DNA
<213> Arabidopsis thaliana

<400> 31
ggccgcagat atcagatctg gtcgacctag aggatccccg gccgcaaaga taataacaaa 60

agcctactat ataacgtaca tgcaagtatt gtatgatatt aatgttttta cgtacgtgta 120

aacaaaaata attacgtttg taacgtatgg tgatgatgtg gtgcactagg tgtaggcctt 180

gtattaataa aaagaagttt gttctatata gagtggttta gtacgacgat ttatttacta 240

gtcggattgg aatagagaac cgaattcttc aatccttgct tttgatcaag aattgaaacc 300

gaatcaaatg taaaagttga tatatttgaa aaacgtattg agcttatgaa aatgctaata 360

ctctcatctg tatggaaaag tgactttaaa accgaactta aaagtgacaa aaggggaata 420

tcgcatcaaa ccgaatgaaa ccgat 445

<210> 32
<211> 216
<212> DNA
<213> CaMV

<400> 32
tcgacaagct cgagtttctc cataataatg tgtgagtagt tcccagataa gggaattagg 60

gttcctatag ggtttcgctc atgtgttgag catataagaa acccttagta tgtatttgta 120

tttgtaaaat acttctatca ataaaatttc taattcctaa aaccaaaatc cagtactaaa 180

atccagatcc ccgaattaa ttcggcgtta attcag 216

<210> 33
<211> 568
<212> DNA
<213> Pisum sativum

<400> 33
taattgattg gttcgagtat tatggcattg ggaaaactgt ttttcttgta ccatttgttg 60

tgcttgtaat ttactgtgtt ttttattcgg ttttcgctat cgaactgtga aatggaaatg 120

gatggagaag agttaatgaa tgatatggtc cttttgttca ttctcaaatt aatattattt 180

gttttttctc ttatttgttg tgtgttgaat ttgaaattat aagagatatg caaacatttt 240

gttttgagta aaaatgtgtc aaatcgtggc ctctaatgac cgaagttaat atgaggagta 300

aaacacttgt agttgtacca ttatgcttat tcactaggca acaaatatat tttcagacct 360

agaaaagctg caaatgttac tgaatacaag tatgtcctct tgtgttttag acatttatga 420

actttccttt atgtaatttt ccagaatcct tgtcagattc taatcattgc tttataatta 480

tagttatact catggatttg tagttgagta tgaaaatatt ttttaatgca ttttatgact 540

tgccaattga ttgacaacat gcatcaat 568

<210> 34
<211> 235
<212> DNA
<213> Agrobacterium tumefaciens

<400> 34
ggccgcctcg agcatgcatc tagagggccc gctagcgtta accctgcttt aatgagatat 60

gcgagacgcc tatgatcgca tgatatttgc tttcaattct gttgtgcacg ttgtaaaaaa 120

cctgagcatg tgtagctcag atccttaccg ccggtttcgg ttcattctaa tgaatatatc 180

acccgttact atcgtatttt tatgaataat attctccgtt caatttactg attgt 235

<210> 35
<211> 605
<212> DNA
<213> Phaseolus vulgaris

<400> 35
ctaagactcc caaaaccacc ttccctgtga cagttaaacc ctgcttatac ctttcctcct 60

aataatgttc atctgtcaca caaactaaaa taaataaaat gggagcaata aataaaatgg 120

gagctcatat atttacacca tttacactgt ctattattca ccatgccaat tattacttca 180

taattttaaa attatgtcat ttttaaaaat tgcttaatga tggaaaggat tattataagt 240

taaaagtata acatagataa actaaccaca aaacaaatca atataaacta acttactctc 300

ccatctaatt tttatttaaa tttctttaca cttctcttcc atttctattt ctacaacatt 360

atttaacatt tttattgtat ttttcttact ttctaactct attcatttca aaaatcaata 420 tatgtttatc accacctctc taaaaaaaac tttacaatca ttggtccaga aaagttaaat 480

cacgagatgg tcattttagc attaaaacaa cgattcttgt atcactattt ttcagcatgt 540

agtccattct cttcaaacaa agacagcggc tatataatcg ttgtgttata ttcagtctaa 600

aacaa 605

<210> 36
<211> 254
<212> DNA
<213> Solanum tuberosum

<400> 36
ggccgcctcg accgtacccc ctgcagatag actatactat gttttagcct gcctgctggc 60

tagctactat gttatgttat gttgtaaaat aaacacctgc taaggtatat ctatctatat 120

tttagcatgg ctttctcaat aaattgtctt tccttatcgt ttactatctt atacctaata 180

atgaaataat aatatcacat atgaggaacg gggcaggttt aggcatatat atacgagtgt 240

agggcggagt gggg 254

<210> 37
<211> 297
<212> DNA
<213> Vicia faba

<400> 37
atcctgcaat agaatgttga ggtgaccact ttctgtaata aaataattat aaaataaatt 60

tagaattgct gtagtcaaga acatcagttc taaaatatta ataaagttat ggccttttga 120

catatgtgtt tcgataaaaa aatcaaaata aattgagatt tattcgaaat acaatgaaag 180

tttgcagata tgagatatgt ttctacaaaa taataactta aaactcaact atatgctaat 240

gtttttcttg gtgtgtttca tagaaaattg tatccgtttc ttagaaaatg ctcgtaa 297

<210> 38
<211> 24631
<212> DNA
<213> Artificial

<220>
<223> Plant Expression Plasmid

<400> 38
acatacaaat ggacgaacgg ataaaccttt tcacgccctt ttaaatatcc gattattcta 60

ataaacgctc ttttctctta ggtttacccg ccaatatatc ctgtcaaaca ctgatagttt 120

aaactgaagg cgggaaacga caatcagatc tagtaggaaa cagctatgac catgattacg 180

ccaagcttat ttaaatcgta ccgtactagt aacggccgcc agtgtgctgg aattcgccct 240

taaaaaagat atcgattacg ccaagctatc aactttgtat agaaaagttg ccatgattac 300

```
gccaagcttg gcgcgccctg cagcaaattt acacattgcc actaaacgtc taaacccttg    360
taatttgttt ttgttttact atgtgtgtta tgtatttgat ttgcgataaa tttttatatt    420
tggtactaaa tttataacac cttttatgct aacgtttgcc aacacttagc aatttgcaag    480
ttgattaatt gattctaaat tatttttgtc ttctaaatac atatactaat caactggaaa    540
tgtaaatatt tgctaatatt tctactatag gagaattaaa gtgagtgaat atggtaccac    600
aaggtttgga gatttaattg ttgcaatgct gcatggatgg catatacacc aaacattcaa    660
taattcttga ggataataat ggtaccacac aagatttgag gtgcatgaac gtcacgtgga    720
caaaaggttt agtaattttt caagacaaca atgttaccac acacaagttt tgaggtgcat    780
gcatggatgc cctgtggaaa gtttaaaaat attttggaaa tgatttgcat ggaagccatg    840
tgtaaaacca tgacatccac ttggaggatg caataatgaa gaaaactaca aatttacatg    900
caactagtta tgcatgtagt ctatataatg aggattttgc aatactttca ttcatacaca    960
ctcactaagt tttacacgat tataatttct tcatagccag taccatggaa gttgttgaga   1020
ggttctacgg agagttggat ggaaaggttt cccaaggagt gaacgctttg ttgggatctt   1080
tcggagttga gttgactgat accccaacta ctaagggatt gccactcgtt gattctccaa   1140
ctccaattgt gttgggagtg tctgtttact tgaccatcgt gatcggagga ttgctttgga   1200
tcaaggctag agatctcaag ccaagagctt ctgagccatt cttgttgcaa gctttggtgt   1260
tggtgcacaa cttgttctgc ttcgctttgt ctctttacat gtgcgtgggt atcgcttacc   1320
aagctatcac ctggagatat tccttgtggg gaaacgctta taacccaaag cacaaggaga   1380
tggctatcct cgtttacctc ttctacatgt ccaagtacgt ggagttcatg gataccgtga   1440
tcatgatcct caagagatcc accagacaga tttctttcct ccacgtgtac caccactctt   1500
ctatctccct tatctggtgg gctattgctc accacgctcc aggaggagag gcttattgga   1560
gtgctgctct caactctgga gtgcacgtgt tgatgtacgc ttactacttc ttggctgctt   1620
gcttgagatc ttccccaaag ctcaagaaca agtacctctt ctggggaaga tacctcaccc   1680
aattccagat gttccagttc atgctcaact tggtgcaagc ttactacgat atgaaaacca   1740
acgctccata tccacaatgg ctcatcaaga tcctcttcta ctacatgatc tccctcttgt   1800
tcctcttcgg aaacttctac gtgcaaaagt acatcaagcc atccgatgga aagcaaaagg   1860
gagctaagac cgagtgatcg acaagctcga gtttctccat aataatgtgt gagtagttcc   1920
cagataaggg aattagggtt cctatagggt ttcgctcatg tgttgagcat ataagaaacc   1980
cttagtatgt atttgtattt gtaaaatact tctatcaata aaatttctaa ttcctaaaac   2040
caaaatccag tactaaaatc cagatccccc gaattaattc ggcgttaatt cagggccggc   2100
cgatctgtcg tctcaaactc attcatcaga accttcttga acttagttat ctcttgttca   2160
gagcttcctg ttagcaatat gtcatcaaca tataaacatg tcccagaagc cagaagatag   2220
```

aagttggatg atagaagtaa agtaatgtta ctggtggagt accacaatac aagttcatac 2280
aaactttatt gtccagaaac taacaaagtt gagttcagca tagatgaaag acaaaaagaa 2340
tatattaaat gacggctgca aaataaggag taatgaatac attgacctac ctactactag 2400
gctatttata cacaatatta gggtataata aaatattaaa ataccctcta tcagacttag 2460
tcaataagac attcctaaaa tataaattat ttccaacaat aatttgtctc aaataaaata 2520
tagaggtgca aaagttaaac taagagtgca aagtaaaatt ttgagagggc tcaaaattga 2580
atataataac aatattagtg tagtttaaga aaactcaggg gatgcagttg aactccctca 2640
actgtacgta gctcctcccc tggatgcagt gtaaagattt gaagatatat tttagtactt 2700
tggatattgt aggccagagg gtgttgaaga taaaggttca ggaactaaca cattcatcca 2760
caacttctat gtgtccatcg tcagtgaaat acatgccaaa taggggagtt aagaagagta 2820
gaaagggtca agatagtgat gtgcatcgtg atccttcata atgggagtgt ggtgagggct 2880
cgcatgggag tcatactaca aagagatcat gcataaaacc aactagaagt caactgtcaa 2940
gtatgacggc tgacaattaa ccgtccacca aatcttccag acatgtttac ttgtcccagt 3000
tttctgattt cttatatcca tacattgatg acattattga tgttggtggc gatggagatt 3060
ggggttttca tgctattaca gctttacttg gatggggtga agagtcatag cctttgattc 3120
agacgcagtt agatactcaa gttcatcaac accctcaatt gtttttaag ttgttttgtg 3180
acacgatctc tacagttaga aatgcgttac gagtagaaca cttggctgtg cagggtatag 3240
ataaatgaat gacgatttat gatatgggtt accctattgc ttctagatac aatgtcgtat 3300
ttgtctccct tccaaaagac ttaacatcac gtttttcct cttgccttat ctccacctat 3360
gtatacaagc aggcataaaa tcattgttgt tggttttgtc aacaacaatc attgagttta 3420
ggtaaagttg aaacttgatt gtccattacc tcttgtcact gactgttgaa gacagaattg 3480
tactgactgt atatatcaac atatgcgaga cgcgttaggc agtggaaaga cgtagttagg 3540
atgtcatcat aatttgtttc gtatttttat atgtagcaca gtttttatat gtatatattt 3600
tatcgggtag ttttttatcg attcagttat ttgagaaaaa gtaatgcaga caaaaagtgg 3660
aaaagacaat ctgactgtac ataagaaatt tccaattttt gaaatttttt tataattatc 3720
agaaatttta aaatttccga taaaaacata catgtataga tcgaaaattt caaatttcta 3780
gtactttcaa atttcttgca gtaaaagttg taattttta aaaatttacg ataatttaca 3840
gtatttaaaa aaaaatccaa tcttaaataa agggtataag aataaaagca ctcatgtgga 3900
gtggcaggtt tcgtcacacc ctaagaacat ccctaaatac accacatatg tataagtatt 3960
aagtgattga tgttaagtga aacgaaaata tttatatgtg aaatttaata ttcagcttac 4020
ttgattaaac tccatagtga cccaataagt gctaactttt actgtcttta cctttaaatg 4080

ttatattgat ttatttatgc atttcttttt cctgcatctc aatagtatat agggtatcaa 4140
atagtgatta tccaaactta aataagttag aggaaacacc aagatatgcc atatactctc 4200
aaatttgaca ctatgattca aagttgcact tgcataaaac ttattaattc aatagtaaaa 4260
ccaaacttgt gcgtgataca gttaaaatga ctaaactact aattaaggtc cctcccatta 4320
gtaaataagt tattttttta gaaaaagaaa ataataaaaa gaatgacgag tctatctaaa 4380
tcatattaac aagtaataca tattgattca ttcgatggag gaggccaata attgtagtaa 4440
acaagcagtg ccgaggttaa tatatgctca agacagtaaa taatctaaat gaattaagac 4500
agtgatttgc aaagagtaga tgcagagaag agaactaaag atttgctgct acacgtatat 4560
aagaatagca acagatattc attctgtctc tttgtggaat atggatatct actaatcatc 4620
atctatctgt gaagaataaa agaagcggcc acaagcgcag cgtcgcacat atgatgtgta 4680
tcaaattagg actccatagc catgcatgct gaagaatgtc acacacgttc tgtcacacgt 4740
gttactctct cactgttctc ctcttcctat aaatcaccgc gccacagctt ctccacttca 4800
ccacttcacc acttcactca caatccttca ttagttgttt actatcacag tcacaaccat 4860
ggttgatttg aagccaggag tgaagagatt ggtttcctgg aaggagatta gagagcacgc 4920
tactccagct actgcttgga ttgtgatcca ccacaaggtg tacgatatct ccaagtggga 4980
ttctcatcca ggtggaagtg tgatgttgac tcaggctgga gaggatgcta ctgatgcttt 5040
cgctgtgttc catccatctt ccgctttgaa gctcttggag cagttctacg taagtttctg 5100
cttctacctt tgatatatat ataataatta tcattaatta gtagtaatat aatatttcaa 5160
atattttttt caaaataaaa gaatgtagta tatagcaatt gcttttctgt agtttataag 5220
tgtgtatatt ttaatttata acttttctaa tatatgacca aaatttgttg atgtgcaggt 5280
aggagatgtg gatgagactt ccaaggctga gattgaggga gaaccagctt ctgatgagga 5340
gagagctaga agagagagga tcaacgagtt catcgcttct tacagaaggc tcagggttaa 5400
ggttaaggga atgggactct acgatgcttc tgctctttac tacgcttgga agctcgtttc 5460
taccttcgga attgctgtgc tctctatggc tatctgcttc ttcttcaact ccttcgctat 5520
gtacatggtg gctggagtta ttatgggact cttctaccaa caatctggat ggcttgctca 5580
cgatttcttg cacaaccagg tgtgcgagaa cagaactttg ggaaacttga tcggatgcct 5640
tgttggaaat gcttggcagg gattctctat gcaatggtgg aagaacaagc acaacttgca 5700
ccacgctgtg ccaaacttgc actccgctaa ggatgaggga ttcatcggag atccagatat 5760
cgataccatg ccattgcttg cttggtctaa ggagatggct agaaaggctt tcgagtctgc 5820
tcacggacca ttcttcatca ggaaccaggc tttcttgtac ttcccattgc tcttgttggc 5880
tagattgtct tggctcgctc agtctttctt ctacgtgttc accgagttct cattcggaat 5940
cttcgataag gtggagttcg atggaccaga aaaggctgga ttgatcgtgc actacatctg 6000

gcaactcgct attccatact tctgcaacat gtccttgttc gagggagttg cttacttctt 6060
gatgggacaa gcttcttgcg gattgctttt ggctctcgtg ttctctattg gacacaacgg 6120
aatgtctgtg tacgagagag agaccaagcc agatttctgg caattgcaag tgactaccac 6180
cagaaacatt agggcttccg tgttcatgga ttggttcacc ggaggactca actaccaaat 6240
cgatcaccac ttgttcccat tggtgccaag acacaacttg ccaaaggtga acgtgttgat 6300
caagtctctc tgcaaggagt tcgatatccc attccacgag actggattct gggagggaat 6360
ctacgaggtt gtggatcacc tcgctgatat ctctaaggag ttcatcactg agttcccagc 6420
tatgtgagat cctgcaatag aatgttgagg tgaccacttt ctgtaataaa ataattataa 6480
aataaattta gaattgctgt agtcaagaac atcagttcta aaatattaat aaagttatgg 6540
ccttttgaca tatgtgtttc gataaaaaaa tcaaaataaa ttgagattta ttcgaaatac 6600
aatgaaagtt tgcagatatg agatatgttt ctacaaaata ataacttaaa actcaactat 6660
atgctaatgt ttttcttggt gtgtttcata gaaaattgta tccgtttctt agaaaatgct 6720
cgtaagttta aacttagcag atatttggtg tctaaatgtt tattttgtga tatgttcatg 6780
tttgaaatgg tggtttcgaa accagggaca acgttgggat ctgatagggt gtcaaagagt 6840
attatggatt gggacaattt cggtcatgag ttgcaaattc aagtatatcg ttcgattatg 6900
aaaattttcg aagaatatcc catttgagag agtctttacc tcattaatgt ttttagatta 6960
tgaaatttta tcatagttca tcgtagtctt tttggtgtaa aggctgtaaa aagaaattgt 7020
tcacttttgt tttcgtttat gtgaaggctg taaaagattg taaaagacta ttttggtgtt 7080
ttggataaaa tgatagtttt tatagattct tttgctttta gaagaaatac atttgaaatt 7140
ttttccatgt tgagtataaa ataccgaaat cgattgaaga tcatagaaat attttaactg 7200
aaaacaaatt tataactgat tcaattctct ccatttttat acctatttaa ccgtaatcga 7260
ttctaataga tgatcgattt tttatataat cctaattaac caacggcatg tattggataa 7320
ttaaccgatc aactctcacc cctaatagaa tcagtatttt ccttcgacgt taattgatcc 7380
tacactatgt aggtcatatc catcgtttta atttttggcc accattcaat tctgtcttgc 7440
ctttagggat gtgaatatga acggccaagg taagagaata aaaataatcc aaattaaagc 7500
aagagaggcc aagtaagata atccaaatgt acacttgtca ttgccaaaat tagtaaaata 7560
ctcggcatat tgtattccca cacattatta aaataccgta tatgtattgg ctgcatttgc 7620
atgaataata ctacgtgtaa gcccaaaaga acccacgtgt agcccatgca aagttaacac 7680
tcacgacccc attcctcagt ctccactata taaacccacc atccccaatc tcaccaaacc 7740
caccacacaa ctcacaactc actctcacac cttaaagaac caatcaccac caaaaaacca 7800
tgggaaaagg atctgaggga agatctgctg ctagagagat gactgctgag gctaacggag 7860

ataagagaaa gaccatcctc attgagggag tgttgtacga tgctaccaac ttcaaacacc 7920
caggaggttc cattattaac ttcctcaccg agggagaagc tggagttgat gctacccaag 7980
cttacagaga gttccatcag agatccggaa aggctgataa gtacctcaag tccctcccaa 8040
agttggatgc ttctaaggtg gagtctaggt tctctgctaa ggagcaggct agaagggacg 8100
ctatgaccag ggattacgct gctttcagag aggagttggt tgctgaggga tacttcgatc 8160
catctatccc acacatgatc tacagagtgg tggagattgt ggctttgttc gctttgtctt 8220
tctggttgat gtctaaggct tctccaacct ctttggtttt gggagtggtg atgaacggaa 8280
tcgctcaagg aagatgcgga tgggttatgc acgagatggg acacggatct ttcactggag 8340
ttatctggct cgatgatagg atgtgcgagt tcttctacgg agttggatgt ggaatgtctg 8400
gacactactg gaagaaccag cactctaagc accacgctgc tccaaacaga ttggagcacg 8460
atgtggattt gaacaccttg ccactcgttg ctttcaacga gagagttgtg aggaaggtta 8520
agccaggatc tttgttggct ttgtggctca gagttcaggc ttatttgttc gctccagtgt 8580
cttgcttgtt gatcggattg ggatggacct tgtacttgca cccaagatat atgctcagga 8640
ccaagagaca catggagttt gtgtggatct tcgctagata tatcggatgg ttctccttga 8700
tgggagcttt gggatattct cctggaactt ctgtgggaat gtacctctgc tctttcggac 8760
ttggatgcat ctacatcttc ctccaattcg ctgtgtctca cacccacttg ccagttacca 8820
acccagagga tcaattgcac tggcttgagt acgctgctga tcacaccgtg aacatctcta 8880
ccaagtcttg gttggttacc tggtggatgt ctaacctcaa cttccaaatc gagcaccact 8940
tgttcccaac cgctccacaa ttcaggttca aggagatctc tccaagagtt gaggctctct 9000
tcaagagaca caacctccct tactacgatt tgccatacac ctctgctgtt tctactacct 9060
tcgctaacct ctactctgtt ggacactctg ttggagctga taccaagaag caggattgac 9120
tgctttaatg agatatgcga gacgcctatg atcgcatgat atttgctttc aattctgttg 9180
tgcacgttgt aaaaaacctg agcatgtgta gctcagatcc ttaccgccgg tttcggttca 9240
ttctaatgaa tatatcaccc gttactatcg tatttttatg aataatattc tccgttcaat 9300
ttactgattg tgtcgacgcg atcgcgtgcg cacgggcccc ctgcaggatt taaatcccgg 9360
gggtacccaa gtttgtacaa aaaagcaggc tccatgatta cgccaagctt cccaattcga 9420
ggtaccctcg acggcccgga ctgtatccaa cttctgatct ttgaatctct ctgttccaac 9480
atgttctgaa ggagttctaa gacttttcag aaagcttgta acatgctttg tagactttct 9540
ttgaattact cttgcaaact ctgattgaac ctacgtgaaa actgctccag aagttctaac 9600
caaattccgt cttgggaagg cccaaaattt attgagtact tcagtttcat ggacgtgtct 9660
tcaaagattt ataacttgaa atcccatcat ttttaagaga agttctgttc cgcaatgtct 9720
tagatctcat tgaaatctac aactcttgtg tcagaagttc ttccagaatc aacttgcatc 9780

atggtgaaaa tctggccaga agttctgaac ttgtcatatt tcttaacagt tagaaaaatt 9840
tctaagtgtt tagaattttg acttttccaa agcaaacttg acttttgact ttcttaataa 9900
aacaaacttc atattctaac atgtcttgat gaaatgtgat tcttgaaatt tgatgttgat 9960
gcaaaagtca aagtttgact tttcagtgtg caattgacca ttttgctctt gtgccaattc 10020
caaacctaaa ttgatgtatc agtgctgcaa acttgatgtc atggaagatc ttatgagaaa 10080
attcttgaag actgagagga aaaattttgt agtacaacac aaagaatcct gtttttcata 10140
gtcggactag acacattaac ataaaacacc acttcattcg aagagtgatt gaagaaggaa 10200
atgtgcagtt acctttctgc agttcataag agcaacttac agacactttt actaaaatac 10260
tacaaagagg aagattttaa caacttagag aagtaatggg agttaaagag caacacatta 10320
agggggagtg ttaaaattaa tgtgttgtaa ccaccactac ctttagtaag tattataaga 10380
aaattgtaat catcacatta taattattgt ccttatttaa aattatgata aagttgtatc 10440
attaagattg agaaaaccaa atagtcctcg tcttgatttt tgaattattg ttttctatgt 10500
tacttttctt caagcctata taaaaacttt gtaatgctaa attgtatgct ggaaaaaaat 10560
gtgtaatgaa ttgaatagaa attatggtat ttcaaagtcc aaaatccatc aatagaaatt 10620
tagtacaaaa cgtaactcaa aaatattctc ttattttaaa ttttacaaca atataaaaat 10680
attctcttat tttaaatttt acaataatat aatttatcac ctgtcacctt tagaatacca 10740
ccaacaatat taatacttag atattttatt cttaataatt ttgagatctc tcaatatatc 10800
tgatatttat tttatatttg tgtcatattt tcttatgttt tagagttaac ccttatatct 10860
tggtcaaact agtaattcaa tatatgagtt tgtgaaggac acattgacat cttgaaacat 10920
tggttttaac cttgttggaa tgttaaaggt aataaaacat tcagaattat gaccatctat 10980
taatatactt cctttgtctt ttaaaaaagt gtgcatgaaa atgctctatg gtaagctaga 11040
gtgtcttgct ggcctgtgta tatcaattcc atttccagat ggtagaaact gccactacga 11100
ataattagtc ataagacacg tatgttaaca cacgtcccct tgcatgtttt ttgccatata 11160
ttccgtctct ttctttttct tcacgtataa aacaatgaac taattaatag agcgatcaag 11220
ctgaaccatg cgcgccacca tgtgtgttga gaccgagaac aacgatggaa tccctactgt 11280
ggagatcgct ttcgatggag agagagaaag agctgaggct aacgtgaagt tgtctgctga 11340
gaagatggaa cctgctgctt tggctaagac cttcgctaga agatacgtgg ttatcgaggg 11400
agttgagtac gatgtgaccg atttcaaaca tcctggagga accgtgattt tctacgctct 11460
ctctaacact ggagctgatg ctactgaggc tttcaaggag ttccaccaca gatctagaaa 11520
ggctaggaag gctttggctg ctttgccttc tagacctgct aagaccgcta aagtggatga 11580
tgctgagatg ctccaggatt tcgctaagtg gagaaaggag ttggagaggg acggattctt 11640

caagccttct cctgctcatg ttgcttacag attcgctgag ttggctgcta tgtacgcttt 11700

gggaacctac ttgatgtacg ctagatacgt tgtgtcctct gtgttggttt acgcttgctt 11760

cttcggagct agatgtggat gggttcaaca tgagggagga cattcttctt tgaccggaaa 11820

catctggtgg gataagagaa tccaagcttt cactgctgga ttcggattgg ctggatctgg 11880

agatatgtgg aactccatgc acaacaagca ccatgctact cctcaaaaag tgaggcacga 11940

tatggatttg gataccactc ctgctgttgc tttcttcaac accgctgtgg aggataatag 12000

acctagggga ttctctaagt actggctcag attgcaagct tggaccttca ttcctgtgac 12060

ttctggattg gtgttgctct tctggatgtt cttcctccat ccttctaagg ctttgaaggg 12120

aggaaagtac gaggagcttg tgtggatgtt ggctgctcat gtgattagaa cctggaccat 12180

taaggctgtt actggattca ccgctatgca atcctacgga ctcttcttgg ctacttcttg 12240

ggtttccgga tgctacttgt tcgctcactt ctctacttct cacacccatt tggatgttgt 12300

tcctgctgat gagcatttgt cttgggttag gtacgctgtg gatcacacca ttgatatcga 12360

tccttctcag ggatgggtta actggttgat gggatacttg aactgccaag tgattcatca 12420

cctcttccct tctatgcctc aattcagaca acctgaggtg tccagaagat tcgttgcttt 12480

cgctaagaag tggaacctca actacaaggt gatgacttat gctggagctt ggaaggctac 12540

tttgggaaac ctcgataatg tgggaaagca ctactacgtg cacggacaac attctggaaa 12600

gaccgcttga taattaatta aggccgcctc gaccgtaccc cctgcagata gactatacta 12660

tgttttagcc tgcctgctgg ctagctacta tgttatgtta tgttgtaaaa taaacacctg 12720

ctaaggtata tctatctata ttttagcatg gctttctcaa taaattgtct ttccttatcg 12780

tttactatct tatacctaat aatgaaataa taatatcaca tatgaggaac ggggcaggtt 12840

taggcatata tatacgagtg tagggcggag tgggggggat cggggggtacc acccagcttt 12900

cttgtacaaa gtggccatga ttacgccaag ctctccaccg cggtggcggc cgctctagcc 12960

caagctttaa ggatgaccta cccattcttg agacaaatgt tacattttag tatcagagta 13020

aaatgtgtac ctataactca aattcgattg acatgtatcc attcaacata aaattaaacc 13080

agcctgcacc tgcatccaca tttcaagtat tttcaaaccg ttcggctcct atccaccggg 13140

tgtaacaaga cggattccga atttggaaga ttttgactca aattcccaat ttatattgac 13200

cgtgactaaa tcaactttaa cttctataat tctgattaag ctcccaattt atattcccaa 13260

cggcactacc tccaaaattt atagactctc atcccctttt aaaccaactt agtaaacgtt 13320

ttttttttaa ttttatgaag ttaagttttt accttgtttt taaaaagaat cgttcataag 13380

atgccatgcc agaacattag ctacacgtta cacatagcat gcagccgcgg agaattgttt 13440

ttcttcgcca cttgtcactc ccttcaaaca cctaagagct tctctctcac agcacacaca 13500

tacaatcaca tgcgtgcatg cattattaca cgtgatcgcc atgcaaatct cctttatagc 13560

ctataaatta actcatcggc ttcactcttt actcaaacca aaactcatca atacaaacaa 13620
gattaaaaac ataaggcgcg ccggatccgc catggctatt ttgaaccctg aggctgattc 13680
tgctgctaac ctcgctactg attctgaggc taagcaaaga caattggctg aggctggata 13740
cactcatgtt gagggtgctc ctgctccttt gcctttggag ttgcctcatt tctctctcag 13800
agatctcaga gctgctattc ctaagcactg cttcgagaga tctttcgtga cctccaccta 13860
ctacatgatc aagaacgtgt tgacttgcgc tgctttgttc tacgctgcta ccttcattga 13920
tagagctgga gctgctgctt atgttttgtg gcctgtgtac tggttcttcc agggatctta 13980
cttgactgga gtgtgggtta tcgctcatga gtgtggacat caggcttatt gctcttctga 14040
ggtggtgaac aacttgattg gactcgtgtt gcattctgct ttgttggtgc cttaccactc 14100
ttggagaatc tctcacagaa agcaccattc caacactgga tcttgcgaga acgatgaggt 14160
tttcgttcct gtgaccagat ctgtgttggc ttcttcttgg aacgagacct tggaggattc 14220
tcctctctac caactctacc gtatcgtgta catgttggtt gttggatgga tgcctggata 14280
cctcttcttc aacgctactg gacctactaa gtactgggga aagtctaggt ctcacttcaa 14340
cccttactcc gctatctatg ctgataggga gagatggatg atcgtgctct ccgatatttt 14400
cttggtggct atgttggctg ttttggctgc tttggtgcac actttctcct tcaacaccat 14460
ggtgaagttc tacgtggtgc cttacttcat tgtgaacgct tacttggtgt tgattaccta 14520
cctccaacac accgatacct acatccctca tttcagagag ggagagtgga attggttgag 14580
aggagctttg tgcactgtgg atagatcatt tggtccattc ctcgattctg tggtgcatag 14640
aatcgtggat acccatgttt gccaccacat cttctccaag atgcctttct atcattgcga 14700
ggaggctacc aacgctatta agcctctcct cggaaagttc tacttgaagg ataccactcc 14760
tgttcctgtt gctctctgga gatcttacac ccattgcaag ttcgttgagg atgatggaaa 14820
ggtggtgttc tacaagaaca agctctagtt aattaaggcc gcctcgagca tgcatctaga 14880
gggcccgcta gcgttaaccc tgctttaatg agatatgcga gacgcctatg atcgcatgat 14940
atttgctttc aattctgttg tgcacgttgt aaaaaacctg agcatgtgta gctcagatcc 15000
ttaccgccgg tttcggttca ttctaatgaa tatatcaccc gttactatcg tatttttatg 15060
aataatattc tccgttcaat ttactgattg tccgtcgagc atatgctaga ggatccccgg 15120
gtacccaact ttattataca tagttgataa ttcactggcc ggatatcttt tttaagggcg 15180
aattctgcag atatccatca cactggcggc cgctcgaggt accatcgttc aaacatttgg 15240
caataaagtt tcttaagatt gaatcctgtt gccggtcttg cgatgattat catataattt 15300
ctgttgaatt acgttaagca tgtaataatt aacatgtaat gcatgacgtt atttatgaga 15360
tgggttttta tgattagagt cccgcaatta tacatttaat acgcgataga aaacaaaata 15420

tagcgcgcaa actaggataa attatcgcgc gcggtgtcat ctatgttact agatcgggca 15480
ttaccctgtt atccctagag gggaaaattc gaatccaaaa attacggata tgaatatagg 15540
catatccgta tccgaattat ccgtttgaca gctagcaacg attgtacaat tgcttcttta 15600
aaaaaggaag aaagaaagaa agaaaagaat caacatcagc gttaacaaac ggccccgtta 15660
cggcccaaac ggtcatatag agtaacggcg ttaagcgttg aaagactcct atcgaaatac 15720
gtaaccgcaa acgtgtcata gtcagatccc ctcttccttc accgcctcaa acacaaaaat 15780
aatcttctac agcctatata tacaaccccc ccttctatct ctcctttctc acaattcatc 15840
atctttcttt ctctaccccc aattttaaga aatcctctct tctcctcttc attttcaagg 15900
taaatctctc tctctctctc tctctctgtt attccttgtt ttaattaggt atgtattatt 15960
gctagtttgt taatctgctt atcttatgta tgccttatgt gaatatcttt atcttgttca 16020
tctcatccgt ttagaagcta taaatttgtt gatttgactg tgtatctaca cgtggttatg 16080
tttatatcta atcagatatg aatttcttca tattgttgcg tttgtgtgta ccaatccgaa 16140
atcgttgatt tttttcattt aatcgtgtag ctaattgtac gtatacatat ggatctacgt 16200
atcaattgtt catctgtttg tgtttgtatg tatacagatc tgaaaacatc acttctctca 16260
tctgattgtg ttgttacata catagatata gatctgttat atcatttttt ttattaattg 16320
tgtatatata tatgtgcata gatctggatt acatgattgt gattatttac atgattttgt 16380
tatttacgta tgtatatatg tagatctgga ctttttggag ttgttgactt gattgtattt 16440
gtgtgtgtat atgtgtgttc tgatcttgat atgttatgta tgtgcagctg aaccatggcg 16500
gcggcaacaa caacaacaac aacatcttct tcgatctcct tctccaccaa accatctcct 16560
tcctcctcca aatcaccatt accaatctcc agattctccc tcccattctc cctaaacccc 16620
aacaaatcat cctcctcctc ccgccgccgc ggtatcaaat ccagctctcc ctcctccatc 16680
tccgccgtgc tcaacacaac caccaatgtc acaaccactc cctctccaac caaacctacc 16740
aaacccgaaa cattcatctc ccgattcgct ccagatcaac cccgcaaagg cgctgatatc 16800
ctcgtcgaag ctttagaacg tcaaggcgta gaaaccgtat tcgcttaccc tggaggtaca 16860
tcaatggaga ttcaccaagc cttaacccgc tcttcctcaa tccgtaacgt ccttcctcgt 16920
cacgaacaag gaggtgtatt cgcagcagaa ggatacgctc gatcctcagg taaaccaggt 16980
atctgtatag ccacttcagg tcccggagct acaaatctcg ttagcggatt agccgatgcg 17040
ttgttagata gtgttcctct tgtagcaatc acaggacaag tccctcgtcg tatgattggt 17100
acagatgcgt ttcaagagac tccgattgtt gaggtaacgc gttcgattac gaagcataac 17160
tatcttgtga tggatgttga agatatccct aggattattg aggaagcttt ctttttagct 17220
acttctggta gacctggacc tgttttggtt gatgttccta aagatattca acaacagctt 17280
gcgattccta attgggaaca ggctatgaga ttacctggtt atatgtctag gatgcctaaa 17340

cctccggaag attctcattt ggagcagatt gttaggttga tttctgagtc taagaagcct 17400

gtgttgtatg ttggtggtgg ttgtttgaat tctagcgatg aattgggtag gtttgttgag 17460

cttacgggga tccctgttgc gagtacgttg atggggctgg gatcttatcc ttgtgatgat 17520

gagttgtcgt tacatatgct tggaatgcat gggactgtgt atgcaaatta cgctgtggag 17580

catagtgatt tgttgttggc gtttggggta aggtttgatg atcgtgtcac gggtaagctt 17640

gaggcttttg ctagtagggc taagattgtt catattgata ttgactcggc tgagattggg 17700

aagaataaga ctcctcatgt gtctgtgtgt ggtgatgtta agctggcttt gcaagggatg 17760

aataaggttc ttgagaaccg agcggaggag cttaagcttg attttggagt ttggaggaat 17820

gagttgaacg tacagaaaca gaagtttccg ttgagcttta agacgtttgg ggaagctatt 17880

cctccacagt atgcgattaa ggtccttgat gagttgactg atggaaaagc cataataagt 17940

actggtgtcg ggcaacatca aatgtgggcg gcgcagttct acaattacaa gaaaccaagg 18000

cagtggctat catcaggagg ccttggagct atgggatttg gacttcctgc tgcgattgga 18060

gcgtctgttg ctaaccctga tgcgatagtt gtggatattg acggagatgg aagctttata 18120

atgaatgtgc aagagctagc cactattcgt gtagagaatc ttccagtgaa ggtactttta 18180

ttaaacaacc agcatcttgg catggttatg caatgggaag atcggttcta caaagctaac 18240

cgagctcaca catttctcgg ggatccggct caggaggacg agatattccc gaacatgttg 18300

ctgtttgcag cagcttgcgg gattccagcg gcgagggtga caaagaaagc agatctccga 18360

gaagctattc agacaatgct ggatacacca ggaccttacc tgttggatgt gatttgtccg 18420

caccaagaac atgtgttgcc gatgatcccg aatggtggca ctttcaacga tgtcataacg 18480

gaaggagatg gccggattaa atactgatag ggataacagg gtaatttccc gacccaagct 18540

ctagatcttg ctgcgttcgg atattttcgt ggagttcccg ccacagaccc ggatgatccc 18600

cgatcgttca aacatttggc aataaagttt cttaagattg aatcctgttg ccggtcttgc 18660

gatgattatc atataatttc tgttgaatta cgttaagcat gtaataatta acatgtaatg 18720

catgacgtta tttatgagat gggtttttat gattagagtc ccgcaattat acatttaata 18780

cgcgatagaa aacaaaatat agcgcgcaaa ctaggataaa ttatcgcgcg cggtgtcatc 18840

tatgttacta gatcgggcct cctgtcaagc tctgcttggt aataattgtc attagattgt 18900

ttttatgcat agatgcactc gaaatcagcc aattttagac aagtatcaaa cggatgttaa 18960

ttcagtacat taaagacgtc cgcaatgtgt tattaagttg tctaagcgtc aatttgttta 19020

caccacaata tatcctgcca ccagccagcc aacagctccc cgaccggcag ctcggcacaa 19080

aatcaccacg cgttaccacc acgccggccg gccgcatggt gttgaccgtg ttcgccggca 19140

ttgccgagtt cgagcgttcc ctaatcatcg accgcacccg gagcgggcgc gaggccgcca 19200 aggcccgagg cgtgaagttt ggcccccgcc ctaccctcac cccggcacag atcgcgcacg 19260

cccgcgagct gatcgaccag gaaggccgca ccgtgaaaga ggcggctgca ctgcttggcg 19320

tgcatcgctc gaccctgtac cgcgcacttg agcgcagcga ggaagtgacg cccaccgagg 19380

ccaggcggcg cggtgccttc cgtgaggacg cattgaccga ggccgacgcc ctggcggccg 19440

ccgagaatga acgccaagag gaacaagcat gaaaccgcac caggacggcc aggacgaacc 19500

gtttttcatt accgaagaga tcgaggcgga gatgatcgcg gccgggtacg tgttcgagcc 19560

gcccgcgcac gtctcaaccg tgcggctgca tgaaatcctg gccggtttgt ctgatgccaa 19620

gctggcggcc tggccggcca gcttggccgc tgaagaaacc gagcgccgcc gtctaaaaag 19680

gtgatgtgta tttgagtaaa acagcttgcg tcatgcggtc gctgcgtata tgatgcgatg 19740

agtaaataaa caaatacgca aggggaacgc atgaaggtta tcgctgtact taaccagaaa 19800

ggcgggtcag gcaagacgac catcgcaacc catctagccc gcgccctgca actcgccggg 19860

gccgatgttc tgttagtcga ttccgatccc cagggcagtg cccgcgattg ggcggccgtg 19920

cgggaagatc aaccgctaac cgttgtcggc atcgaccgcc cgacgattga ccgcgacgtg 19980

aaggccatcg gccggcgcga cttcgtagtg atcgacggag cgccccaggc ggcggacttg 20040

gctgtgtccg cgatcaaggc agccgacttc gtgctgattc cggtgcagcc aagcccttac 20100

gacatatggg ccaccgccga cctggtggag ctggttaagc agcgcattga ggtcacggat 20160

ggaaggctac aagcggcctt tgtcgtgtcg cgggcgatca aaggcacgcg catcggcggt 20220

gaggttgccg aggcgctggc cgggtacgag ctgcccattc ttgagtcccg tatcacgcag 20280

cgcgtgagct acccaggcac tgccgccgcc ggcacaaccg ttcttgaatc agaacccgag 20340

ggcgacgctg cccgcgaggt ccaggcgctg gccgctgaaa ttaaatcaaa actcatttga 20400

gttaatgagg taaagagaaa atgagcaaaa gcacaaacac gctaagtgcc ggccgtccga 20460

gcgcacgcag cagcaaggct gcaacgttgg ccagcctggc agacacgcca gccatgaagc 20520

gggtcaactt tcagttgccg gcggaggatc acaccaagct gaagatgtac gcggtacgcc 20580

aaggcaagac cattaccgag ctgctatctg aatacatcgc gcagctacca gagtaaatga 20640

gcaaatgaat aaatgagtag atgaatttta gcggctaaag gaggcggcat ggaaaatcaa 20700

gaacaaccag gcaccgacgc cgtggaatgc cccatgtgtg gaggaacggg cggttggcca 20760

ggcgtaagcg gctgggttgt ctgccggccc tgcaatggca ctggaacccc caagcccgag 20820

gaatcggcgt gagcggtcgc aaaccatccg gcccggtaca aatcggcgcg gcgctgggtg 20880

atgacctggt ggagaagttg aaggccgcgc aggccgccca gcggcaacgc atcgaggcag 20940

aagcacgccc cggtgaatcg tggcaagcgg ccgctgatcg aatccgcaaa gaatcccggc 21000

aaccgccggc agccggtgcg ccgtcgatta ggaagccgcc caagggcgac gagcaaccag 21060

atttttcgt tccgatgctc tatgacgtgg gcacccgcga tagtcgcagc atcatggacg 21120

tggccgtttt ccgtctgtcg aagcgtgacc gacgagctgg cgaggtgatc cgctacgagc 21180
ttccagacgg gcacgtagag gtttccgcag ggccggccgg catggccagt gtgtgggatt 21240
acgacctggt actgatggcg gtttcccatc taaccgaatc catgaaccga taccgggaag 21300
ggaagggaga caagcccggc cgcgtgttcc gtccacacgt tgcggacgta ctcaagttct 21360
gccggcgagc cgatggcgga aagcagaaag acgacctggt agaaacctgc attcggttaa 21420
acaccacgca cgttgccatg cagcgtacga agaaggccaa gaacggccgc ctggtgacgg 21480
tatccgaggg tgaagccttg attagccgct acaagatcgt aaagagcgaa accgggcggc 21540
cggagtacat cgagatcgag ctagctgatt ggatgtaccg cgagatcaca gaaggcaaga 21600
acccggacgt gctgacggtt caccccgatt actttttgat cgatcccggc atcggccgtt 21660
ttctctaccg cctggcacgc cgcgccgcag gcaaggcaga agccagatgg ttgttcaaga 21720
cgatctacga acgcagtggc agcgccggag agttcaagaa gttctgtttc accgtgcgca 21780
agctgatcgg gtcaaatgac ctgccggagt acgatttgaa ggaggaggcg gggcaggctg 21840
gcccgatcct agtcatgcgc taccgcaacc tgatcgaggg cgaagcatcc gccggttcct 21900
aatgtacgga gcagatgcta gggcaaattg ccctagcagg ggaaaaaggt cgaaaaggtc 21960
tctttcctgt ggatagcacg tacattggga acccaaagcc gtacattggg aaccggaacc 22020
cgtacattgg gaacccaaag ccgtacattg ggaaccggtc acacatgtaa gtgactgata 22080
taaaagagaa aaaaggcgat ttttccgcct aaaactcttt aaaacttatt aaaactctta 22140
aaacccgcct ggcctgtgca taactgtctg gccagcgcac agccgaagag ctgcaaaaag 22200
cgcctaccct tcggtcgctg cgctccctac gccccgccgc ttcgcgtcgg cctatcgcgg 22260
ccgctggccg ctcaaaaatg gctggcctac ggccaggcaa tctaccaggg cgcggacaag 22320
ccgcgccgtc gccactcgac cgccggcgcc cacatcaagg caccctgcct cgcgcgtttc 22380
ggtgatgacg gtgaaaacct ctgacacatg cagctcccgg agacggtcac agcttgtctg 22440
taagcggatg ccgggagcag acaagcccgt cagggcgcgt cagcgggtgt tggcgggtgt 22500
cggggcgcag ccatgaccca gtcacgtagc gatagcggag tgtatactgg cttaactatg 22560
cggcatcaga gcagattgta ctgagagtgc accatatgcg gtgtgaaata ccgcacagat 22620
gcgtaaggag aaaataccgc atcaggcgct cttccgcttc ctcgctcact gactcgctgc 22680
gctcggtcgt tcggctgcgg cgagcggtat cagctcactc aaaggcggta atacggttat 22740
ccacagaatc aggggataac gcaggaaaga acatgtgagc aaaaggccag caaaaggcca 22800
ggaaccgtaa aaaggccgcg ttgctggcgt ttttccatag gctccgcccc cctgacgagc 22860
atcacaaaaa tcgacgctca agtcagaggt ggcgaaaccc gacaggacta taaagatacc 22920
aggcgtttcc ccctggaagc tccctcgtgc gctctcctgt tccgaccctg ccgcttaccg 22980

gatacctgtc cgcctttctc ccttcgggaa gcgtggcgct ttctcatagc tcacgctgta 23040
ggtatctcag ttcggtgtag gtcgttcgct ccaagctggg ctgtgtgcac gaaccccccg 23100
ttcagcccga ccgctgcgcc ttatccggta actatcgtct tgagtccaac ccggtaagac 23160
acgacttatc gccactggca gcagccactg gtaacaggat tagcagagcg aggtatgtag 23220
gcggtgctac agagttcttg aagtggtggc ctaactacgg ctacactaga aggacagtat 23280
ttggtatctg cgctctgctg aagccagtta ccttcggaaa aagagttggt agctcttgat 23340
ccggcaaaca aaccaccgct ggtagcggtg gtttttttgt ttgcaagcag cagattacgc 23400
gcagaaaaaa aggatctcaa gaagatcctt tgatcttttc tacggggtct gacgctcagt 23460
ggaacgaaaa ctcacgttaa gggattttgg tcatgcatga tatatctccc aatttgtgta 23520
gggcttatta tgcacgctta aaaataataa aagcagactt gacctgatag tttggctgtg 23580
agcaattatg tgcttagtgc atctaacgct tgagttaagc cgcgccgcga agcggcgtcg 23640
gcttgaacga atttctagct agacattatt tgccgactac cttggtgatc tcgcctttca 23700
cgtagtggac aaattcttcc aactgatctg cgcgcgaggc caagcgatct tcttcttgtc 23760
caagataagc ctgtctagct tcaagtatga cgggctgata ctgggccggc aggcgctcca 23820
ttgcccagtc ggcagcgaca tccttcggcg cgattttgcc ggttactgcg ctgtaccaaa 23880
tgcgggacaa cgtaagcact acatttcgct catcgccagc ccagtcgggc ggcgagttcc 23940
atagcgttaa ggtttcattt agcgcctcaa atagatcctg ttcaggaacc ggatcaaaga 24000
gttcctccgc cgctggacct accaaggcaa cgctatgttc tcttgctttt gtcagcaaga 24060
tagccagatc aatgtcgatc gtggctggct cgaagatacc tgcaagaatg tcattgcgct 24120
gccattctcc aaattgcagt tcgcgcttag ctggataacg ccacggaatg atgtcgtcgt 24180
gcacaacaat ggtgacttct acagcgcgga gaatctcgct ctctccaggg gaagccgaag 24240
tttccaaaag gtcgttgatc aaagctcgcc gcgttgtttc atcaagcctt acggtcaccg 24300
taaccagcaa atcaatatca ctgtgtggct tcaggccgcc atccactgcg gagccgtaca 24360
aatgtacggc cagcaacgtc ggttcgagat ggcgctcgat gacgccaact acctctgata 24420
gttgagtcga tacttcggcg atcaccgctt cccccatgat gtttaacttt gttttagggc 24480
gactgccctg ctgcgtaaca tcgttgctgc tccataacat caaacatcga cccacggcgt 24540
aacgcgcttg ctgcttggat gcccgaggca tagactgtac cccaaaaaaa cagtcataac 24600
aagccatgaa aaccgccact gcgttccatg g 24631

<210> 39
<211> 24356
<212> DNA
<213> Artificial

<220>

<223> Plant Expression Plasmid

<400> 39

```
tgatcatcta aaaaggtgat gtgtatttga gtaaaacagc ttgcgtcatg cggtcgctgc      60
gtatatgatg cgatgagtaa ataaacaaat acgcaagggg aacgcatgaa ggttatcgct     120
gtacttaacc agaaaggcgg gtcaggcaag acgaccatcg caacccatct agcccgcgcc     180
ctgcaactcg ccggggccga tgttctgtta gtcgattccg atccccaggg cagtgcccgc     240
gattgggcgg ccgtgcggga agatcaaccg ctaaccgttg tcggcatcga ccgcccgacg     300
attgaccgcg acgtgaaggc catcggccgg cgcgacttcg tagtgatcga cggagcgccc     360
caggcggcgg acttggctgt gtccgcgatc aaggcagccg acttcgtgct gattccggtg     420
cagccaagcc cttacgacat ttgggccacc gccgacctgg tggagctggt taagcagcgc     480
attgaggtca cggatggaag gctacaagcg gcctttgtcg tgtcgcgggc gatcaaaggc     540
acgcgcatcg gcggtgaggt tgccgaggcg ctggccgggt acgagctgcc cattcttgag     600
tcccgtatca cgcagcgcgt gagctaccca ggcactgccg ccgccggcac aaccgttctt     660
gaatcagaac ccgagggcga cgctgcccgc gaggtccagg cgctggccgc tgaaattaaa     720
tcaaaactca tttgagttaa tgaggtaaag agaaaatgag caaaagcaca aacacgctaa     780
gtgccggccg tccgagcgca cgcagcagca aggctgcaac gttggccagc ctggcagaca     840
cgccagccat gaagcgggtc aactttcagt tgccggcgga ggatcacacc aagctgaaga     900
tgtacgcggt acgccaaggc aagaccatta ccgagctgct atctgaatac atcgcgcagc     960
taccagagta aatgagcaaa tgaataaatg agtagatgaa ttttagcggc taaaggaggc    1020
ggcatggaaa atcaagaaca accaggcacc gacgccgtgg aatgccccat gtgtggagga    1080
acgggcggtt ggccaggcgt aagcggctgg gttgtctgcc ggccctgcaa tggcactgga    1140
acccccaagc ccgaggaatc ggcgtgagcg gtcgcaaacc atccggcccg gtacaaatcg    1200
gcgcggcgct gggtgatgac ctggtggaga agttgaaggc cgcgcaggcc gcccagcggc    1260
aacgcatcga ggcagaagca cgccccggtg aatcgtggca aggggccgct gatcgaatcc    1320
gcaaagaatc ccggcaaccg ccggcagccg gtgcgccgtc gattaggaag ccgcccaagg    1380
gcgacgagca accagatttt ttcgttccga tgctctatga cgtgggcacc cgcgatagtc    1440
gcagcatcat ggacgtggcc gttttccgtc tgtcgaagcg tgaccgacga gctggcgagg    1500
tgatccgcta cgagcttcca gacgggcacg tagaggtttc cgcaggcccc gccggcatgg    1560
ccagtgtgtg ggattacgac ctggtactga tggcggtttc ccatctaacc gaatccatga    1620
accgataccg ggaagggaag ggagacaagc ccggccgcgt gttccgtcca cacgttgcgg    1680
acgtactcaa gttctgccgg cgagccgatg gcggaaagca gaaagacgac ctggtagaaa    1740
cctgcattcg gttaaacacc acgcacgttg ccatgcagcg taccaagaag gccaagaacg    1800
```

gccgcctggt gacggtatcc gagggtgaag ccttgattag ccgctacaag atcgtaaaga 1860

gcgaaaccgg gcggccggag tacatcgaga tcgagcttgc tgattggatg taccgcgaga 1920

tcacagaagg caagaacccg gacgtgctga cggttcaccc cgattacttt ttgatcgacc 1980

ccggcatcgg ccgttttctc taccgcctgg cacgccgcgc cgcaggcaag gcagaagcca 2040

gatggttgtt caagacgatc tacgaacgca gtggcagcgc cggagagttc aagaagttct 2100

gtttcaccgt gcgcaagctg atcgggtcaa atgacctgcc ggagtacgat ttgaaggagg 2160

aggcggggca ggctggcccg atcctagtca tgcgctaccg caacctgatc gagggcgaag 2220

catccgccgg ttcctaatgt acggagcaga tgctagggca aattgcccta gcaggggaaa 2280

aaggtcgaaa aggtctcttt cctgtggata gcacgtacat tgggaaccca aagccgtaca 2340

ttgggaaccg gaacccgtac attgggaacc caaagccgta cattgggaac cggtcacaca 2400

tgtaagtgac tgatataaaa gagaaaaaag gcgatttttc cgcctaaaac tctttaaaac 2460

ttattaaaac tcttaaaacc cgcctggcct gtgcataact gtctggccag cgcacagccg 2520

aagagctgca aaaagcgcct acccttcggt cgctgcgctc cctacgcccc gccgcttcgc 2580

gtcggcctat cgcggcctat gcggtgtgaa ataccgcaca gatgcgtaag gagaaaatac 2640

cgcatcaggc gctcttccgc ttcctcgctc actgactcgc tgcgctcggt cgttcggctg 2700

cggcgagcgg tatcagctca ctcaaaggcg gtaatacggt tatccacaga atcaggggat 2760

aacgcaggaa agaacatgtg agcaaaaggc cagcaaaagg ccaggaaccg taaaaaggcc 2820

gcgttgctgg cgtttttcca taggctccgc ccccctgacg agcatcacaa aaatcgacgc 2880

tcaagtcaga ggtggcgaaa cccgacagga ctataaagat accaggcgtt tccccctgga 2940

agctccctcg tgcgctctcc tgttccgacc ctgccgctta ccggatacct gtccgccttt 3000

ctcccttcgg gaagcgtggc gctttctcat agctcacgct gtaggtatct cagttcggtg 3060

taggtcgttc gctccaagct gggctgtgtg cacgaacccc ccgttcagcc cgaccgctgc 3120

gccttatccg gtaactatcg tcttgagtcc aacccggtaa gacacgactt atcgccactg 3180

gcagcagcca ctggtaacag gattagcaga gcgaggtatg taggcggtgc tacagagttc 3240

ttgaagtggt ggcctaacta cggctacact agaaggacag tatttggtat ctgcgctctg 3300

ctgaagccag ttaccttcgg aaaaagagtt ggtagctctt gatccggcaa acaaaccacc 3360

gctggtagcg gtggtttttt tgtttgcaag cagcagatta cgcgcagaaa aaaaggatct 3420

caagaagatc ctttgatctt ttctacgggg tcctcaact catcgatagt ttggctgtga 3480

gcaattatgt gcttagtgca tctaacgctt gagttaagcc gcgccgcgaa gcggcgtcgg 3540

cttgaacgaa tttctagcta gacattattt gccaacgacc ttcgtgatct cgcccttgac 3600

atagtggaca aattcttcga gctggtcggc ccgggacgcg agacggtctt cttcttggcc 3660

cagataggct tggcgcgctt cgaggatcac gggctggtat tgcgccggaa ggcgctccat 3720 cgcccagtcg gcggcgacat ccttcggcgc gatcttgccg gtaaccgccg agtaccaaat 3780

ccggctcagc gtaaggacca cattgcgctc atcgcccgcc caatccggcg gggagttcca 3840

cagggtcagc gtctcgttca gtgcttcgaa cagatcctgt tccggcaccg ggtcgaaaag 3900

ttcctcggcc gcggggccga cgagggccac gctatgctcc cgggccttgg tgagcaggat 3960

cgccagatca atgtcgatgg tggccggttc aaagataccc gccagaatat cattacgctg 4020

ccattcgccg aactggagtt cgcgtttggc cggatagcgc caggggatga tgtcatcgtg 4080

caccacaatc gtcacctcaa ccgcgcgcag gatttcgctc tcgccggggg aggcggacgt 4140

ttccagaagg tcgttgataa gcgcgcggcg cgtggtctcg tcgagacgga cggtaacggt 4200

gacaagcagg tcgatgtccg aatggggctt aaggccgccg tcaacggcgc taccatacag 4260

atgcacggcg aggagggtcg gttcgaggtg gcgctcgatg acacccacga cttccgacag 4320

ctgggtggac acctcggcga tgaccgcttc acccatgatg tttaactttg ttttagggcg 4380

actgccctgc tgcgtaacat cgttgctgct ccataacatc aaacatcgac ccacggcgta 4440

acgcgcttgc tgcttggatg cccgaggcat agactgtacc ccaaaaaaac agtcataaca 4500

agccatgaaa accgccactg cgttccatga atattcaaac aaacacatac agcgcgactt 4560

atcatggata ttgacataca aatggacgaa cggataaacc ttttcacgcc cttttaaata 4620

tccgattatt ctaataaacg ctcttttctc ttaggtttac ccgccaatat atcctgtcaa 4680

acactgatag tttaaactga aggcgggaaa cgacaatctg atcactgatt agtaactaag 4740

gcctttaatt aatctagagg cgcgccgggc cccctgcagg gagctcggcc ggccaattta 4800

aattgatatc ggtacatcga ttacgccaag ctatcaactt tgtatagaaa agttgccatg 4860

attacgccaa gcttggcgcg ccctgcagca aatttacaca ttgccactaa acgtctaaac 4920

ccttgtaatt tgtttttgtt ttactatgtg tgttatgtat ttgatttgcg ataaattttt 4980

atatttggta ctaaatttat aacacctttt atgctaacgt ttgccaacac ttagcaattt 5040

gcaagttgat taattgattc taaattattt ttgtcttcta aatacatata ctaatcaact 5100

ggaaatgtaa atatttgcta atatttctac tataggagaa ttaaagtgag tgaatatggt 5160

accacaaggt ttggagattt aattgttgca atgctgcatg gatggcatat acaccaaaca 5220

ttcaataatt cttgaggata ataatggtac cacacaagat ttgaggtgca tgaacgtcac 5280

gtggacaaaa ggtttagtaa tttttcaaga caacaatgtt accacacaca agttttgagg 5340

tgcatgcatg gatgccctgt ggaaagttta aaaatatttt ggaaatgatt tgcatggaag 5400

ccatgtgtaa aaccatgaca tccacttgga ggatgcaata atgaagaaaa ctacaaattt 5460

acatgcaact agttatgcat gtagtctata taatgaggat tttgcaatac tttcattcat 5520

acacactcac taagttttac acgattataa tttcttcata gccagtacca tggaagttgt 5580 tgagaggttc tacggagagt tggatggaaa ggtttcccaa ggagtgaacg ctttgttggg 5640

atctttcgga gttgagttga ctgatacccc aactactaag ggattgccac tcgttgattc 5700

tccaactcca attgtgttgg gagtgtctgt ttacttgacc atcgtgatcg gaggattgct 5760

ttggatcaag gctagagatc tcaagccaag agcttctgag ccattcttgt tgcaagcttt 5820

ggtgttggtg cacaacttgt tctgcttcgc tttgtctctt tacatgtgcg tgggtatcgc 5880

ttaccaagct atcacctgga gatattcctt gtggggaaac gcttataacc caaagcacaa 5940

ggagatggct atcctcgttt acctcttcta catgtccaag tacgtggagt tcatggatac 6000

cgtgatcatg atcctcaaga gatccaccag acagatttct ttcctccacg tgtaccacca 6060

ctcttctatc tcccttatct ggtgggctat tgctcaccac gctccaggag gagaggctta 6120

ttggagtgct gctctcaact ctggagtgca cgtgttgatg tacgcttact acttcttggc 6180

tgcttgcttg agatcttccc caaagctcaa gaacaagtac ctcttctggg gaagatacct 6240

cacccaattc cagatgttcc agttcatgct caacttggtg caagcttact acgatatgaa 6300

aaccaacgct ccatatccac aatggctcat caagatcctc ttctactaca tgatctccct 6360

cttgttcctc ttcggaaact tctacgtgca aaagtacatc aagccatccg atggaaagca 6420

aaagggagct aagaccgagt gatcgacaag ctcgagtttc tccataataa tgtgtgagta 6480

gttcccagat aagggaatta gggttcctat agggtttcgc tcatgtgttg agcatataag 6540

aaacccttag tatgtatttg tatttgtaaa atacttctat caataaaatt tctaattcct 6600

aaaaccaaaa tccagtacta aaatccagat cccccgaatt aattcggcgt taattcaggg 6660

aaacttagca gatatttggt gtctaaatgt ttattttgtg atatgttcat gtttgaaatg 6720

gtggtttcga aaccagggac aacgttggga tctgataggg tgtcaaagag tattatggat 6780

tgggacaatt tcggtcatga gttgcaaatt caagtatatc gttcgattat gaaaattttc 6840

gaagaatatc ccatttgaga gagtctttac ctcattaatg tttttagatt atgaaatttt 6900

atcatagttc atcgtagtct tttggtgta aaggctgtaa aaagaaattg ttcacttttg 6960

ttttcgttta tgtgaaggct gtaaaagatt gtaaaagact attttggtgt tttggataaa 7020

atgatagttt ttatagattc ttttgctttt agaagaaata catttgaaat tttttccatg 7080

ttgagtataa aataccgaaa tcgattgaag atcatagaaa tattttaact gaaaacaaat 7140

ttataactga ttcaattctc tccatttta tacctattta accgtaatcg attctaatag 7200

atgatcgatt ttttatataa tcctaattaa ccaacggcat gtattggata attaaccgat 7260

caactctcac ccctaataga atcagtattt tccttcgacg ttaattgatc ctacactatg 7320

taggtcatat ccatcgtttt aatttttggc caccattcaa ttctgtcttg cctttaggga 7380

tgtgaatatg aacggccaag gtaagagaat aaaaataatc caaattaaag caagagaggc 7440

caagtaagat aatccaaatg tacacttgtc attgccaaaa ttagtaaaat actcggcata 7500

ttgtattccc acacattatt aaaataccgt atatgtattg gctgcatttg catgaataat 7560
actacgtgta agcccaaaag aacccacgtg tagcccatgc aaagttaaca ctcacgaccc 7620
cattcctcag tctccactat ataaacccac catccccaat ctcaccaaac ccaccacaca 7680
actcacaact cactctcaca ccttaaagaa ccaatcacca ccaaaaaacc atgggaaaag 7740
gatctgaggg aagatctgct gctagagaga tgactgctga ggctaacgga gataagagaa 7800
agaccatcct cattgaggga gtgttgtacg atgctaccaa cttcaaacac ccaggaggtt 7860
ccattattaa cttcctcacc gagggagaag ctggagttga tgctacccaa gcttacagag 7920
agttccatca gagatccgga aaggctgata agtacctcaa gtccctccca aagttggatg 7980
cttctaaggt ggagtctagg ttctctgcta aggagcaggc tagaagggac gctatgacca 8040
gggattacgc tgctttcaga gaggagttgg ttgctgaggg atacttcgat ccatctatcc 8100
cacacatgat ctacagagtg gtggagattg tggctttgtt cgctttgtct ttctggttga 8160
tgtctaaggc ttctccaacc tctttggttt tgggagtggt gatgaacgga atcgctcaag 8220
gaagatgcgg atgggttatg cacgagatgg gacacggatc tttcactgga gttatctggc 8280
tcgatgatag gatgtgcgag ttcttctacg gagttggatg tggaatgtct ggacactact 8340
ggaagaacca gcactctaag caccacgctg ctccaaacag attggagcac gatgtggatt 8400
tgaacacctt gccactcgtt gctttcaacg agagagttgt gaggaaggtt aagccaggat 8460
ctttgttggc tttgtggctc agagttcagg cttatttgtt cgctccagtg tcttgcttgt 8520
tgatcggatt gggatggacc ttgtacttgc acccaagata tatgctcagg accaagagac 8580
acatggagtt tgtgtggatc ttcgctagat atatcggatg gttctccttg atgggagctt 8640
tgggatattc tcctggaact tctgtgggaa tgtacctctg ctctttcgga cttggatgca 8700
tctacatctt cctccaattc gctgtgtctc acacccactt gccagttacc aacccagagg 8760
atcaattgca ctggcttgag tacgctgctg atcacaccgt gaacatctct accaagtctt 8820
ggttggttac ctggtggatg tctaacctca acttccaaat cgagcaccac ttgttcccaa 8880
ccgctccaca attcaggttc aaggagatct ctccaagagt tgaggctctc ttcaagagac 8940
acaacctccc ttactacgat ttgccataca cctctgctgt ttctactacc ttcgctaacc 9000
tctactctgt tggacactct gttggagctg ataccaagaa gcaggattga ctgctttaat 9060
gagatatgcg agacgcctat gatcgcatga tatttgcttt caattctgtt gtgcacgttg 9120
taaaaaacct gagcatgtgt agctcagatc cttaccgccg gtttcggttc attctaatga 9180
atatatcacc cgttactatc gtatttttat gaataatatt ctccgttcaa tttactgatt 9240
gtgtcgacgc gatcgcgtgc gcacgggccc cctgcaggat ttaaatcccg gggtacccca 9300
agtttgtaca aaaaagcagg ctccatgatt acgccaagct tggccactaa ggccaattta 9360

aatctactag gccggccatc gacggcccgg actgtatcca acttctgatc tttgaatctc 9420
tctgttccaa catgttctga aggagttcta agacttttca gaaagcttgt aacatgcttt 9480
gtagactttc tttgaattac tcttgcaaac tctgattgaa cctacgtgaa aactgctcca 9540
gaagttctaa ccaaattccg tcttgggaag gcccaaaatt tattgagtac ttcagtttca 9600
tggacgtgtc ttcaaagatt tataacttga aatcccatca tttttaagag aagttctgtt 9660
ccgcaatgtc ttagatctca ttgaaatcta caactcttgt gtcagaagtt cttccagaat 9720
caacttgcat catggtgaaa atctggccag aagttctgaa cttgtcatat ttcttaacag 9780
ttagaaaaat ttctaagtgt ttagaatttt gacttttcca aagcaaactt gacttttgac 9840
tttcttaata aaacaaactt catattctaa catgtcttga tgaaatgtga ttcttgaaat 9900
ttgatgttga tgcaaaagtc aaagtttgac ttttcagtgt gcaattgacc attttgctct 9960
tgtgccaatt ccaaacctaa attgatgtat cagtgctgca aacttgatgt catggaagat 10020
cttatgagaa aattcttgaa gactgagagg aaaaattttg tagtacaaca caaagaatcc 10080
tgtttttcat agtcggacta gacacattaa cataaaacac cacttcattc gaagagtgat 10140
tgaagaagga aatgtgcagt tacctttctg cagttcataa gagcaactta cagacacttt 10200
tactaaaata ctacaaagag gaagatttta acaacttaga gaagtaatgg gagttaaaga 10260
gcaacacatt aaggggagt gttaaaatta atgtgttgta accaccacta cctttagtaa 10320
gtattataag aaaattgtaa tcatcacatt ataattattg tccttattta aaattatgat 10380
aaagttgtat cattaagatt gagaaaacca aatagtcctc gtcttgattt ttgaattatt 10440
gttttctatg ttacttttct tcaagcctat ataaaaactt tgtaatgcta aattgtatgc 10500
tggaaaaaaa tgtgtaatga attgaataga aattatggta tttcaaagtc caaaatccat 10560
caatagaaat ttagtacaaa acgtaactca aaaatattct cttattttaa attttacaac 10620
aatataaaaa tattctctta ttttaaattt tacaataata taatttatca cctgtcacct 10680
ttagaatacc accaacaata ttaatactta gatattttat tcttaataat tttgagatct 10740
ctcaatatat ctgatattta ttttatattt gtgtcatatt ttcttatgtt ttagagttaa 10800
cccttatatc ttggtcaaac tagtaattca atatatgagt ttgtgaagga cacattgaca 10860
tcttgaaaca ttggttttaa ccttgttgga atgttaaagg taataaaaca ttcagaatta 10920
tgaccatcta ttaatatact tcctttgtct tttaaaaaag tgtgcatgaa aatgctctat 10980
ggtaagctag agtgtcttgc tggcctgtgt atatcaattc catttccaga tggtagaaac 11040
tgccactacg aataattagt cataagacac gtatgttaac acacgtcccc ttgcatgttt 11100
tttgccatat attccgtctc tttctttttc ttcacgtata aaacaatgaa ctaattaata 11160
gagcgatcaa gctgaaccct accatgtgtg ttgagaccga gaacaacgat ggaatcccta 11220
ctgtggagat cgctttcgat ggagagagag aaagagctga ggctaacgtg aagttgtctg 11280

ctgagaagat ggaacctgct gctttggcta agaccttcgc tagaagatac gtggttatcg 11340
agggagttga gtacgatgtg accgatttca aacatcctgg aggaaccgtg attttctacg 11400
ctctctctaa cactggagct gatgctactg aggctttcaa ggagttccac cacagatcta 11460
gaaaggctag gaaggctttg gctgctttgc cttctagacc tgctaagacc gctaaagtgg 11520
atgatgctga gatgctccag gatttcgcta agtggagaaa ggagttggag agggacggat 11580
tcttcaagcc ttctcctgct catgttgctt acagattcgc tgagttggct gctatgtacg 11640
ctttgggaac ctacttgatg tacgctagat acgttgtgtc ctctgtgttg gtttacgctt 11700
gcttcttcgg agctagatgt ggatgggttc aacacgaggg aggacactct tctttgaccg 11760
gaaacatctg gtgggataag agaatccaag ctttcactgc tggattcgga ttggctggat 11820
ctggagatat gtggaactcc atgcacaaca agcaccacgc tactcctcaa aaagtgaggc 11880
acgatatgga tttggatacc actcctgctg ttgctttctt caacaccgct gtggaggata 11940
atagacctag gggattctct aagtactggc tcagattgca agcttggacc ttcattcctg 12000
tgacttctgg attggtgttg ctcttctgga tgttcttcct ccacccttct aaggctttga 12060
agggaggaaa gtacgaggag cttgtgtgga tgttggctgc tcacgtgatt agaacctgga 12120
ccattaaggc tgttactgga ttcaccgcta tgcaatccta cggactcttc ttggctactt 12180
cttgggtttc cggatgctac ttgttcgctc acttctctac ttctcacacc cacttggatg 12240
ttgttcctgc tgatgagcac ttgtcttggg ttaggtacgc tgtggatcac accattgata 12300
tcgatccttc tcagggatgg gttaactggt tgatgggata cttgaactgc caagtgattc 12360
accacctctt cccttctatg cctcaattca gacaacctga ggtgtccaga agattcgttg 12420
ctttcgctaa gaagtggaac ctcaactaca aggtgatgac ttatgctgga gcttggaagg 12480
ctactttggg aaacctcgat aatgtgggaa agcactacta cgtgcacgga caacactctg 12540
gaaagaccgc ttgattaatt aaggccgcct cgaccgtacc ccctgcagat agactatact 12600
atgttttagc ctgcctgctg gctagctact atgttatgtt atgttgtaaa ataaacacct 12660
gctaaggtat atctatctat attttagcat ggctttctca ataaattgtc tttccttatc 12720
gtttactatc ttatacctaa taatgaaata ataatatcac atatgaggaa cggggcaggt 12780
ttaggcatat atatacgagt gtagggcgga gtggggggcg cctactaccg gtaattcccg 12840
ggattagcgg ccgctagtct gtgcgcactt gtatcctgca ggttaggccg gccacacggg 12900
caggacatag ggactactac aagcatagta tgcttcagac aaagagctag gaaagaactc 12960
ttgatggagg ttaagagaaa aaagtgctag aggggcatag taatcaaact tgtcaaaacc 13020
gtcatcatga tgagggatga cataatataa aaagttgact aaggtcttgg tagtactctt 13080
tgattagtat tatatattgg tgagaacatg agtcaagagg agacaagaaa ccgaggaacc 13140

atagtttagc aacaagatgg aagttgcaaa gttgagctag ccgctcgatt agttacatct 13200
cctaagcagt actacaagga atggtctcta tactttcatg tttagcacat ggtagtgcgg 13260
attgacaagt tagaaacagt gcttaggaga caaagagtca gtaaaggtat tgaaagagtg 13320
aagttgatgc tcgacaggtc aggagaagtc cctccgccag atggtgacta ccaaggggtt 13380
ggtatcagct gagacccaaa taagattctt cggttgaacc agtggttcga ccgagactct 13440
tagggtggga tttcactgta agatttgtgc attttgttga atataaattg acaatttttt 13500
ttatttaatt atagattatt tagaatgaat tacatattta gtttctaaca aggatagcaa 13560
tggatgggta tgggtacagg ttaaacatat ctattaccca cccatctagt cgtcgggttt 13620
tacacgtacc cacccgttta cataaaccag accggaattt taaaccgtac ccgtccgtta 13680
gcgggtttca gatttacccg tttaatcggg taaaacctga ttactaaata tatatttttt 13740
atttgataaa caaaacaaaa atgttaatat tttcatattg gatgcaattt taagaaacac 13800
atattcataa atttccatat ttgtaggaaa ataaaaagaa aaatatattc aagaacacaa 13860
atttcaccga catgactttt attacagagt tggaattaga tctaacaatt gaaaaattaa 13920
aattaagata gaatatgttg aggaacatga catagtataa tgctgggtta cccgtcgggt 13980
aggtatcgag gcggatacta ctaaatccat cccactcgct atccgataat cactggtttc 14040
gggtataccc attcccgtca acaggccttt ttaaccggat aatttcaact tatagtgaat 14100
gaattttgaa taaatagtta gaataccaaa atcctggatt gcatttgcaa tcaaattttg 14160
tgaaccgtta aattttgcat gtacttggga tagatataat agaaccgaat tttcattagt 14220
ttaatttata acttactttg ttcaaagaaa aaaaatatct atccaattta cttataataa 14280
aaaataatct atccaagtta cttattataa tcaacttgta aaaaggtaag aatacaaatg 14340
tggtagcgta cgtgtgatta tatgtgacga aatgttatat ctaacaaaag tccaaattcc 14400
catggtaaaa aaaatcaaaa tgcatggcag gctgtttgta accttggaat aagatgttgg 14460
ccaattctgg agccgccacg tacgcaagac tcagggccac gttctcttca tgcaaggata 14520
gtagaacacc actccaccca cctcctatat tagacctttg cccaaccctc cccaactttc 14580
ccatcccatc cacaaagaaa ccgacatttt tatcataaat cggcgcgccc taccatggat 14640
gcttataacg ctgctatgga taagattgga gctgctatca tcgattggag tgatccagat 14700
ggaaagttca gagctgatag ggaggattgg tggttgtgcg atttcagatc cgctatcacc 14760
attgctctca tctacatcgc tttcgtgatc ttgggatctg ctgtgatgca atctctccca 14820
gctatggacc catacccctat caagttcctc tacaacgtgt ctcaaatctt cctctgcgct 14880
tacatgactg ttgaggctgg attcctcgct tataggaacg gatacaccgt tatgccatgc 14940
aaccacttca acgtgaacga tccaccagtt gctaacttgc tctggctctt ctacatctcc 15000
aaagtgtggg atttctggga taccatcttc attgtgctcg gaaagaagtg gagacaactc 15060

tctttcttgc acgtgtacca ccacaccacc atcttcctct tctactggtt gaacgctaac 15120

gtgctctacg atggagatat cttcttgacc atcctcctca acggattcat tcacaccgtg 15180

atgtacacct actacttcat ctgcatgcac accaaggatt ctaagaccgg aaagtctttg 15240

ccaatctggt ggaagtcatc tttgaccgct ttccaactct tgcaattcac catcatgatg 15300

tcccaagcta cctacttggt tttccacgga tgcgataagg tttccctcag aatcaccatc 15360

gtgtacttcg tgtacattct ctcccttttc ttcctcttcg ctcagttctt cgtgcaatcc 15420

tacatggctc caaagaagaa gaagtccgct tgatgttaat taaggccgca gatatcagat 15480

ctggtcgacc tagaggatcc ccggccgcaa agataataac aaaagcctac tatataacgt 15540

acatgcaagt attgtatgat attaatgttt ttacgtacgt gtaaacaaaa ataattacgt 15600

ttgtaacgta tggtgatgat gtggtgcact aggtgtaggc cttgtattaa taaaaagaag 15660

tttgttctat atagagtggt ttagtacgac gatttattta ctagtcggat tggaatagag 15720

aaccgaattc ttcaatcctt gcttttgatc aagaattgaa accgaatcaa atgtaaaagt 15780

tgatatattt gaaaaacgta ttgagcttat gaaaatgcta atactctcat ctgtatggaa 15840

aagtgacttt aaaaccgaac ttaaaagtga caaaagggga atatcgcatc aaaccgaatg 15900

aaaccgatgg caaacactgt acggaccgtg gcctaatagg ccggtaccac ccagctttct 15960

tgtacaaagt ggccatgatt acgccaagct tggccactaa ggccaattta aatctactag 16020

gccggccata aggatgacct acccattctt gagacaaatg ttacatttta gtatcagagt 16080

aaaatgtgta cctataactc aaattcgatt gacatgtatc cattcaacat aaaattaaac 16140

cagcctgcac ctgcatccac atttcaagta ttttcaaacc gttcggctcc tatccaccgg 16200

gtgtaacaag acggattccg aatttggaag attttgactc aaattcccaa tttatattga 16260

ccgtgactaa atcaacttta acttctataa ttctgattaa gctcccaatt tatattccca 16320

acggcactac ctccaaaatt tatagactct catccccttt taaaccaact tagtaaacgt 16380

ttttttttta attttatgaa gttaagtttt taccttgttt ttaaaaagaa tcgttcataa 16440

gatgccatgc cagaacatta gctacacgtt acacatagca tgcagccgcg gagaattgtt 16500

tttcttcgcc acttgtcact cccttcaaac acctaagagc ttctctctca cagcacacac 16560

atacaatcac atgcgtgcat gcattattac acgtgatcgc catgcaaatc tcctttatag 16620

cctataaatt aactcatcgg cttcactctt tactcaaacc aaaactcatc aatacaaaca 16680

agattaaaaa caccatgcgc gccggatccg ccatggctat tttgaaccct gaggctgatt 16740

ctgctgctaa cctcgctact gattctgagg ctaagcaaag acaattggct gaggctggat 16800

acactcatgt tgagggtgct cctgctcctt tgcctttgga gttgcctcat ttctctctca 16860

gagatctcag agctgctatt cctaagcact gcttcgagag atctttcgtg acctccacct 16920

actacatgat caagaacgtg ttgacttgcg ctgctttgtt ctacgctgct accttcattg 16980
atagagctgg agctgctgct tatgttttgt ggcctgtgta ctggttcttc cagggatctt 17040
acttgactgg agtgtgggtt atcgctcatg agtgtggaca tcaggcttat tgctcttctg 17100
aggtggtgaa caacttgatt ggactcgtgt tgcattctgc tttgttggtg ccttaccact 17160
cttggagaat ctctcacaga aagcaccatt ccaacactgg atcttgcgag aacgatgagg 17220
ttttcgttcc tgtgaccaga tctgtgttgg cttcttcttg gaacgagacc ttggaggatt 17280
ctcctctcta ccaactctac cgtatcgtgt acatgttggt tgttggatgg atgcctggat 17340
acctcttctt caacgctact ggacctacta agtactgggg aaagtctagg tctcacttca 17400
acccttactc cgctatctat gctgataggg agagatggat gatcgtgctc tccgatattt 17460
tcttggtggc tatgttggct gttttggctg ctttggtgca cactttctcc ttcaacacca 17520
tggtgaagtt ctacgtggtg ccttacttca ttgtgaacgc ttacttggtg ttgattacct 17580
acctccaaca caccgatacc tacatccctc atttcagaga gggagagtgg aattggttga 17640
gaggagcttt gtgcactgtg gatagatcat ttggtccatt cctcgattct gtggtgcata 17700
gaatcgtgga tacccatgtt tgccaccaca tcttctccaa gatgcctttc tatcattgcg 17760
aggaggctac caacgctatt aagcctctcc tcggaaagtt ctacttgaag gataccactc 17820
ctgttcctgt tgctctctgg agatcttaca cccattgcaa gttcgttgag gatgatggaa 17880
aggtggtgtt ctacaagaac aagctctagt taattaataa ttgattggtt cgagtattat 17940
ggcattggga aaactgtttt tcttgtacca tttgttgtgc ttgtaattta ctgtgttttt 18000
tattcggttt tcgctatcga actgtgaaat ggaaatggat ggagaagagt taatgaatga 18060
tatggtcctt ttgttcattc tcaaattaat attatttgtt ttttctctta tttgttgtgt 18120
gttgaatttg aaattataag agatatgcaa acattttgtt ttgagtaaaa atgtgtcaaa 18180
tcgtggcctc taatgaccga agttaatatg aggagtaaaa cacttgtagt tgtaccatta 18240
tgcttattca ctaggcaaca aatatatttt cagacctaga aaagctgcaa atgttactga 18300
atacaagtat gtcctcttgt gttttagaca tttatgaact ttcctttatg taattttcca 18360
gaatccttgt cagattctaa tcattgcttt ataattatag ttatactcat ggatttgtag 18420
ttgagtatga aaatattttt taatgcattt tatgacttgc caattgattg acaacatgca 18480
tcaatggcgc ctactaccgg taattcccgg gattagcggc cgctagtctg tgcgcacttg 18540
tatcctgcag gtcaatcgtt taaacactgt acggaccgtg gcctaatagg ccggtaccca 18600
actttattat acatagttga taattcactg gccggatgta ccgaattcgc ggccgcaagc 18660
ttgtacacta gtacgcgtca attggcgatc gcggatctga gatgaaaccg gtgattatca 18720
gaacctttta tggtctttgt atgcatatgg taaaaaaact tagtttgcaa tttcctgttt 18780
gttttggtaa tttgagtttc ttttagttgt tgatctgcct gctttttggt ttacgtcaga 18840

ctactactgc tgttgttgtt tggtttcctt tctttcattt tataaataaa taatccggtt 18900
cggtttactc cttgtgactg gctcagtttg gttattgcga aatgcgaatg gtaaattgag 18960
taattgaaat tcgttattag ggttctaagc tgttttaaca gtcactgggt taatatctct 19020
cgaatcttgc atggaaaatg ctcttaccat tggtttttaa ttgaaatgtg ctcatatggg 19080
ccgtggtttc caaattaaat aaaactacga tgtcatcgag aagtaaaatc aactgtgtcc 19140
acattatcag ttttgtgtat acgatgaaat agggtaattc aaaatctagc ttgatatgcc 19200
ttttggttca ttttaacctt ctgtaaacat tttttcagat tttgaacaag taaatccaaa 19260
aaaaaaaaaa aaaaatctca actcaacact aaattatttt aatgtataaa agatgcttaa 19320
aacatttggc ttaaaagaaa gaagctaaaa acatagagaa ctcttgtaaa ttgaagtatg 19380
aaaatatact gaattgggta ttatatgaat ttttctgatt taggattcac atgatccaaa 19440
aaggaaatcc agaagcacta atcagacatt ggaagtagga atatttcaaa aagttttttt 19500
tttttaagta agtgacaaaa gcttttaaaa aatagaaaag aaactagtat taaagttgta 19560
aatttaataa acaaaagaaa ttttttatat tttttcattt ctttttccag catgaggtta 19620
tgatggcagg atgtggattt catttttttc cttttgatag ccttttaatt gatctattat 19680
aattgacgaa aaaatattag ttaattatag atatatttta ggtagtatta gcaatttaca 19740
cttccaaaag actatgtaag ttgtaaatat gatgcgttga tctcttcatc attcaatggt 19800
tagtcaaaaa aataaaagct taactagtaa actaaagtag tcaaaaattg tactttagtt 19860
taaaatatta catgaataat ccaaaacgac atttatgtga aacaaaaaca atatagatcc 19920
attaccctgt tatccctaga ggggaaaatt cgaatccaaa aattacggat atgaatatag 19980
gcatatccgt atccgaatta tccgtttgac agctagcaac gattgtacaa ttgcttcttt 20040
aaaaaaggaa gaaagaaaga aagaaaagaa tcaacatcag cgttaacaaa cggccccgtt 20100
acggcccaaa cggtcatata gagtaacggc gttaagcgtt gaaagactcc tatcgaaata 20160
cgtaaccgca aacgtgtcat agtcagatcc cctcttcctt caccgcctca aacacaaaaa 20220
taatcttcta cagcctatat atacaacccc cccttctatc tctcctttct cacaattcat 20280
catctttctt tctctacccc caattttaag aaatcctctc ttctcctctt cattttcaag 20340
gtaaatctct ctctctctct ctctctctgt tattccttgt tttaattagg tatgtattat 20400
tgctagtttg ttaatctgct tatcttatgt atgccttatg tgaatatctt tatcttgttc 20460
atctcatccg tttagaagct ataaatttgt tgatttgact gtgtatctac acgtggttat 20520
gtttatatct aatcagatat gaatttcttc atattgttgc gtttgtgtgt accaatccga 20580
aatcgttgat ttttttcatt taatcgtgta gctaattgta cgtatacata tggatctacg 20640
tatcaattgt tcatctgttt gtgtttgtat gtatacagat ctgaaaacat cacttctctc 20700

atctgattgt gttgttacat acatagatat agatctgtta tatcattttt tttattaatt 20760
gtgtatatat atatgtgcat agatctggat tacatgattg tgattattta catgattttg 20820
ttatttacgt atgtatatat gtagatctgg actttttgga gttgttgact tgattgtatt 20880
tgtgtgtgta tatgtgtgtt ctgatcttga tatgttatgt atgtgcagct gaaccatggc 20940
ggcggcaaca acaacaacaa caacatcttc ttcgatctcc ttctccacca aaccatctcc 21000
ttcctcctcc aaatcaccat taccaatctc cagattctcc ctcccattct ccctaaaccc 21060
caacaaatca tcctcctcct cccgccgccg cggtatcaaa tccagctctc cctcctccat 21120
ctccgccgtg ctcaacacaa ccaccaatgt cacaaccact ccctctccaa ccaaacctac 21180
caaacccgaa acattcatct cccgattcgc tccagatcaa ccccgcaaag gcgctgatat 21240
cctcgtcgaa gctttagaac gtcaaggcgt agaaaccgta ttcgcttacc ctggaggtac 21300
atcaatggag attcaccaag ccttaacccg ctcttcctca atccgtaacg tccttcctcg 21360
tcacgaacaa ggaggtgtat tcgcagcaga aggatacgct cgatcctcag gtaaaccagg 21420
tatctgtata gccacttcag gtcccggagc tacaaatctc gttagcggat tagccgatgc 21480
gttgttagat agtgttcctc ttgtagcaat cacaggacaa gtccctcgtc gtatgattgg 21540
tacagatgcg tttcaagaga ctccgattgt tgaggtaacg cgttcgatta cgaagcataa 21600
ctatcttgtg atggatgttg aagatatccc taggattatt gaggaagctt tctttttagc 21660
tacttctggt agacctggac ctgttttggt tgatgttcct aaagatattc aacaacagct 21720
tgcgattcct aattgggaac aggctatgag attacctggt tatatgtcta ggatgcctaa 21780
acctccggaa gattctcatt tggagcagat tgttaggttg atttctgagt ctaagaagcc 21840
tgtgttgtat gttggtggtg gttgtttgaa ttctagcgat gaattgggta ggtttgttga 21900
gcttacgggg atccctgttg cgagtacgtt gatggggctg ggatcttatc cttgtgatga 21960
tgagttgtcg ttacatatgc ttggaatgca tgggactgtg tatgcaaatt acgctgtgga 22020
gcatagtgat ttgttgttgg cgtttggggt aaggtttgat gatcgtgtca cgggtaagct 22080
tgaggctttt gctagtaggg ctaagattgt tcatattgat attgactcgg ctgagattgg 22140
gaagaataag actcctcatg tgtctgtgtg tggtgatgtt aagctggctt tgcaagggat 22200
gaataaggtt cttgagaacc gagcggagga gcttaagctt gattttggag tttggaggaa 22260
tgagttgaac gtacagaaac agaagtttcc gttgagcttt aagacgtttg gggaagctat 22320
tcctccacag tatgcgatta aggtccttga tgagttgact gatggaaaag ccataataag 22380
tactggtgtc gggcaacatc aaatgtgggc ggcgcagttc tacaattaca agaaaccaag 22440
gcagtggcta tcatcaggag gccttggagc tatgggattt ggacttcctg ctgcgattgg 22500
agcgtctgtt gctaaccctg atgcgatagt tgtggatatt gacggagatg gaagctttat 22560
aatgaatgtg caagagctag ccactattcg tgtagagaat cttccagtga aggtactttt 22620

attaaacaac cagcatcttg gcatggttat gcaatgggaa gatcggttct acaaagctaa 22680
ccgagctcac acatttctcg gggatccggc tcaggaggac gagatattcc cgaacatgtt 22740
gctgtttgca gcagcttgcg ggattccagc ggcgagggtg acaaagaaag cagatctccg 22800
agaagctatt cagacaatgc tggatacacc aggaccttac ctgttggatg tgatttgtcc 22860
gcaccaagaa catgtgttgc cgatgatccc gaatggtggc actttcaacg atgtcataac 22920
ggaaggagat ggccggatta aatactgata gggataacag ggtaatctcg acgagatgaa 22980
accggtgatt atcagaacct tttatggtct ttgtatgcat atggtaaaaa aacttagttt 23040
gcaatttcct gtttgttttg gtaatttgag tttcttttag ttgttgatct gcctgctttt 23100
tggtttacgt cagactacta ctgctgttgt tgtttggttt cctttctttc attttataaa 23160
taaataatcc ggttcggttt actccttgtg actggctcag tttggttatt gcgaaatgcg 23220
aatggtaaat tgagtaattg aaattcgtta ttagggttct aagctgtttt aacagtcact 23280
gggttaatat ctctcgaatc ttgcatggaa aatgctctta ccattggttt ttaattgaaa 23340
tgtgctcata tgggccgtgg tttccaaatt aaataaaact acgatgtcat cgagaagtaa 23400
aatcaactgt gtccacatta tcagttttgt gtatacgatg aaatagggta attcaaaatc 23460
tagcttgata tgccttttgg ttcattttaa ccttctgtaa acatttttc agattttgaa 23520
caagtaaatc caaaaaaaaa aaaaaaaaat ctcaactcaa cactaaatta ttttaatgta 23580
taaaagatgc ttaaaacatt tggcttaaaa gaaagaagct aaaaacatag agaactcttg 23640
taaattgaag tatgaaaata tactgaattg ggtattatat gaatttttct gatttaggat 23700
tcacatgatc caaaaaggaa atccagaagc actaatcaga cattggaagt aggaatattt 23760
caaaaagttt ttttttttta agtaagtgac aaaagctttt aaaaaataga aaagaaacta 23820
gtattaaagt tgtaaattta ataaacaaaa gaaatttttt atattttttc atttcttttt 23880
ccagcatgag gttatgatgg caggatgtgg atttcatttt tttccttttg atagcctttt 23940
aattgatcta ttataattga cgaaaaaata ttagttaatt atagatatat tttaggtagt 24000
attagcaatt tacacttcca aaagactatg taagttgtaa atatgatgcg ttgatctctt 24060
catcattcaa tggttagtca aaaaaataaa agcttaacta gtaaactaaa gtagtcaaaa 24120
attgtacttt agtttaaaat attacatgaa taatccaaaa cgacatttat gtgaaacaaa 24180
aacaatatgt cgaggcgatc gcagtactta atcagtgatc agtaactaaa ttcagtacat 24240
taaagacgtc cgcaatgtgt tattaagttg tctaagcgtc aatttgttta caccacaata 24300
tatcctgcca ccagccagcc aacagctccc cgaccggcag ctcggcacaa aatcac 24356

<210> 40
<211> 27539
<212> DNA

<213> Artificial

<220>
<223> Plant Expression Plasmid

<400> 40
aaaagttgcc atgattacgc caagcttggc cactaaggcc aatttcgcgc cctgcagcaa 60

atttacacat tgccactaaa cgtctaaacc cttgtaattt gtttttgttt tactatgtgt 120

gttatgtatt tgatttgcga taaattttta tatttggtac taaatttata acacctttta 180

tgctaacgtt tgccaacact tagcaatttg caagttgatt aattgattct aaattatttt 240

tgtcttctaa atacatatac taatcaactg gaaatgtaaa tatttgctaa tatttctact 300

ataggagaat taaagtgagt gaatatggta ccacaaggtt tggagattta attgttgcaa 360

tgctgcatgg atggcatata caccaaacat tcaataattc ttgaggataa taatggtacc 420

acacaagatt tgaggtgcat gaacgtcacg tggacaaaag gtttagtaat ttttcaagac 480

aacaatgtta ccacacacaa gttttgaggt gcatgcatgg atgccctgtg gaaagtttaa 540

aaatattttg gaaatgattt gcatggaagc catgtgtaaa accatgacat ccacttggag 600

gatgcaataa tgaagaaaac tacaaattta catgcaacta gttatgcatg tagtctatat 660

aatgaggatt ttgcaatact ttcattcata cacactcact aagttttaca cgattataat 720

ttcttcatag ccagtactgt ttaagcttca ctgtctctga atcggcaaag gtaaacgtat 780

caattattct acaaaccctt ttatttttct tttgaattac cgtcttcatt ggttatatga 840

taacttgata agtaaagctt caataattga atttgatctg tgtttttttg gccttaatac 900

taaatcctta cataagcttt gttgcttctc ctcttgtgag ttgagtgtta agttgtaata 960

atggttcact ttcagcttta gaagaaacca tggaagttgt tgagaggttc tacggagagt 1020

tggatggaaa ggtttcccaa ggagtgaacg ctttgttggg atctttcgga gttgagttga 1080

ctgatacccc aactactaag ggattgccac tcgttgattc tccaactcca attgtgttgg 1140

gagtgtctgt ttacttgacc atcgtgatcg gaggattgct ttggatcaag gctagagatc 1200

tcaagccaag agcttctgag ccattcttgt tgcaagcttt ggtgttggtg cacaacttgt 1260

tctgcttcgc tttgtctctt tacatgtgcg tgggtatcgc ttaccaagct atcacctgga 1320

gatattcctt gtggggaaac gcttataacc caaagcacaa ggagatggct atcctcgttt 1380

acctcttcta catgtccaag tacgtggagt tcatggatac cgtgatcatg atcctcaaga 1440

gatccaccag acagatttct ttcctccacg tgtaccacca ctcttctatc tcccttatct 1500

ggtgggctat tgctcaccac gctccaggag gagaggctta ttggagtgct gctctcaact 1560

ctggagtgca cgtgttgatg tacgcttact acttcttggc tgcttgcttg agatcttccc 1620

caaagctcaa gaacaagtac ctcttctggg gaagatacct cacccaattc cagatgttcc 1680

agttcatgct caacttggtg caagcttact acgatatgaa aaccaacgct ccatatccac 1740

aatggctcat caagatcctc ttctactaca tgatctccct cttgttcctc ttcggaaact 1800
tctacgtgca aaagtacatc aagccatccg atggaaagca aaagggagct aagaccgagt 1860
gatcgacaag ctcgagtttc tccataataa tgtgtgagta gttcccagat aagggaatta 1920
gggttcctat agggtttcgc tcatgtgttg agcatataag aaacccttag tatgtatttg 1980
tatttgtaaa atacttctat caataaaatt tctaattcct aaaaccaaaa tccagtacta 2040
aaatccagat cccccgaatt aattcggcgt taattcaggg ccggccaaag taggcgccta 2100
ctaccggtaa ttcccgggat tagcggccgc tagtctgtgc gcacttgtat cctgcaggtt 2160
aggccggcca ttagcagata tttggtgtct aaatgtttat tttgtgatat gttcatgttt 2220
gaaatggtgg tttcgaaacc agggacaacg ttgggatctg atagggtgtc aaagagtatt 2280
atggattggg acaatttcgg tcatgagttg caaattcaag tatatcgttc gattatgaaa 2340
attttcgaag aatatcccat ttgagagagt ctttacctca ttaatgtttt tagattatga 2400
aattttatca tagttcatcg tagtcttttt ggtgtaaagg ctgtaaaaag aaattgttca 2460
cttttgtttt cgtttatgtg aaggctgtaa aagattgtaa aagactattt tggtgttttg 2520
gataaaatga tagtttttat agattctttt gcttttagaa gaaatacatt tgaaattttt 2580
tccatgttga gtataaaata ccgaaatcga ttgaagatca tagaaatatt ttaactgaaa 2640
acaaatttat aactgattca attctctcca tttttatacc tatttaaccg taatcgattc 2700
taatagatga tcgatttttt atataatcct aattaaccaa cggcatgtat tggataatta 2760
accgatcaac tctcacccct aatagaatca gtattttcct tcgacgttaa ttgatcctac 2820
actatgtagg tcatatccat cgttttaatt tttggccacc attcaattct gtcttgcctt 2880
tagggatgtg aatatgaacg gccaaggtaa gagaataaaa ataatccaaa ttaaagcaag 2940
agaggccaag taagataatc caaatgtaca cttgtcattg ccaaaattag taaaatactc 3000
ggcatattgt attcccacac attattaaaa taccgtatat gtattggctg catttgcatg 3060
aataatacta cgtgtaagcc caaaagaacc cacgtgtagc ccatgcaaag ttaacactca 3120
cgaccccatt cctcagtctc cactatataa acccaccatc cccaatctca ccaaacccac 3180
cacacaactc acaactcact ctcacacctt aaagaaccaa tcaccaccaa aaaatttcac 3240
gatttggaat ttgattcctg cgatcacagg tatgacaggt tagattttgt tttgtatagt 3300
tgtatacata cttctttgtg atgttttgtt tacttaatcg aatttttgga gtgttttaag 3360
gtctctcgtt tagaaatcgt ggaaaatatc actgtgtgtg tgttcttatg attcacagtg 3420
tttatgggtt tcatgttctt tgttttatca ttgaatggga agaaatttcg ttgggataca 3480
aatttctcat gttcttactg atcgttatta ggagtttggg gaaaaaggaa gagttttttt 3540
ggttggttcg agtgattatg aggttatttc tgtatttgat ttatgagtta atggtcgttt 3600

taatgttgta gaccatggga aaaggatctg agggaagatc tgctgctaga gagatgactg 3660
ctgaggctaa cggagataag agaaagacca tcctcattga gggagtgttg tacgatgcta 3720
ccaacttcaa acacccagga ggttccatta ttaacttcct caccgaggga gaagctggag 3780
ttgatgctac ccaagcttac agagagttcc atcagagatc cggaaaggct gataagtacc 3840
tcaagtccct cccaaagttg gatgcttcta aggtggagtc taggttctct gctaaggagc 3900
aggctagaag ggacgctatg accagggatt acgctgcttt cagagaggag ttggttgctg 3960
agggatactt cgatccatct atcccacaca tgatctacag agtggtggag attgtggctt 4020
tgttcgcttt gtctttctgg ttgatgtcta aggcttctcc aacctctttg gttttgggag 4080
tggtgatgaa cggaatcgct caaggaagat gcggatgggt tatgcacgag atgggacacg 4140
gatctttcac tggagttatc tggctcgatg ataggatgtg cgagttcttc tacggagttg 4200
gatgtggaat gtctggacac tactggaaga accagcactc taagcaccac gctgctccaa 4260
acagattgga gcacgatgtg gatttgaaca ccttgccact cgttgctttc aacgagagag 4320
ttgtgaggaa ggttaagcca ggatctttgt tggctttgtg gctcagagtt caggcttatt 4380
tgttcgctcc agtgtcttgc ttgttgatcg gattgggatg gaccttgtac ttgcacccaa 4440
gatatatgct caggaccaag agacacatgg agtttgtgtg gatcttcgct agatatatcg 4500
gatggttctc cttgatggga gctttgggat attctcctgg aacttctgtg ggaatgtacc 4560
tctgctcttt cggacttgga tgcatctaca tcttcctcca attcgctgtg tctcacaccc 4620
acttgccagt taccaaccca gaggatcaat tgcactggct tgagtacgct gctgatcaca 4680
ccgtgaacat ctctaccaag tcttggttgg ttacctggtg gatgtctaac ctcaacttcc 4740
aaatcgagca ccacttgttc ccaaccgctc cacaattcag gttcaaggag atctctccaa 4800
gagttgaggc tctcttcaag agacacaacc tcccttacta cgatttgcca tacacctctg 4860
ctgtttctac taccttcgct aacctctact ctgttggaca ctctgttgga gctgatacca 4920
agaagcagga ttgactgctt taatgagata tgcgagacgc ctatgatcgc atgatatttg 4980
ctttcaattc tgttgtgcac gttgtaaaaa acctgagcat gtgtagctca gatccttacc 5040
gccggtttcg gttcattcta atgaatatat cacccgttac tatcgtattt ttatgaataa 5100
tattctccgt tcaatttact gattgtgtcg acgcgatcgc gtgcaaacac tgtacggacc 5160
gtggcctaat aggccggtac ccaagtttgt acaaaaaagc aggctccatg attacgccaa 5220
gcttggccac taaggccaat ttaaatctac taggccggcc atcgacggcc cggactgtat 5280
ccaacttctg atctttgaat ctctctgttc caacatgttc tgaaggagtt ctaagacttt 5340
tcagaaagct tgtaacatgc tttgtagact ttctttgaat tactcttgca aactctgatt 5400
gaacctacgt gaaaactgct ccagaagttc taaccaaatt ccgtcttggg aaggcccaaa 5460
atttattgag tacttcagtt tcatggacgt gtcttcaaag atttataact tgaaatccca 5520

tcatttttaa gagaagttct gttccgcaat gtcttagatc tcattgaaat ctacaactct 5580
tgtgtcagaa gttcttccag aatcaacttg catcatggtg aaaatctggc cagaagttct 5640
gaacttgtca tatttcttaa cagttagaaa aatttctaag tgtttagaat tttgactttt 5700
ccaaagcaaa cttgactttt gactttctta ataaaacaaa cttcatattc taacatgtct 5760
tgatgaaatg tgattcttga aatttgatgt tgatgcaaaa gtcaaagttt gacttttcag 5820
tgtgcaattg accattttgc tcttgtgcca attccaaacc taaattgatg tatcagtgct 5880
gcaaacttga tgtcatggaa gatcttatga gaaaattctt gaagactgag aggaaaaatt 5940
ttgtagtaca acacaaagaa tcctgttttt catagtcgga ctagacacat taacataaaa 6000
caccacttca ttcgaagagt gattgaagaa ggaaatgtgc agttaccttt ctgcagttca 6060
taagagcaac ttacagacac ttttactaaa atactacaaa gaggaagatt ttaacaactt 6120
agagaagtaa tgggagttaa agagcaacac attaaggggg agtgttaaaa ttaatgtgtt 6180
gtaaccacca ctacctttag taagtattat aagaaaattg taatcatcac attataatta 6240
ttgtccttat ttaaaattat gataaagttg tatcattaag attgagaaaa ccaaatagtc 6300
ctcgtcttga tttttgaatt attgttttct atgttacttt tcttcaagcc tatataaaaa 6360
ctttgtaatg ctaaattgta tgctggaaaa aaatgtgtaa tgaattgaat agaaattatg 6420
gtatttcaaa gtccaaaatc catcaataga aatttagtac aaaacgtaac tcaaaaatat 6480
tctcttattt taaattttac aacaatataa aaatattctc ttattttaaa ttttacaata 6540
atataattta tcacctgtca cctttagaat accaccaaca atattaatac ttagatattt 6600
tattcttaat aattttgaga tctctcaata tatctgatat ttattttata tttgtgtcat 6660
attttcttat gttttagagt taacccttat atcttggtca aactagtaat tcaatatatg 6720
agtttgtgaa ggacacattg acatcttgaa acattggttt taaccttgtt ggaatgttaa 6780
aggtaataaa acattcagaa ttatgaccat ctattaatat acttcctttg tcttttaaaa 6840
aagtgtgcat gaaaatgctc tatggtaagc tagagtgtct tgctggcctg tgtatatcaa 6900
ttccatttcc agatggtaga aactgccact acgaataatt agtcataaga cacgtatgtt 6960
aacacacgtc cccttgcatg ttttttgcca tatattccgt ctctttcttt ttcttcacgt 7020
ataaaacaat gaactaatta atagagcgat caagctgaac tggtgcttaa acactctggt 7080
gagttctagt acttctgcta tgatcgatct cattaccatt tcttaaattt ctctccctaa 7140
atattccgag ttcttgattt ttgataactt caggttttct ctttttgata aatctggtct 7200
ttccattttt ttttttttgt ggttaattta gtttcctatg ttcttcgatt gtattatgca 7260
tgatctgtgt ttggattctg ttagattatg tattggtgaa tatgtatgtg tttttgcatg 7320
tctggttttg gtcttaaaaa tgttcaaatc tgatgatttg attgaagctt ttttagtgtt 7380

ggtttgattc ttctcaaaac tactgttaat ttactatcat gttttccaac tttgattcat 7440
gatgacactt ttgttctgct ttgttataaa attttggttg gtttgatttt gtaattatag 7500
tgtaattttg ttaggaatga acatgtttta atactctgtt ttcgatttgt cacacattcg 7560
aattattaat cgataattta actgaaaatt catggttcta gatcttgttg tcatcagatt 7620
atttgtttcg ataattcatc aaatatgtag tccttttgct gatttgcgac tgtttcattt 7680
tttctcaaaa ttgttttttg ttaagtttat ctaacagtta tcgttgtcaa aagtctcttt 7740
cattttgcaa aatcttcttt tttttttgt ttgtaacttt gttttttaag ctacacattt 7800
agtctgtaaa atagcatcga ggaacagttg tcttagtaga cttgcatgtt cttgtaactt 7860
ctatttgttt cagtttgttg atgactgctt tgattttgta ggtcaaaggc gcgcctacca 7920
tgtgtgttga gaccgagaac aacgatggaa tccctactgt ggagatcgct ttcgatggag 7980
agagagaaag agctgaggct aacgtgaagt tgtctgctga gaagatggaa cctgctgctt 8040
tggctaagac cttcgctaga agatacgtgg ttatcgaggg agttgagtac gatgtgaccg 8100
atttcaaaca tcctggagga accgtgattt tctacgctct ctctaacact ggagctgatg 8160
ctactgaggc tttcaaggag ttccaccaca gatctagaaa ggctaggaag gctttggctg 8220
ctttgccttc tagacctgct aagaccgcta aagtggatga tgctgagatg ctccaggatt 8280
tcgctaagtg gagaaaggag ttggagaggg acggattctt caagccttct cctgctcatg 8340
ttgcttacag attcgctgag ttggctgcta tgtacgcttt gggaacctac ttgatgtacg 8400
ctagatacgt tgtgtcctct gtgttggttt acgcttgctt cttcggagct agatgtggat 8460
gggttcaaca cgagggagga cactcttctt tgaccggaaa catctggtgg gataagagaa 8520
tccaagcttt cactgctgga ttcggattgg ctggatctgg agatatgtgg aactccatgc 8580
acaacaagca ccacgctact cctcaaaaag tgaggcacga tatggatttg gataccactc 8640
ctgctgttgc tttcttcaac accgctgtgg aggataatag acctagggga ttctctaagt 8700
actggctcag attgcaagct tggaccttca ttcctgtgac ttctggattg gtgttgctct 8760
tctggatgtt cttcctccac ccttctaagg ctttgaaggg aggaaagtac gaggagcttg 8820
tgtggatgtt ggctgctcac gtgattagaa cctggaccat taaggctgtt actggattca 8880
ccgctatgca atcctacgga ctcttcttgg ctacttcttg ggtttccgga tgctacttgt 8940
tcgctcactt ctctacttct cacacccact tggatgttgt tcctgctgat gagcacttgt 9000
cttgggttag gtacgctgtg gatcacacca ttgatatcga tccttctcag ggatgggtta 9060
actggttgat gggatacttg aactgccaag tgattcacca cctcttccct tctatgcctc 9120
aattcagaca acctgaggtg tccagaagat tcgttgcttt cgctaagaag tggaacctca 9180
actacaaggt gatgacttat gctggagctt ggaaggctac tttgggaaac ctcgataatg 9240
tgggaaagca ctactacgtg cacggacaac actctggaaa gaccgcttga ttaattaact 9300

aagactccca aaaccacctt ccctgtgaca gttaaaccct gcttatacct ttcctcctaa 9360
taatgttcat ctgtcacaca aactaaaata aataaaatgg gagcaataaa taaaatggga 9420
gctcatatat ttacaccatt tacactgtct attattcacc atgccaatta ttacttcata 9480
attttaaaat tatgtcattt ttaaaaattg cttaatgatg gaaaggatta ttataagtta 9540
aaagtataac atagataaac taaccacaaa acaaatcaat ataaactaac ttactctccc 9600
atctaatttt tatttaaatt tctttacact tctcttccat ttctatttct acaacattat 9660
ttaacatttt tattgtattt ttcttacttt ctaactctat tcatttcaaa aatcaatata 9720
tgtttatcac cacctctcta aaaaaaactt tacaatcatt ggtccagaaa agttaaatca 9780
cgagatggtc attttagcat taaaacaacg attcttgtat cactattttt cagcatgtag 9840
tccattctct tcaaacaaag acagcggcta tataatcgtt gtgttatatt cagtctaaaa 9900
caaggcgcct actaccggta attcccggga ttagcggccg ctagtctgtg cgcacttgta 9960
tcctgcaggt taggccggcc acacgggcag gacataggga ctactacaag catagtatgc 10020
ttcagacaaa gagctaggaa agaactcttg atggaggtta agagaaaaaa gtgctagagg 10080
ggcatagtaa tcaaacttgt caaaaccgtc atcatgatga gggatgacat aatataaaaa 10140
gttgactaag gtcttggtag tactctttga ttagtattat atattggtga gaacatgagt 10200
caagaggaga caagaaaccg aggaaccata gtttagcaac aagatggaag ttgcaaagtt 10260
gagctagccg ctcgattagt tacatctcct aagcagtact acaaggaatg gtctctatac 10320
tttcatgttt agcacatggt agtgcggatt gacaagttag aaacagtgct taggagacaa 10380
agagtcagta aaggtattga aagagtgaag ttgatgctcg acaggtcagg agaagtccct 10440
ccgccagatg gtgactacca aggggttggt atcagctgag acccaaataa gattcttcgg 10500
ttgaaccagt ggttcgaccg agactcttag ggtgggattt cactgtaaga tttgtgcatt 10560
ttgttgaata taaattgaca attttttta tttaattata gattatttag aatgaattac 10620
atatttagtt tctaacaagg atagcaatgg atgggtatgg gtacaggtta aacatatcta 10680
ttacccaccc atctagtcgt cgggttttac acgtacccac ccgtttacat aaaccagacc 10740
ggaattttaa accgtacccg tccgttagcg ggtttcagat ttacccgttt aatcgggtaa 10800
aacctgatta ctaaatatat attttttatt tgataaacaa aacaaaaatg ttaatatttt 10860
catattggat gcaattttaa gaaacacata ttcataaatt tccatatttg taggaaaata 10920
aaaagaaaaa tatattcaag aacacaaatt tcaccgacat gacttttatt acagagttgg 10980
aattagatct aacaattgaa aaattaaaat taagatagaa tatgttgagg aacatgacat 11040
agtataatgc tgggttaccc gtcgggtagg tatcgaggcg gatactacta aatccatccc 11100
actcgctatc cgataatcac tggtttcggg tatacccatt cccgtcaaca ggccttttta 11160

accggataat ttcaacttat agtgaatgaa ttttgaataa atagttagaa taccaaaatc 11220
ctggattgca tttgcaatca aattttgtga accgttaaat tttgcatgta cttgggatag 11280
atataataga accgaatttt cattagttta atttataact tactttgttc aaagaaaaaa 11340
aatatctatc caatttactt ataataaaaa ataatctatc caagttactt attataatca 11400
acttgtaaaa aggtaagaat acaaatgtgg tagcgtacgt gtgattatat gtgacgaaat 11460
gttatatcta acaaaagtcc aaattcccat ggtaaaaaaa atcaaaatgc atggcaggct 11520
gtttgtaacc ttggaataag atgttggcca attctggagc cgccacgtac gcaagactca 11580
gggccacgtt ctcttcatgc aaggatagta gaacaccact ccacccacct cctatattag 11640
acctttgccc aaccctcccc aactttccca tcccatccac aaagaaaccg acatttttat 11700
cataaatcag ggtttcgttt ttgtttcatc gataaactca aaggtgatga ttttagggtc 11760
ttgtgagtgt gctttttttgt ttgattctac tgtagggttt atgttcttta gctcataggt 11820
tttgtgtatt tcttagaaat gtggcttctt taatctctgg gtttgtgact ttttgtgtgg 11880
tttctgtgtt tttcatatca aaaacctatt ttttccgagt ttttttttac aaattcttac 11940
tctcaagctt gaatacttca catgcagtgt tcttttgtag attttagagt taatgtgtta 12000
aaaagtttgg atttttcttg cttatagagc ttcttcactt tgattttgtg ggtttttttg 12060
ttttaaaggt gagatttttg atgaggtttt tgcttcaaag atgtcacctt tctgggtttg 12120
tcttttgaat aaagctatga actgtcacat ggctgacgca attttgttac tatgtcatga 12180
aagctgacgt ttttccgtgt tatacatgtt tgcttacact tgcatgcgtc aaaaaaattg 12240
gggcttttta gttttagtca aagattttac ttctcttttg ggatttatga aggaaagttg 12300
caaactttct caaattttac catttttgct ttgatgtttg tttagattgc gacagaacaa 12360
actcatatat gttgaaattt ttgcttggtt ttgtatagga ttgtgtcttt tgcttataaa 12420
tgttgaaatc tgaacttttt ttttgtttgg tttctttgag caggagataa ggcgcgccct 12480
accatggatg cttataacgc tgctatggat aagattggag ctgctatcat cgattggagt 12540
gatccagatg gaaagttcag agctgatagg gaggattggt ggttgtgcga tttcagatcc 12600
gctatcacca ttgctctcat ctacatcgct ttcgtgatct tgggatctgc tgtgatgcaa 12660
tctctcccag ctatggaccc ataccctatc aagttcctct acaacgtgtc tcaaatcttc 12720
ctctgcgctt acatgactgt tgaggctgga ttcctcgctt ataggaacgg atacaccgtt 12780
atgccatgca accacttcaa cgtgaacgat ccaccagttg ctaacttgct ctggctcttc 12840
tacatctcca aagtgtggga tttctgggat accatcttca ttgtgctcgg aaagaagtgg 12900
agacaactct ctttcttgca cgtgtaccac cacaccacca tcttcctctt ctactggttg 12960
aacgctaacg tgctctacga tggagatatc ttcttgacca tcctcctcaa cggattcatt 13020
cacaccgtga tgtacaccta ctacttcatc tgcatgcaca ccaaggattc taagaccgga 13080

aagtctttgc caatctggtg gaagtcatct ttgaccgctt tccaactctt gcaattcacc 13140

atcatgatgt cccaagctac ctacttggtt ttccacggat gcgataaggt ttccctcaga 13200

atcaccatcg tgtacttcgt gtacattctc tccctttctt tcctcttcgc tcagttcttc 13260

gtgcaatcct acatggctcc aaagaagaag aagtccgctt gatgttaatt aaggccgcag 13320

atatcagatc tggtcgacct agaggatccc cggccgcaaa gataataaca aaagcctact 13380

atataacgta catgcaagta ttgtatgata ttaatgtttt tacgtacgtg taaacaaaaa 13440

taattacgtt tgtaacgtat ggtgatgatg tggtgcacta ggtgtaggcc ttgtattaat 13500

aaaaagaagt ttgttctata tagagtggtt tagtacgacg atttatttac tagtcggatt 13560

ggaatagaga accgaattct tcaatccttg cttttgatca agaattgaaa ccgaatcaaa 13620

tgtaaaagtt gatatatttg aaaaacgtat tgagcttatg aaaatgctaa tactctcatc 13680

tgtatggaaa agtgacttta aaaccgaact taaaagtgac aaaaggggaa tatcgcatca 13740

aaccgaatga aaccgatggc gcctaccggt atcggtccga ttgcggccgc ttaaagggcg 13800

aattcgttta aacactgtac ggaccgtggc ctaataggcc ggtaccaccc agctttcttg 13860

tacaaagtgg ccatgattac gccaagcttg gccactaagg ccaatttaaa tctactaggc 13920

cggccataag gatgacctac ccattcttga gacaaatgtt acattttagt atcagagtaa 13980

aatgtgtacc tataactcaa attcgattga catgtatcca ttcaacataa aattaaacca 14040

gcctgcacct gcatccacat ttcaagtatt ttcaaaccgt tcggctccta tccaccgggt 14100

gtaacaagac ggattccgaa tttggaagat tttgactcaa attcccaatt tatattgacc 14160

gtgactaaat caactttaac ttctataatt ctgattaagc tcccaattta tattcccaac 14220

ggcactacct ccaaaattta tagactctca tcccctttta aaccaactta gtaaacgttt 14280

ttttttaat tttatgaagt taagttttta ccttgttttt aaaaagaatc gttcataaga 14340

tgccatgcca gaacattagc tacacgttac acatagcatg cagccgcgga gaattgtttt 14400

tcttcgccac ttgtcactcc cttcaaacac ctaagagctt ctctctcaca gcacacacat 14460

acaatcacat gcgtgcatgc attattacac gtgatcgcca tgcaaatctc ctttatagcc 14520

tataaattaa ctcatcggct tcactcttta ctcaaaccaa aactcatcaa tacaaacaag 14580

attaaaaaca agttctttgc tttcgaagtt gccgcaacct aaacaggttt ttccttcttc 14640

tttcttctta ttaactacga ccttgtcctt tgcctatgta aaattactag gttttcatca 14700

gttacactga ttaagttcgt tatagtggaa gataaaatgc cctcaaagca ttttgcagga 14760

tatctttgat ttttcaaaga tatggaactg tagagtttga tagtgttctt gaatgtggtt 14820

gcatgaagtt tttttggtct gcatgttatt ttttcctcga aatatgtttt gagtccaaca 14880

agtgattcac ttgggattca gaaagttgtt ttctcaatat gtaacagttt ttttctatgg 14940

agaaaaatca tagggaccgt tggttttggc ttctttaatt ttgagctcag attaaaccca 15000
ttttacccgg tgttcttggc agaattgaaa acagtacgta gtaccgccat ggctattttg 15060
aaccctgagg ctgattctgc tgctaacctc gctactgatt ctgaggctaa gcaaagacaa 15120
ttggctgagg ctggatacac tcatgttgag ggtgctcctg ctcctttgcc tttggagttg 15180
cctcatttct ctctcagaga tctcagagct gctattccta agcactgctt cgagagatct 15240
ttcgtgacct ccacctacta catgatcaag aacgtgttga cttgcgctgc tttgttctac 15300
gctgctacct tcattgatag agctggagct gctgcttatg ttttgtggcc tgtgtactgg 15360
ttcttccagg gatcttactt gactggagtg tgggttatcg ctcatgagtg tggacatcag 15420
gcttattgct cttctgaggt ggtgaacaac ttgattggac tcgtgttgca ttctgctttg 15480
ttggtgcctt accactcttg gagaatctct cacagaaagc accattccaa cactggatct 15540
tgcgagaacg atgaggtttt cgttcctgtg accagatctg tgttggcttc ttcttggaac 15600
gagaccttgg aggattctcc tctctaccaa ctctaccgta tcgtgtacat gttggttgtt 15660
ggatggatgc ctggatacct cttcttcaac gctactggac ctactaagta ctggggaaag 15720
tctaggtctc acttcaaccc ttactccgct atctatgctg atagggagag atggatgatc 15780
gtgctctccg atattttctt ggtggctatg ttggctgttt tggctgcttt ggtgcacact 15840
ttctccttca acaccatggt gaagttctac gtggtgcctt acttcattgt gaacgcttac 15900
ttggtgttga ttacctacct ccaacacacc gatacctaca tccctcattt cagagaggga 15960
gagtggaatt ggttgagagg agctttgtgc actgtggata gatcatttgg tccattcctc 16020
gattctgtgg tgcatagaat cgtggatacc catgtttgcc accacatctt ctccaagatg 16080
cctttctatc attgcgagga ggctaccaac gctattaagc ctctcctcgg aaagttctac 16140
ttgaaggata ccactcctgt tcctgttgct ctctggagat cttacaccca ttgcaagttc 16200
gttgaggatg atggaaaggt ggtgttctac aagaacaagc tctagttaat taataattga 16260
ttggttcgag tattatggca ttgggaaaac tgtttttctt gtaccatttg ttgtgcttgt 16320
aatttactgt gtttttattt cggttttcgc tatcgaactg tgaaatggaa atggatggag 16380
aagagttaat gaatgatatg gtccttttgt tcattctcaa attaatatta tttgtttttt 16440
ctcttatttg ttgtgtgttg aatttgaaat tataagagat atgcaaacat tttgttttga 16500
gtaaaaatgt gtcaaatcgt ggcctctaat gaccgaagtt aatatgagga gtaaaacact 16560
tgtagttgta ccattatgct tattcactag gcaacaaata tattttcaga cctagaaaag 16620
ctgcaaatgt tactgaatac aagtatgtcc tcttgtgttt tagacattta tgaactttcc 16680
tttatgtaat tttccagaat ccttgtcaga ttctaatcat tgctttataa ttatagttat 16740
actcatggat ttgtagttga gtatgaaaat atttttaat gcattttatg acttgccaat 16800
tgattgacaa catgcatcaa tggcgcctac taccggtaat tcccgggatt agcggccgct 16860

agtctgtgcg cacttgtatc ctgcaggtca atcgtttaaa cactgtacgg accgtggcct 16920
aataggccgg tacccaactt tattatacat agttgataat tcactggccg gatgtaccga 16980
attcgcggcc gcaagcttgt acactagtac gcgtcaattg gcgatcgcgg atctgagatg 17040
aaaccggtga ttatcagaac cttttatggt ctttgtatgc atatggtaaa aaaacttagt 17100
ttgcaatttc ctgtttgttt tggtaatttg agtttctttt agttgttgat ctgcctgctt 17160
tttggtttac gtcagactac tactgctgtt gttgtttggt ttcctttctt tcattttata 17220
aataaataat ccggttcggt ttactccttg tgactggctc agtttggtta ttgcgaaatg 17280
cgaatggtaa attgagtaat tgaaattcgt tattagggtt ctaagctgtt ttaacagtca 17340
ctgggttaat atctctcgaa tcttgcatgg aaaatgctct taccattggt ttttaattga 17400
aatgtgctca tatgggccgt ggtttccaaa ttaaataaaa ctacgatgtc atcgagaagt 17460
aaaatcaact gtgtccacat tatcagtttt gtgtatacga tgaaataggg taattcaaaa 17520
tctagcttga tatgcctttt ggttcatttt aaccttctgt aaacattttt tcagattttg 17580
aacaagtaaa tccaaaaaaa aaaaaaaaaa atctcaactc aacactaaat tattttaatg 17640
tataaaagat gcttaaaaca tttggcttaa aagaaagaag ctaaaaacat agagaactct 17700
tgtaaattga agtatgaaaa tatactgaat tgggtattat atgaattttt ctgatttagg 17760
attcacatga tccaaaaagg aaatccagaa gcactaatca gacattggaa gtaggaatat 17820
ttcaaaaagt tttttttttt taagtaagtg acaaaagctt ttaaaaaata gaaaagaaac 17880
tagtattaaa gttgtaaatt taataaacaa aagaaatttt ttatattttt tcatttcttt 17940
ttccagcatg aggttatgat ggcaggatgt ggatttcatt tttttccttt tgatagcctt 18000
ttaattgatc tattataatt gacgaaaaaa tattagttaa ttatagatat attttaggta 18060
gtattagcaa tttacacttc caaaagacta tgtaagttgt aaatatgatg cgttgatctc 18120
ttcatcattc aatggttagt caaaaaaata aaagcttaac tagtaaacta aagtagtcaa 18180
aaattgtact ttagtttaaa atattacatg aataatccaa aacgacattt atgtgaaaca 18240
aaaacaatat agatccatta ccctgttatc cctagagggg aaaattcgaa tccaaaaatt 18300
acggatatga atataggcat atccgtatcc gaattatccg tttgacagct agcaacgatt 18360
gtacaattgc ttctttaaaa aaggaagaaa gaaagaaaga aaagaatcaa catcagcgtt 18420
aacaaacggc cccgttacgg cccaaacggt catatagagt aacggcgtta agcgttgaaa 18480
gactcctatc gaaatacgta accgcaaacg tgtcatagtc agatcccctc ttccttcacc 18540
gcctcaaaca caaaaataat cttctacagc ctatatatac aacccccccct tctatctctc 18600
ctttctcaca attcatcatc tttctttctc tacccccaat tttaagaaat cctctcttct 18660
cctcttcatt ttcaaggtaa atctctctct ctctctctct ctctgttatt ccttgtttta 18720

attaggtatg tattattgct agtttgttaa tctgcttatc ttatgtatgc cttatgtgaa 18780
tatctttatc ttgttcatct catccgttta gaagctataa atttgttgat ttgactgtgt 18840
atctacacgt ggttatgttt atatctaatc agatatgaat ttcttcatat tgttgcgttt 18900
gtgtgtacca atccgaaatc gttgattttt ttcatttaat cgtgtagcta attgtacgta 18960
tacatatgga tctacgtatc aattgttcat ctgtttgtgt ttgtatgtat acagatctga 19020
aaacatcact tctctcatct gattgtgttg ttacatacat agatatagat ctgttatatc 19080
atttttttta ttaattgtgt atatatatat gtgcatagat ctggattaca tgattgtgat 19140
tatttacatg attttgttat ttacgtatgt atatatgtag atctggactt tttggagttg 19200
ttgacttgat tgtatttgtg tgtgtatatg tgtgttctga tcttgatatg ttatgtatgt 19260
gcagctgaac catggcggcg gcaacaacaa caacaacaac atcttcttcg atctccttct 19320
ccaccaaacc atctccttcc tcctccaaat caccattacc aatctccaga ttctccctcc 19380
cattctccct aaaccccaac aaatcatcct cctcctcccg ccgccgcggt atcaaatcca 19440
gctctccctc ctccatctcc gccgtgctca acacaaccac caatgtcaca accactccct 19500
ctccaaccaa acctaccaaa cccgaaacat tcatctcccg attcgctcca gatcaacccc 19560
gcaaaggcgc tgatatcctc gtcgaagctt tagaacgtca aggcgtagaa accgtattcg 19620
cttaccctgg aggtacatca atggagattc accaagcctt aacccgctct tcctcaatcc 19680
gtaacgtcct tcctcgtcac gaacaaggag gtgtattcgc agcagaagga tacgctcgat 19740
cctcaggtaa accaggtatc tgtatagcca cttcaggtcc cggagctaca aatctcgtta 19800
gcggattagc cgatgcgttg ttagatagtg ttcctcttgt agcaatcaca ggacaagtcc 19860
ctcgtcgtat gattggtaca gatgcgtttc aagagactcc gattgttgag gtaacgcgtt 19920
cgattacgaa gcataactat cttgtgatgg atgttgaaga tatccctagg attattgagg 19980
aagctttctt tttagctact tctggtagac ctggacctgt tttggttgat gttcctaaag 20040
atattcaaca acagcttgcg attcctaatt gggaacaggc tatgagatta cctggttata 20100
tgtctaggat gcctaaacct ccggaagatt ctcatttgga gcagattgtt aggttgattt 20160
ctgagtctaa gaagcctgtg ttgtatgttg gtggtggttg tttgaattct agcgatgaat 20220
tgggtaggtt tgttgagctt acggggatcc ctgttgcgag tacgttgatg gggctgggat 20280
cttatccttg tgatgatgag ttgtcgttac atatgcttgg aatgcatggg actgtgtatg 20340
caaattacgc tgtggagcat agtgatttgt tgttggcgtt tggggtaagg tttgatgatc 20400
gtgtcacggg taagcttgag gcttttgcta gtagggctaa gattgttcat attgatattg 20460
actcggctga gattgggaag aataagactc ctcatgtgtc tgtgtgtggt gatgttaagc 20520
tggctttgca agggatgaat aaggttcttg agaaccgagc ggaggagctt aagcttgatt 20580
ttggagtttg gaggaatgag ttgaacgtac agaaacagaa gtttccgttg agctttaaga 20640

cgtttgggga agctattcct ccacagtatg cgattaaggt ccttgatgag ttgactgatg 20700
gaaaagccat aataagtact ggtgtcgggc aacatcaaat gtgggcggcg cagttctaca 20760
attacaagaa accaaggcag tggctatcat caggaggcct tggagctatg ggatttggac 20820
ttcctgctgc gattggagcg tctgttgcta accctgatgc gatagttgtg gatattgacg 20880
gagatggaag ctttataatg aatgtgcaag agctagccac tattcgtgta gagaatcttc 20940
cagtgaaggt acttttatta aacaaccagc atcttggcat ggttatgcaa tgggaagatc 21000
ggttctacaa agctaaccga gctcacacat ttctcgggga tccggctcag gaggacgaga 21060
tattcccgaa catgttgctg tttgcagcag cttgcgggat tccagcggcg agggtgacaa 21120
agaaagcaga tctccgagaa gctattcaga caatgctgga tacaccagga ccttacctgt 21180
tggatgtgat ttgtccgcac caagaacatg tgttgccgat gatcccgaat ggtggcactt 21240
tcaacgatgt cataacggaa ggagatggcc ggattaaata ctgataggga taacagggta 21300
atctcgacga gatgaaaccg gtgattatca gaacctttta tggtctttgt atgcatatgg 21360
taaaaaaact tagtttgcaa tttcctgttt gttttggtaa tttgagtttc ttttagttgt 21420
tgatctgcct gctttttggt ttacgtcaga ctactactgc tgttgttgtt tggtttcctt 21480
tctttcattt tataaataaa taatccggtt cggtttactc cttgtgactg gctcagtttg 21540
gttattgcga aatgcgaatg gtaaattgag taattgaaat tcgttattag ggttctaagc 21600
tgttttaaca gtcactgggt taatatctct cgaatcttgc atggaaaatg ctcttaccat 21660
tggtttttaa ttgaaatgtg ctcatatggg ccgtggtttc caaattaaat aaaactacga 21720
tgtcatcgag aagtaaaatc aactgtgtcc acattatcag ttttgtgtat acgatgaaat 21780
agggtaattc aaaatctagc ttgatatgcc ttttggttca ttttaacctt ctgtaaacat 21840
tttttcagat tttgaacaag taaatccaaa aaaaaaaaaa aaaaatctca actcaacact 21900
aaattatttt aatgtataaa agatgcttaa aacatttggc ttaaaagaaa gaagctaaaa 21960
acatagagaa ctcttgtaaa ttgaagtatg aaaatatact gaattgggta ttatatgaat 22020
ttttctgatt taggattcac atgatccaaa aaggaaatcc agaagcacta atcagacatt 22080
ggaagtagga atatttcaaa aagttttttt tttttaagta agtgacaaaa gcttttaaaa 22140
aatagaaaag aaactagtat taaagttgta aatttaataa acaaaagaaa ttttttatat 22200
tttttcattt ctttttccag catgaggtta tgatggcagg atgtggattt catttttttc 22260
cttttgatag ccttttaatt gatctattat aattgacgaa aaaatattag ttaattatag 22320
atatatttta ggtagtatta gcaatttaca cttccaaaag actatgtaag ttgtaaatat 22380
gatgcgttga tctcttcatc attcaatggt tagtcaaaaa aataaaagct taactagtaa 22440
actaaagtag tcaaaaattg tactttagtt taaaatatta catgaataat ccaaaacgac 22500

atttatgtga aacaaaaaca atatgtcgag gcgatcgcag tacttaatca gtgatcagta 22560
actaaattca gtacattaaa gacgtccgca atgtgttatt aagttgtcta agcgtcaatt 22620
tgtttacacc acaatatatc ctgccaccag ccagccaaca gctccccgac cggcagctcg 22680
gcacaaaatc actgatcatc taaaaaggtg atgtgtattt gagtaaaaca gcttgcgtca 22740
tgcggtcgct gcgtatatga tgcgatgagt aaataaacaa atacgcaagg ggaacgcatg 22800
aaggttatcg ctgtacttaa ccagaaaggc gggtcaggca agacgaccat cgcaacccat 22860
ctagcccgcg ccctgcaact cgccggggcc gatgttctgt tagtcgattc cgatccccag 22920
ggcagtgccc gcgattgggc ggccgtgcgg gaagatcaac cgctaaccgt tgtcggcatc 22980
gaccgcccga cgattgaccg cgacgtgaag gccatcggcc ggcgcgactt cgtagtgatc 23040
gacggagcgc cccaggcggc ggacttggct gtgtccgcga tcaaggcagc cgacttcgtg 23100
ctgattccgg tgcagccaag cccttacgac atttgggcca ccgccgacct ggtggagctg 23160
gttaagcagc gcattgaggt cacggatgga aggctacaag cggcctttgt cgtgtcgcgg 23220
gcgatcaaag gcacgcgcat cggcggtgag gttgccgagg cgctggccgg gtacgagctg 23280
cccattcttg agtcccgtat cacgcagcgc gtgagctacc caggcactgc cgccgccggc 23340
acaaccgttc ttgaatcaga acccgagggc gacgctgccc gcgaggtcca ggcgctggcc 23400
gctgaaatta aatcaaaact catttgagtt aatgaggtaa agagaaaatg agcaaaagca 23460
caaacacgct aagtgccggc cgtccgagcg cacgcagcag caaggctgca acgttggcca 23520
gcctggcaga cacgccagcc atgaagcggg tcaactttca gttgccggcg gaggatcaca 23580
ccaagctgaa gatgtacgcg gtacgccaag gcaagaccat taccgagctg ctatctgaat 23640
acatcgcgca gctaccagag taaatgagca aatgaataaa tgagtagatg aattttagcg 23700
gctaaaggag gcggcatgga aaatcaagaa caaccaggca ccgacgccgt ggaatgcccc 23760
atgtgtggag gaacgggcgg ttggccaggc gtaagcggct gggttgtctg ccggccctgc 23820
aatggcactg gaacccccaa gcccgaggaa tcggcgtgag cggtcgcaaa ccatccggcc 23880
cggtacaaat cggcgcggcg ctgggtgatg acctggtgga gaagttgaag gccgcgcagg 23940
ccgcccagcg gcaacgcatc gaggcagaag cacgccccgg tgaatcgtgg caaggggccg 24000
ctgatcgaat ccgcaaagaa tcccggcaac cgccggcagc cggtgcgccg tcgattagga 24060
agccgcccaa gggcgacgag caaccagatt ttttcgttcc gatgctctat gacgtgggca 24120
cccgcgatag tcgcagcatc atggacgtgg ccgttttccg tctgtcgaag cgtgaccgac 24180
gagctggcga ggtgatccgc tacgagcttc cagacgggca cgtagaggtt tccgcaggcc 24240
ccgccggcat ggccagtgtg tgggattacg acctggtact gatggcggtt tcccatctaa 24300
ccgaatccat gaaccgatac cgggaaggga agggagacaa gcccggccgc gtgttccgtc 24360
cacacgttgc ggacgtactc aagttctgcc ggcgagccga tggcggaaag cagaaagacg 24420

acctggtaga aacctgcatt cggttaaaca ccacgcacgt tgccatgcag cgtaccaaga 24480
aggccaagaa cggccgcctg gtgacggtat ccgagggtga agccttgatt agccgctaca 24540
agatcgtaaa gagcgaaacc gggcggccgg agtacatcga gatcgagctt gctgattgga 24600
tgtaccgcga gatcacagaa ggcaagaacc cggacgtgct gacggttcac cccgattact 24660
ttttgatcga ccccggcatc ggccgttttc tctaccgcct ggcacgccgc gccgcaggca 24720
aggcagaagc cagatggttg ttcaagacga tctacgaacg cagtggcagc gccggagagt 24780
tcaagaagtt ctgtttcacc gtgcgcaagc tgatcgggtc aaatgacctg ccggagtacg 24840
atttgaagga ggaggcgggg caggctggcc cgatcctagt catgcgctac cgcaacctga 24900
tcgagggcga agcatccgcc ggttcctaat gtacggagca gatgctaggg caaattgccc 24960
tagcagggga aaaaggtcga aaaggtctct ttcctgtgga tagcacgtac attgggaacc 25020
caaagccgta cattgggaac cggaacccgt acattgggaa cccaaagccg tacattggga 25080
accggtcaca catgtaagtg actgatataa aagagaaaaa aggcgatttt tccgcctaaa 25140
actctttaaa acttattaaa actcttaaaa cccgcctggc ctgtgcataa ctgtctggcc 25200
agcgcacagc cgaagagctg caaaaagcgc ctacccttcg gtcgctgcgc tccctacgcc 25260
ccgccgcttc gcgtcggcct atcgcggcct atgcggtgtg aaataccgca cagatgcgta 25320
aggagaaaat accgcatcag gcgctcttcc gcttcctcgc tcactgactc gctgcgctcg 25380
gtcgttcggc tgcggcgagc ggtatcagct cactcaaagg cggtaatacg gttatccaca 25440
gaatcagggg ataacgcagg aaagaacatg tgagcaaaag gccagcaaaa ggccaggaac 25500
cgtaaaaagg ccgcgttgct ggcgtttttc cataggctcc gcccccctga cgagcatcac 25560
aaaaatcgac gctcaagtca gaggtggcga aacccgacag gactataaag ataccaggcg 25620
tttccccctg gaagctccct cgtgcgctct cctgttccga ccctgccgct taccggatac 25680
ctgtccgcct ttctcccttc gggaagcgtg gcgctttctc atagctcacg ctgtaggtat 25740
ctcagttcgg tgtaggtcgt tcgctccaag ctgggctgtg tgcacgaacc ccccgttcag 25800
cccgaccgct gcgccttatc cggtaactat cgtcttgagt ccaacccggt aagacacgac 25860
ttatcgccac tggcagcagc cactggtaac aggattagca gagcgaggta tgtaggcggt 25920
gctacagagt tcttgaagtg gtggcctaac tacggctaca ctagaaggac agtatttggt 25980
atctgcgctc tgctgaagcc agttaccttc ggaaaaagag ttggtagctc ttgatccggc 26040
aaacaaacca ccgctggtag cggtggtttt tttgtttgca agcagcagat tacgcgcaga 26100
aaaaaaggat ctcaagaaga tcctttgatc ttttctacgg ggtccttcaa ctcatcgata 26160
gtttggctgt gagcaattat gtgcttagtg catctaacgc ttgagttaag ccgcgccgcg 26220
aagcggcgtc ggcttgaacg aatttctagc tagacattat ttgccaacga ccttcgtgat 26280

ctcgcccttg acatagtgga caaattcttc gagctggtcg gcccgggacg cgagacggtc 26340

ttcttcttgg cccagatagg cttggcgcgc ttcgaggatc acgggctggt attgcgccgg 26400

aaggcgctcc atcgcccagt cggcggcgac atccttcggc gcgatcttgc cggtaaccgc 26460

cgagtaccaa atccggctca gcgtaaggac cacattgcgc tcatcgcccg cccaatccgg 26520

cggggagttc cacagggtca gcgtctcgtt cagtgcttcg aacagatcct gttccggcac 26580

cgggtcgaaa agttcctcgg ccgcggggcc gacgagggcc acgctatgct cccgggcctt 26640

ggtgagcagg atcgccagat caatgtcgat ggtggccggt tcaaagatac ccgccagaat 26700

atcattacgc tgccattcgc cgaactggag ttcgcgtttg gccggatagc gccaggggat 26760

gatgtcatcg tgcaccacaa tcgtcacctc aaccgcgcgc aggatttcgc tctcgccggg 26820

ggaggcggac gtttccagaa ggtcgttgat aagcgcgcgg cgcgtggtct cgtcgagacg 26880

gacggtaacg gtgacaagca ggtcgatgtc cgaatggggc ttaaggccgc cgtcaacggc 26940

gctaccatac agatgcacgg cgaggagggt cggttcgagg tggcgctcga tgacacccac 27000

gacttccgac agctgggtgg acacctcggc gatgaccgct tcacccatga tgtttaactt 27060

tgttttaggg cgactgccct gctgcgtaac atcgttgctg ctccataaca tcaaacatcg 27120

acccacggcg taacgcgctt gctgcttgga tgcccgaggc atagactgta ccccaaaaaa 27180

acagtcataa caagccatga aaaccgccac tgcgttccat gaatattcaa acaaacacat 27240

acagcgcgac ttatcatgga tattgacata caaatggacg aacggataaa ccttttcacg 27300

ccctttaaa tatccgatta ttctaataaa cgctcttttc tcttaggttt acccgccaat 27360

atatcctgtc aaacactgat agtttaaact gaaggcggga aacgacaatc tgatcactga 27420

ttagtaacta aggcctttaa ttaatctaga ggcgcgccgg gccccctgca gggagctcgg 27480

ccggccaatt taaattgata tcggtacatc gattacgcca agctatcaac tttgtatag 27539

<210> 41
<211> 161
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 41
aagcttggcc actaaggcca atttaaatct actaggccgg ccaaagtagg cgcctactac 60

cggtaattcc cgggattagc ggccgctagt ctgtgcgcac ttgtatcctg caggtcaatc 120

gtttaaacac tgtacggacc gtggcctaat aggccggtac c 161

<210> 42
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 42
tggtgcttaa acactctggt gagt   24

<210> 43
<211> 26
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 43
tttgacctac aaaatcaaag cagtca   26

<210> 44
<211> 22
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 44
agttctttgc tttcgaagtt gc   22

<210> 45
<211> 23
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 45
tactacgtac tgttttcaat tct   23

<210> 46
<211> 25
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 46
atttccacac gctttctatc atttc   25

<210> 47
<211> 30
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 47
ttatctctct ctaaaaaata aaaacgaatc 30

<210> 48
<211> 21
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 48
gtccagaatt ttctccattg a 21

<210> 49
<211> 22
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 49
tcttcactat ccaaagctct ca 22

<210> 50
<211> 25
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 50
gtctactttc attacagtga ctctg 25

<210> 51
<211> 27
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 51
ttatatttta cctgcaacac aattcaa 27

<210> 52
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 52
cactcgaata ctgcatgcaa 20

<210> 53
<211> 26
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 53
ttatgtagcc tttacacaga aaacaa 26

<210> 54
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 54
aacaactatg gcctgagggt 20

<210> 55
<211> 32
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 55
ttatcttact gtttttaacc aaaaaataaa at 32

<210> 56
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 56
atcttagggt ttcgcgagat ctca 24

<210> 57
<211> 30
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 57
tgctaagcta tctctgttaa tataaaattg 30

<210> 58

<211> 22
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 58
atttttgttg gtgaaaggta ga 22

<210> 59
<211> 25
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 59
ttacgttttt gtctctgctt cttct 25

<210> 60
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 60
tctgggaaat atcgattttg atct 24

<210> 61
<211> 21
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 61
tctcaccaca tcccaaagct c 21

<210> 62
<211> 23
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 62
gcacaatctt agcttacctt gaa 23

<210> 63
<211> 25
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 63
ttatttaatc cacaagcctt gcctc 25

<210> 64
<211> 17
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 64
tgtcggagaa gtgggcg 17

<210> 65
<211> 15
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 65
agaagtgggc ggacg 15

<210> 66
<211> 25
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 66
tagcttaatc tcagattcga atcgt 25

<210> 67
<211> 28
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 67
tagtatctac ataccaatca tacaaatg 28

<210> 68
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 68
tttcacgatt tggaatttga 20

<210> 69
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 69
tctacaacat taaaacgacc atta 24

<210> 70
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 70
agggtttcgt ttttgtttca 20

<210> 71
<211> 23
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 71
ttatctcctg ctcaaagaaa cca 23

<210> 72
<211> 21
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 72
agaagctcat ttcttcgata c 21

<210> 73
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 73
tctctgcgca aaaattcacc 20

<210> 74
<211> 19
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 74
tctaaaaata cagggcacc 19

<210> 75
<211> 23
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 75
ttactcttcg ttgcagaagc cta 23

<210> 76
<211> 21
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 76
actgtttaag cttcactgtc t 21

<210> 77
<211> 20
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 77
tttcttctaa agctgaaagt 20

<210> 78
<211> 27
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 78
ttaagctttt aagaatctct actcaca 27

<210> 79

<211> 29
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 79
ttaaatttta cctgtcatca aaaacaaca 29

<210> 80
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 80
tcgacggccc ggactgtatc caac 24

<210> 81
<211> 48
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 81
actcaccaga gtgtttaagc accagttcag cttgatcgct ctattaat 48

<210> 82
<211> 48
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 82
attaatagag cgatcaagct gaactggtgc ttaaacactc tggtgagt 48

<210> 83
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 83
taaggatgac ctacccattc ttga 24

<210> 84
<211> 46
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 84
gcaacttcga aagcaaagaa cttgttttta atcttgtttg tattga   46

<210> 85
<211> 46
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 85
tcaatacaaa caagattaaa aacaagttct ttgctttcga agttgc   46

<210> 86
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 86
ttagcagata tttggtgtct aaat   24

<210> 87
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 87
tcaaattcca aatcgtgaaa ttttttggtg gtgattggtt cttt   44

<210> 88
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 88
aaagaaccaa tcaccaccaa aaaatttcac gatttggaat ttga   44

<210> 89
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 89
cacgggcagg acatagggac tact 24

<210> 90
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 90
tgaaacaaaa acgaaaccct gatttatgat aaaaatgtcg gttt 44

<210> 91
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 91
aaaccgacat ttttatcata aatcagggtt tcgtttttgt ttca 44

<210> 92
<211> 24
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 92
ctgcagcaaa tttacacatt gcca 24

<210> 93
<211> 45
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 93
agacagtgaa gcttaaacag tactggctat gaagaaatta taatc 45

<210> 94
<211> 45
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 94
gattataatt tcttcatagc cagtactgtt taagcttcac tgtct 45

<210> 95
<211> 1197
<212> DNA
<213> Phytophtora sojae

<400> 95
atggctattt tgaaccctga ggctgattct gctgctaacc tcgctactga ttctgaggct 60

aagcaaagac aattggctga ggctggatac actcatgttg agggtgctcc tgctcctttg 120

cctttggagt tgcctcattt ctctctcaga gatctcagag ctgctattcc taagcactgc 180

ttcgagagat ctttcgtgac ctccacctac tacatgatca agaacgtgtt gacttgcgct 240

gctttgttct acgctgctac cttcattgat agagctggag ctgctgctta tgttttgtgg 300

cctgtgtact ggttcttcca gggatcttac ttgactggag tgtgggttat cgctcatgag 360

tgtggacatc aggcttattg ctcttctgag gtggtgaaca acttgattgg actcgtgttg 420

cattctgctt tgttggtgcc ttaccactct tggagaatct ctcacagaaa gcaccattcc 480

aacactggat cttgcgagaa cgatgaggtt ttcgttcctg tgaccagatc tgtgttggct 540

tcttcttgga acgagacctt ggaggattct cctctctacc aactctaccg tatcgtgtac 600

atgttggttg ttggatggat gcctggatac ctcttcttca acgctactgg acctactaag 660

tactggggaa agtctaggtc tcacttcaac ccttactccg ctatctatgc tgatagggag 720

agatggatga tcgtgctctc cgatattttc ttggtggcta tgttggctgt tttggctgct 780

ttggtgcaca ctttctcctt caacaccatg gtgaagttct acgtggtgcc ttacttcatt 840

gtgaacgctt acttggtgtt gattacctac ctccaacaca ccgataccta catccctcat 900

ttcagagagg gagagtggaa ttggttgaga ggagctttgt gcactgtgga tagatcattt 960

ggtccattcc tcgattctgt ggtgcataga atcgtggata cccatgtttg ccaccacatc 1020

ttctccaaga tgcctttcta tcattgcgag gaggctacca acgctattaa gcctctcctc 1080

ggaaagttct acttgaagga taccactcct gttcctgttg ctctctggag atcttacacc 1140

cattgcaagt tcgttgagga tgatggaaag gtggtgttct acaagaacaa gctctag 1197

<210> 96
<211> 1371
<212> DNA
<213> Ostreococcus tauri

<400> 96
atgtgtgttg agaccgagaa caacgatgga atccctactg tggagatcgc tttcgatgga 60

gagagagaaa gagctgaggc taacgtgaag ttgtctgctg agaagatgga acctgctgct 120

ttggctaaga ccttcgctag aagatacgtg gttatcgagg gagttgagta cgatgtgacc 180

gatttcaaac atcctggagg aaccgtgatt ttctacgctc tctctaacac tggagctgat 240 gctactgagg ctttcaagga gttccaccac agatctagaa aggctaggaa ggctttggct 300

gctttgcctt ctagacctgc taagaccgct aaagtggatg atgctgagat gctccaggat 360

ttcgctaagt ggagaaagga gttggagagg gacggattct tcaagccttc tcctgctcat 420

gttgcttaca gattcgctga gttggctgct atgtacgctt tgggaaccta cttgatgtac 480

gctagatacg ttgtgtcctc tgtgttggtt tacgcttgct tcttcggagc tagatgtgga 540

tgggttcaac acgagggagg acactcttct ttgaccggaa acatctggtg ggataagaga 600

atccaagctt tcactgctgg attcggattg gctggatctg gagatatgtg gaactccatg 660

cacaacaagc accacgctac tcctcaaaaa gtgaggcacg atatggattt ggataccact 720

cctgctgttg ctttcttcaa caccgctgtg gaggataata gacctagggg attctctaag 780

tactggctca gattgcaagc ttggaccttc attcctgtga cttctggatt ggtgttgctc 840

ttctggatgt tcttcctcca cccttctaag gctttgaagg gaggaaagta cgaggagctt 900

gtgtggatgt tggctgctca cgtgattaga acctggacca ttaaggctgt tactggattc 960

accgctatgc aatcctacgg actcttcttg gctacttctt gggtttccgg atgctacttg 1020

ttcgctcact tctctacttc tcacacccac ttggatgttg ttcctgctga tgagcacttg 1080

tcttgggtta ggtacgctgt ggatcacacc attgatatcg atccttctca gggatgggtt 1140

aactggttga tgggatactt gaactgccaa gtgattcacc acctcttccc ttctatgcct 1200

caattcagac aacctgaggt gtccagaaga ttcgttgctt tcgctaagaa gtggaacctc 1260

aactacaagg tgatgactta tgctggagct tggaaggcta ctttgggaaa cctcgataat 1320

gtgggaaagc actactacgt gcacggacaa cactctggaa agaccgcttg a 1371

<210> 97
<211> 1371
<212> DNA
<213> Ostreococcus tauri

<400> 97
atgtgtgttg agaccgagaa caacgatgga atccctactg tggagatcgc tttcgatgga 60

gagagagaaa gagctgaggc taacgtgaag ttgtctgctg agaagatgga acctgctgct 120

ttggctaaga ccttcgctag aagatacgtg gttatcgagg gagttgagta cgatgtgacc 180

gatttcaaac atcctggagg aaccgtgatt ttctacgctc tctctaacac tggagctgat 240

gctactgagg ctttcaagga gttccaccac agatctagaa aggctaggaa ggctttggct 300

gctttgcctt ctagacctgc taagaccgct aaagtggatg atgctgagat gctccaggat 360

ttcgctaagt ggagaaagga gttggagagg gacggattct tcaagccttc tcctgctcat 420

gttgcttaca gattcgctga gttggctgct atgtacgctt tgggaaccta cttgatgtac 480

gctagatacg ttgtgtcctc tgtgttggtt tacgcttgct tcttcggagc tagatgtgga 540 tgggttcaac atgagggagg acattcttct ttgaccggaa acatctggtg ggataagaga 600

atccaagctt tcactgctgg attcggattg gctggatctg gagatatgtg gaactccatg 660

cacaacaagc accatgctac tcctcaaaaa gtgaggcacg atatggattt ggataccact 720

cctgctgttg ctttcttcaa caccgctgtg gaggataata gacctagggg attctctaag 780

tactggctca gattgcaagc ttggaccttc attcctgtga cttctggatt ggtgttgctc 840

ttctggatgt tcttcctcca tccttctaag gctttgaagg gaggaaagta cgaggagctt 900

gtgtggatgt tggctgctca tgtgattaga acctggacca ttaaggctgt tactggattc 960

accgctatgc aatcctacgg actcttcttg gctacttctt gggtttccgg atgctacttg 1020

ttcgctcact tctctacttc tcacacccat ttggatgttg ttcctgctga tgagcatttg 1080

tcttgggtta ggtacgctgt ggatcacacc attgatatcg atccttctca gggatgggtt 1140

aactggttga tgggatactt gaactgccaa gtgattcatc acctcttccc ttctatgcct 1200

caattcagac aacctgaggt gtccagaaga ttcgttgctt tcgctaagaa gtggaacctc 1260

aactacaagg tgatgactta tgctggagct tggaaggcta ctttgggaaa cctcgataat 1320

gtgggaaagc actactacgt gcacggacaa cattctggaa agaccgcttg a 1371

<210> 98
<211> 1569
<212> DNA
<213> Pythium irregulare

<400> 98
atggttgatt tgaagccagg agtgaagaga ttggtttcct ggaaggagat tagagagcac 60

gctactccag ctactgcttg gattgtgatc caccacaagg tgtacgatat ctccaagtgg 120

gattctcatc caggtggaag tgtgatgttg actcaggctg gagaggatgc tactgatgct 180

ttcgctgtgt tccatccatc ttccgctttg aagctcttgg agcagttcta cgtaagtttc 240

tgcttctacc tttgatatat atataataat tatcattaat tagtagtaat ataatatttc 300

aaatattttt ttcaaaataa aagaatgtag tatatagcaa ttgcttttct gtagtttata 360

agtgtgtata ttttaattta taacttttct aatatatgac caaaatttgt tgatgtgcag 420

gtaggagatg tggatgagac ttccaaggct gagattgagg gagaaccagc ttctgatgag 480

gagagagcta gaagagagag gatcaacgag ttcatcgctt cttacagaag gctcagggtt 540

aaggttaagg gaatgggact ctacgatgct tctgctcttt actacgcttg gaagctcgtt 600

tctaccttcg gaattgctgt gctctctatg gctatctgct tcttcttcaa ctccttcgct 660

atgtacatgg tggctggagt tattatggga ctcttctacc aacaatctgg atggcttgct 720

cacgatttct tgcacaacca ggtgtgcgag aacagaactt tgggaaactt gatcggatgc 780

cttgttggaa atgcttggca gggattctct atgcaatggt ggaagaacaa gcacaacttg 840 caccacgctg tgccaaactt gcactccgct aaggatgagg gattcatcgg agatccagat 900

atcgatacca tgccattgct tgcttggtct aaggagatgg ctagaaaggc tttcgagtct 960

gctcacggac cattcttcat caggaaccag gctttcttgt acttcccatt gctcttgttg 1020

gctagattgt cttggctcgc tcagtctttc ttctacgtgt tcaccgagtt ctcattcgga 1080

atcttcgata aggtggagtt cgatggacca gaaaaggctg gattgatcgt gcactacatc 1140

tggcaactcg ctattccata cttctgcaac atgtccttgt tcgagggagt tgcttacttc 1200

ttgatgggac aagcttcttg cggattgctt ttggctctcg tgttctctat tggacacaac 1260

ggaatgtctg tgtacgagag agagaccaag ccagatttct ggcaattgca agtgactacc 1320

accagaaaca ttagggcttc cgtgttcatg gattggttca ccggaggact caactaccaa 1380

atcgatcacc acttgttccc attggtgcca agacacaact tgccaaaggt gaacgtgttg 1440

atcaagtctc tctgcaagga gttcgatatc ccattccacg agactggatt ctgggaggga 1500

atctacgagg ttgtggatca cctcgctgat atctctaagg agttcatcac tgagttccca 1560

gctatgtga 1569

<210> 99
<211> 873
<212> DNA
<213> Physcomitrella patens

<400> 99
atggaagttg ttgagaggtt ctacggagag ttggatggaa aggtttccca aggagtgaac 60

gctttgttgg gatctttcgg agttgagttg actgataccc caactactaa gggattgcca 120

ctcgttgatt ctccaactcc aattgtgttg ggagtgtctg tttacttgac catcgtgatc 180

ggaggattgc tttggatcaa ggctagagat ctcaagccaa gagcttctga gccattcttg 240

ttgcaagctt tggtgttggt gcacaacttg ttctgcttcg ctttgtctct ttacatgtgc 300

gtgggtatcg cttaccaagc tatcacctgg agatattcct tgtggggaaa cgcttataac 360

ccaaagcaca aggagatggc tatcctcgtt tacctcttct acatgtccaa gtacgtggag 420

ttcatggata ccgtgatcat gatcctcaag agatccacca gacagatttc tttcctccac 480

gtgtaccacc actcttctat ctcccttatc tggtgggcta ttgctcacca cgctccagga 540

ggagaggctt attggagtgc tgctctcaac tctggagtgc acgtgttgat gtacgcttac 600

tacttcttgg ctgcttgctt gagatcttcc ccaaagctca agaacaagta cctcttctgg 660

ggaagatacc tcacccaatt ccagatgttc cagttcatgc tcaacttggt gcaagcttac 720

tacgatatga aaaccaacgc tccatatcca caatggctca tcaagatcct cttctactac 780

atgatctccc tcttgttcct cttcggaaac ttctacgtgc aaaagtacat caagccatcc 840

gatggaaagc aaaagggagc taagaccgag tga 873

<210> 100
<211> 819
<212> DNA
<213> Thalassiosira pseudonana

<400> 100
atggatgctt ataacgctgc tatggataag attggagctg ctatcatcga ttggagtgat 60

ccagatggaa agttcagagc tgatagggag gattggtggt tgtgcgattt cagatccgct 120

atcaccattg ctctcatcta catcgctttc gtgatcttgg gatctgctgt gatgcaatct 180

ctcccagcta tggacccata ccctatcaag ttcctctaca acgtgtctca aatcttcctc 240

tgcgcttaca tgactgttga ggctggattc ctcgcttata ggaacggata caccgttatg 300

ccatgcaacc acttcaacgt gaacgatcca ccagttgcta acttgctctg gctcttctac 360

atctccaaag tgtgggattt ctgggatacc atcttcattg tgctcggaaa gaagtggaga 420

caactctctt tcttgcacgt gtaccaccac accaccatct tcctcttcta ctggttgaac 480

gctaacgtgc tctacgatgg agatatcttc ttgaccatcc tcctcaacgg attcattcac 540

accgtgatgt acacctacta cttcatctgc atgcacacca aggattctaa gaccggaaag 600

tctttgccaa tctggtggaa gtcatctttg accgctttcc aactcttgca attcaccatc 660

atgatgtccc aagctaccta cttggttttc cacggatgcg ataaggtttc cctcagaatc 720

accatcgtgt acttcgtgta cattctctcc cttttcttcc tcttcgctca gttcttcgtg 780

caatcctaca tggctccaaa gaagaagaag tccgcttga 819

<210> 101
<211> 1320
<212> DNA
<213> Thraustochytrium ssp.

<400> 101
atgggaaaag gatctgaggg aagatctgct gctagagaga tgactgctga ggctaacgga 60

gataagagaa agaccatcct cattgaggga gtgttgtacg atgctaccaa cttcaaacac 120

ccaggaggtt ccattattaa cttcctcacc gagggagaag ctggagttga tgctacccaa 180

gcttacagag agttccatca gagatccgga aaggctgata agtacctcaa gtccctccca 240

aagttggatg cttctaaggt ggagtctagg ttctctgcta aggagcaggc tagaagggac 300

gctatgacca gggattacgc tgctttcaga gaggagttgg ttgctgaggg atacttcgat 360

ccatctatcc cacacatgat ctacagagtg gtggagattg tggctttgtt cgctttgtct 420

ttctggttga tgtctaaggc ttctccaacc tctttggttt tgggagtggt gatgaacgga 480

atcgctcaag gaagatgcgg atgggttatg cacgagatgg gacacggatc tttcactgga 540

gttatctggc tcgatgatag gatgtgcgag ttcttctacg gagttggatg tggaatgtct 600

ggacactact ggaagaacca gcactctaag caccacgctg ctccaaacag attggagcac 660 gatgtggatt tgaacacctt gccactcgtt gctttcaacg agagagttgt gaggaaggtt 720

aagccaggat ctttgttggc tttgtggctc agagttcagg cttatttgtt cgctccagtg 780

tcttgcttgt tgatcggatt gggatggacc ttgtacttgc acccaagata tatgctcagg 840

accaagagac acatggagtt tgtgtggatc ttcgctagat atatcggatg gttctccttg 900

atgggagctt tgggatattc tcctggaact tctgtgggaa tgtacctctg ctctttcgga 960

cttggatgca tctacatctt cctccaattc gctgtgtctc acacccactt gccagttacc 1020

aacccagagg atcaattgca ctggcttgag tacgctgctg atcacaccgt gaacatctct 1080

accaagtctt ggttggttac ctggtggatg tctaacctca acttccaaat cgagcaccac 1140

ttgttcccaa ccgctccaca attcaggttc aaggagatct ctccaagagt tgaggctctc 1200

ttcaagagac acaacctccc ttactacgat ttgccataca cctctgctgt ttctactacc 1260

ttcgctaacc tctactctgt tggacactct gttggagctg ataccaagaa gcaggattga 1320

<210> 102
<211> 903
<212> DNA
<213> Ostreococcus tauri

<400> 102
atgtctgcta gcggagcttt gttgcctgct atagctttcg ctgcttacgc ttacgctacc 60

tacgcttatg ctttcgagtg gagccacgct aacggaatcg ataacgtgga tgctagagag 120

tggattggag ctttgtcttt gagactccct gcaattgcaa ccacaatgta cctcttgttc 180

tgccttgtgg gacctagatt gatggctaag agggaggctt ttgatcctaa gggatttatg 240

ctcgcttaca acgcttacca aaccgctttc aacgttgtgg tgctcggaat gttcgctaga 300

gagatctctg gattgggaca acctgtttgg ggatctacta tgccttggag cgataggaag 360

tccttcaaga ttttgttggg agtgtggctc cactacaaca ataagtacct cgagttgttg 420

gatactgtgt tcatggtggc taggaaaaag accaagcagc tctctttctt gcacgtgtac 480

caccacgctt tgttgatttg ggcttggtgg cttgtttgtc acctcatggc taccaacgat 540

tgcatcgatg cttatttcgg agctgcttgc aactctttca tccacatcgt gatgtactcc 600

tactacctca tgtctgcttt gggaattagg tgcccttgga agagatatat cacccaggct 660

cagatgttgc aattcgtgat cgtgttcgct cacgctgttt tcgtgctcag acaaaagcac 720

tgccctgtta ctttgccttg ggcacaaatg ttcgtgatga caaatatgtt ggtgctcttc 780

ggaaacttct acctcaaggc ttactctaac aagtctaggg gagatggagc ttcttctgtt 840

aagcctgctg agactactag agcaccttct gtgagaagaa ccaggtcaag gaagatcgat 900

tga 903

<210> 103
<211> 1560
<212> DNA
<213> Traustochytrium ssp.

<400> 103
atgactgttg gatacgacga ggagatccca ttcgagcaag ttagggctca taacaagcca 60

gacgacgctt ggtgtgctat tcacggacac gtgtacgacg ttaccaagtt cgcttcagtt 120

cacccaggag gagatattat cttgctcgct gctggaaagg aagctactgt cctctacgag 180

acctaccatg ttagaggagt gtctgacgct gtgctcagaa agtacagaat aggaaagttg 240

ccagacggac aaggaggagc taacgagaag gagaagagaa ccttgtctgg attgtcctct 300

gcttcttact acacctggaa ctccgatttc tacagagtga tgagggagag agttgtggct 360

agattgaagg agagaggaaa ggctagaaga ggaggatacg aactctggat caaggctttc 420

ttgctccttg ttggattctg gtcctctctt tactggatgt gcaccctcga tccatctttc 480

ggagctatct tggctgctat gtctttggga gtgttcgctg cttttgttgg aacctgcatc 540

caacacgatg gaaaccacgg agctttcgct caatctagat gggttaacaa ggtggcagga 600

tggactttgg atatgatcgg agcttctgga atgacttggg agttccaaca cgtgttggga 660

caccacccat acactaactt gatcgaggag gagaacggat tgcaaaaggt gtccggaaag 720

aagatggata ccaagttggc tgatcaagag tctgatccag atgtgttctc cacctaccca 780

atgatgagat tgcacccttg gcaccagaag aggtggtatc acaggttcca gcacatctac 840

ggacctttca tcttcggatt catgaccatc aacaaggtgg tgactcaaga tgttggagtg 900

gtgttgagaa agagactctt ccaaatcgat gctgagtgca gatatgcttc cccaatgtac 960

gttgctaggt tctggattat gaaggctttg accgtgttgt atatggttgc tttgccttgt 1020

tatatgcaag gaccttggca cggattgaaa ctcttcgcta tcgctcactt cacttgcgga 1080

gaggttttgg ctaccatgtt catcgtgaac cacattatcg agggagtgtc ttacgcttct 1140

aaggatgctg ttaagggaac tatggctcca ccaaagacta tgcacggagt gaccccaatg 1200

aacaacacta gaaaggaggt tgaggctgag gcttctaagt ctggagctgt ggttaagtct 1260

gtgccattgg atgattgggc tgctgttcag tgccaaacct ctgtgaactg gtctgttgga 1320

tcttggtttt ggaaccactt ctctggagga ctcaaccacc aaatcgagca ccacctcttc 1380

ccaggattgt ctcacgagac ctactaccac atccaagacg tggttcaatc tacctgtgct 1440

gagtacggag ttccatacca acacgagcca tctttgtgga ctgcttactg gaagatgctc 1500

gaacacctta gacaattggg aaacgaggag actcacgagt catggcagag agctgcttga 1560

<210> 104
<211> 1563
<212> DNA
<213> Phythophtora infestance

<400> 104
atgaactgcc agcgtcatcc aacacacgtc gcacatgaca tcaccttcgg cagcatcctt 60

gccatcctcg ccgcgcagcc tcccattcct gtttctgcct cgcatttggc actcatggct 120

tctcacgttg tctcgtcgct gagtaatgca gccactccgc tgcgattcac cttgttaaac 180

cagcagctca cacaactctc ggagctcgta ggggttccag tggaccaact acgttgcgtc 240

gcttgcctgt tagctgtcta cccattggca cttatcgtgc gcaagttgcc gtcggtcaca 300

gctaagcatt ggctgcacat ttgcgctggt gtgagcatcg cccaattcgt ctatggaaca 360

ggatggctac actcgcttct atcctcgctg gtcacgtacg cgttggtgtg cgtgctgccg 420

cccaaacgcg caccgttcgt ggtgtttctc gccaatatgt tgtttgtggc ggcactgcac 480

atccaccgta tgcgagtcaa ctatatgggc tggagtatgg actcgacagc gagtcagatg 540

ctgctgctca tcaagctcac gagcttcgcc ttcaactacc acgatggtgt tgttcccagt 600

gccacagcag tgcagaacgg cgactcagag cacacgaaaa gagtcaagca gttgcgtaaa 660

caactggcga tcccacagat cccgtcactg ctggagtttt tgggcttcgt ctactgcttc 720

acgacgttcc tggccggtcc ggcatttgag tacaaagagt acagcgacgc tattcaccag 780

gctaggttcg tcgacaacaa cggtgtccga cgtaatgtgt cccctgcgcg tgcggcaatg 840

tccaagttgg tattgggtct tggacttatg ggacttttgg tgcagttcgg agctctagcc 900

gacttgaatc agattttgaa cgatgagaat cagtccatgc tcatgaagtg gggcgacta 960

tttgtcgcgt tgttcttgac tcgtgccaag tattacgtgg cgtggaaact ggcggagggg 1020

gcgactgtgc tgaccggaac gggattcgaa ggattcgacg agcagaacaa ccccaaaggc 1080

tgggatggtg tcagtaatgt ggacatcctg ggcttcgaac tcggcgccaa cgtgcgtgag 1140

atctcgcgtg cttggaacaa gggcacgcag aactggctgg agcgttatgt gtacacacgc 1200

acgggcaact cgttgcttgc cacgtactct gtatcggctc tgtggcacgg attctaccct 1260

ggttactatc tcttcttcct cacggtgccg cttgcgacgt ctgtgaatcg cctggcgcga 1320

cgtcacgtgc gtccgtacgt tgtggacagc ccgctgaagc cactctacga cctcgtcggt 1380

atgatctgta ctgctttggt cgtcaactac ttggccgtct cgttcgtagt gctgtcgtgg 1440

gaggacgcag ttgctggttt ccgctccatg cgctttactg gccacgtcgg gcttgtgggc 1500

tgctacttgt tgctcacctt tgtgcctatc aagaagactg cgaacagtaa gaagaccttg 1560

taa 1563

<210> 105
<211> 1371
<212> DNA
<213> Phythophtora infestance

<400> 105

atggaccgcg tcgtggactt tgtggagcac ctgcagccgt acacggagct tgccactcct 60

ttggacttca gtttcctcca tgcaaaagtg gacgagctgt ccgtgtcgct cggtctgggc 120

agcgaccagc tctgctacgt cctctgccta ttcgctgcgt atccgctggc tgttgtgtac 180

aaactgctac ccggtgccag cctcaagcac gtgtttgatg tggtgctagg tgtgagcatc 240

gctcagttcg tgctgggctc cggctgggtg cactcgttca tctcgagctt cctgacgtac 300

ctgatcgtta agttcgggcc atccaagcac gcgccaggca tcgtgttcct cttcaacatg 360

ctatacatgt cagcgtcaca catctaccgt ttgtatgtgg actacatggg ttggacgctg 420

gacttcaccg gcccgcagat gctgctggtc atcaagctca ccagcttcgc ctacaactac 480

tacgacggcg tggtggacaa gacgtttgag aagaaaggtg ccgagatgtc cccccggcata 540

aagaaagtgt acgaaggacg tcagaagctc gctatccagg agatcccgtc tctgctcgag 600

ttcttcggct acgtgtacag cttcaccacc ttcctggccg gcccggcgtt cgagatccgc 660

gagtatttgg acgtgacgag cggcaaaaag ttccttatgg acggcaagaa caaagagccg 720

tcgagtgtgc tcgctgcgtt ctctaaattc ctggtgggat cgctgttgat ggctgcgttc 780

gctgtgtatg gccccatgta cccgctgtcg aacctgcacg accccaagat cgctgcgcag 840

ccgttgctgt accagatccg cgacctgtac atcgcgctga tcttctgcaa ggccaagtat 900

tactccgcct ggaagattgc cgagggcgcc accgtgctgt gtggcttcgg attcgagggc 960

ttcaacaagg acggaaccag tcgcggctgg aacggtgtga gcaacatgga catcttgggc 1020

tttgagttct cgcagagcat ccgtgcggcc tcgcgagcct ggaacaaggg gacgcagaac 1080

tggctggaac gctacgtgta cacgcgcacg ggcaactcgc tgatggccac gtacttcatc 1140

tcagccttct ggcacggatt ctacccgggc tactacattt tcttcatgag tctgccgctg 1200

gctacggcgg tgaaccgttt ggctttcaag cgtcttcgtc cacgtttcat cgaggccgac 1260

ggatcgttcg gagccaagaa gaaaatttac gacgtgctca gctacttgtt gacgctcttc 1320

gctatgcact acttcgtcat gccgttccag gtacttaata agtatttgtg a 1371

<210> 106
<211> 1458
<212> DNA
<213> Phythophtora infestance

<400> 106
atgcgtgtca ctcgccgcat tcgaagactt gccgaagcgt ggatcgtgtt tcgctatcga 60

gcagcagagc agagcatgga gatactgcgt ggccccgtgg acggcatcgc cctaagcgag 120

aacttccctg ttgatggatt ccgcctcatg gtggcgcttg cgggttgcag cctcatcgca 180

ccgctcatcc acctcacacg cggcgagaca tctcgtcact tgttcaatgt tgcggtggga 240

ctattcgccg gcgtcttcgt gttcgacttg gccgtgttgc acactatcgg gacggccgtt 300 gttgtgtatt tgctcatgat ggtggctcca agcttgtggg gcgcattgtg ctgccgctgc 360

tgttggcgta cctctcacta ttaccgtgaa ttctacagcc cagacattgt gtgggactcg 420

gcccaaatga tcctaacgct taagctcagc agcgtcgcga tcaactacag tgacggcggg 480

ctgcccacgg agaagaagac gcccacaatg cttaagaacg agctgcaaga aatcccagag 540

ctgatcccgt actttggctt cgttttcttc ttcccgacct acttggctgg tcctgcgttc 600

gagtacaagg actacattta ctggatgaag gacgttcgcg ttgctccttt catggtccat 660

ctccgcaatc tcgtcatttc cgctgctggt ttcttcgtct cgctccaatt ccccgtcgag 720

gaaatcgact cccccgactt cttcccgaaa tcgtcgtggg ctgtgcgctg cctccgtatg 780

tgcatccctg tcgtgttgtt ccgtttccgc tactatctgg cctggtcgct ggccgaggcg 840

gcgagtgctg ctgcgggcgt gggctacgtg caagctactg gaaaatggaa cggcatcacg 900

aacaacgatc tcctgtgtgt ggagcttccg acgaatttcc gagtggccat caacagctgg 960

aacattggag ttgcgcgctg gattaacact tacatttacc agcgcgtcgg tctgaccaag 1020

tctgggaagt ccacgatgct ctccacgatg gcgtcattct ttgtcagcgc tctgtggcat 1080

ggactgtcgc ctggttacta cctgttcttc ctcttgggtg gcatctacat cgaagttggc 1140

aagcaacttc gtcgtcgtct gcgtccatac ttccactaca cggaggaccg taaggctcac 1200

tcgcatgcca ttttcctctc gtactttagc ggcacgtctc atccactggc cttcttgtac 1260

gacatctcgg gcatgttctt cacgtgggtg gcgatgcagt acgctggtgt cgccttcgag 1320

atcctggacg tgcgtcgttg cctcgccatt tggagctcgt ggtacttcct cccgcacctt 1380

gtgagcatcg gcttgctggt tttctttaac ctcttcccgc aacgtcgctc cactcccacc 1440

gacaagaaga cgcagtaa 1458

<210> 107
<211> 1677
<212> DNA
<213> Phythophtora infestance

<400> 107
atgagcacca ccgcgctatt acaagcctcc acttctcctc ctccttcgcg agagccggaa 60

tacgcagcat tggagcagct cgagccgcct ctgtcccatg caatcgacat gggggtcaaa 120

gtctcaccgt ccgagtcagc ggcgatagca ggtggggtct acgtgaccgc ctcgtccagt 180

tgtggggcct ccactatcaa gcacaatccg ttcacgtaca cgacaccggt ggacacgtac 240

gagaaggcca agatgaccat cttgtgtctc ttaggagtcc cattcattcg tttcgtactg 300

ctactctgtg tgggcattct actcgtcatc gtaagtcact tggctctcat tgggtacaaa 360

ccattggacg ctcactctgg agctcgtcca cctctgccac gttggagacg tatcgtcggt 420

tcgcctgtgc cgtatctgct acggtcactg atgctcatcg tgggttacta ctgggttcca 480 gtgaaatacc ctccgaattt taatcgtcat gccatgccac gcgtcatcgt aagcaaccat 540

ttgaccttct tcgacggact ctacatcttc acgttgctat cgcccagtat cgccatgaag 600

acggacgtag ctaacctccc attgatcagt cgaatcgtgc agatgattca accgattctg 660

atcgacagag gaacacccga aggacgtaga agagcgatga atgacatcac gtcacatgtt 720

gctgatccca gtaagcctcc gcttcttgta ttcccggaag gcactacatc gaatcaaacg 780

gtactgtgta aattcaaggt cgggtctttc gtctcaggtg taccgtgtca gccggttgta 840

ctacggtacc cctacaaaca cttcgatttg agttggccac ctggggtttc tgggttgtac 900

ttggcgttac gtgtgttgtg tcaggtgtac aaccgattgg aagtggagat tctaccagcg 960

tactacccgt cggagcgaga acggaaagac cctcaattat acgctattaa tgtgcgtgag 1020

gtaatggcca aagcgctggg agttcccaca acgaaccacg cttttgaaga tgtagccatg 1080

ttgatgcgtg tcggagacta cgccacaaaa cacgtcgtac cactgacaga cgtgggtgaa 1140

gtgatctcgc taacggcact aaagcgaggt gacgtagatc gcctggtggg ctacttccgt 1200

cgccacgacc ttgataagga cggccactta tctatgcagg agctacgtgc actgttccct 1260

aatgacgatc ctgtgatcgt tgatcagctc ttcgacctcg ttgatttaga cgacagtggg 1320

ctcatcgatt tccgggaatt gtgcttggct ctacgtgcac taaacccgca gaatatcaac 1380

gagggagacg acgccttggc gaaattcgct ttccgtctct atgatcttga taacaacgga 1440

gtcatcgacg cctctgaact ggaacaacta cttcgcttcc aacgcaactt ctacggcgtt 1500

tctgaagcga gtgttgcagc cgcgttacgt caagctcagg cagaaaacac gaccggtatc 1560

acttataaca gattcgagca gctggtatta caaaaccccg aagttttgtg gtacgtccgc 1620

gacaaactcg aagtcctacg tggctccatg cgagaaagca gtctcgagat tccgtag 1677

<210> 108
<211> 1047
<212> DNA
<213> Phythophtora infestance

<400> 108
atggagaagt atagtcggtg gtcggatctg acgacaggca tcaacccgtt cgtgccgcag 60

cgtcggcgct tcacgtccgg atggcccgtg accatcttgc aggtcatatc tggctccgct 120

ttggcgctcg tacgcttccc gttggtgcta gtagccttcg tcgcgctatt tctagtcaac 180

ctagtggtgt ccattctcgc cgtaatcccg ttcctaggac gtctgcttaa gcgcatcaca 240

gaatggttgc tgtgctcact cctcctcctg cttttcggtg tgttcacctc gaacggctca 300

actcgcgttg gatctggcga cgtgctggtt tgcaactaca cgagcttttt ggagatatta 360

tacctggcca cgcgcttctc accagttttt gtatttgcta cagagaccaa gagtaacgac 420

gaaggattgg tacacgtatg tggcctactc gaggcgctgt acaggtcgtt ggcaatgcct 480 gtgagtgttg aacgtgtcaa acccacaagg aagatcgcag acgtagtgcg tcgagctgct 540

gggccagtag tcgtgcttcc cgagggggct agaagcaatg gtaaggctgt gctgaagttc 600

atccccgtgc tacagaacct gccggtcaag acccgcgtac acctcgtggc cttccgctac 660

gagttcaagc gcttcagtcc gagtcaaagt gccggtggtg cctggtctca cctcttctgg 720

actgccttcc acgtgtacca caccatgcgt gtgacggtat tgagtgctaa agacttgaat 780

ctagacgact taacgccgac taaactaccg agtaacaaga gcagtaagaa gcaggagaac 840

tccaagacac tgtcgactga tcaggtcgag aaactacgca cacttctagc cgctatgtta 900

cgcaccaaga ccgttgactt gggaccagag gactctgtgt ctttcaataa ttactggaag 960

cacgtcaaca gcggaggacg tcaaccagcg tcccaattca cggaccgcaa ggctcctcat 1020

gaacacgccc aatgggccaa gagatag 1047

<210> 109
<211> 1275
<212> DNA
<213> Phythophtora infestance

<400> 109
atgtcgttcg ctacacctgc gcaggtgctg caggatgtgc gcttcgaaga gcgttttgct 60

gagattgagt cgaggttgcc ggccacgttg gctttggcca aggagggatc tttagccaaa 120

cgcaatcaga ccaagcgcaa gctttaccac gacagcgagc tcatccgtat cgagctggaa 180

gagcgtctga atgaactagg tatcgaaagt cagtgggtca ctgccccgga gatgaaggaa 240

gccaatgaga agctggacgc agtgcgtaag cagctcaaac tggacgtgct gcccgccagt 300

tcctctcctc tggagaagat ctacatggtc gtgcgcatgc ttacaatggt gctggtgctc 360

gtgggttggc tcagctgtgt gacagtgctg atcccactca aatggctcaa cccagtactc 420

aagaagatgg gagtcaagaa gaactacctt cccatggaca ttgtgtcatg gggtacggcc 480

ttcatggtct gtgtcacggc ctgtaccgac atgaaggccg agggcgtcga aaacctgctc 540

aaccttaagg actctgtcgt ctgcatgttc agccactcgt ccaacttgga cggcttcatt 600

gtcaatggat catcgccgat tgccttcaag tttgccgcca agaaaagcat ttttctagtc 660

ccgttcctcg gctggtcgtc tcgttggggc ttcgactttg tggccatcga ccgctcgcac 720

cgtaaatcag cgctgaagag tttaaaggaa cttgcagtgt cggtaaacga gcatggcaat 780

tcagtctgca tctcgcctga aggcacacgc tcgaaggacg gactgcttca agaattcaag 840

aaggggccat tctacctgcg tgaggacacg aagaagaacg tggtgccctc catcgtgttc 900

ggcgcgtacg agctgtggcc tcctggacga ttgttcagca tccccggaca cacgttggtg 960

cgttacctgc ccgagtacaa gtcagatccg aacttgaacc gtaaccagaa ccggttggcg 1020

ctgcgtcgca tctatctcaa ggcgttcacg gaggatgttc cggactacat tggcactcgc 1080 gtgagcacca acttcatcct gaagaacatg ttctatcact atcttgcgtg ggcgatcacg 1140

ttcaaagtga cttcgtgggc actcacagtg atcagcctcg tcttgtactg gctcaacatc 1200

acatatggca cctttatgct gttctcgctg gtcatgatgg tggcgggaga agccctcatg 1260

ttcttcacct gctaa 1275

<210> 110
<211> 1278
<212> DNA
<213> Phythophtora infestance

<400> 110
atgagtcaaa gtgacgagtg ccaagcaacc caaacctccg tgtatccaac caagcgctgc 60

gtgtcaggag gccccgtagt cgagcccgac gctgagccag tgctcaatcg cgtcatccat 120

ccgagtacaa agtttgagac tgcatggacg tggtccggat gcatcatcgg ctgcagctac 180

ctgctccttc tcgtagtatg tgccttcctg aacaccactt tcgtgctgtg gccactgacg 240

ctgctgcaat ggagccacct cctctcaacg cgcagctgcc gatggatatg tcgctttctg 300

gaggataaat acttcgctat gttaagtgga tatttggaac tagttggcgg cgtcaagatt 360

atcatcactg gagacgaaga gctgcagttc gcacaccacg agcacgtgct cttgatctgc 420

aatcatcgca gtgaagtcga ctggatcttc ttctggaatc tggcgctgcg tctcaatgtt 480

catgaccgta ttcgagtcat gatgaagagt gtcattcgat acgcccctgg cgtcggctgg 540

accatgatgc tgctgcgata cccgtacgtt aaccggaact gggccacgga ccaggacaga 600

ttgaccaagg tgattgagtc gtacaaggac gtggacatgg gcacgtggct agccatgttt 660

ccggaaggaa cggcgttgta tgacaagacg ctcaagaaaa gccacgagtt tgctagcaag 720

caaggagaag cgaaatggaa ctacgtgttg cagcccagag tcaagggctt tgagctgtgt 780

atggacaaga tggacccgga ctatgtcgtg gacctcacgg tggcgtatcc ggagctcatg 840

gagggcgtga gaccgtcacc ggtgcgattt gtgagaggac agttcccgac tgaagtacac 900

atgcacgtgc agcggtatca ccggtcaacg ctgctgaagc acaaggaccg catgggtcaa 960

tggctgaaag atcgatttgc agaaaaagag gagcgtcttg aacatttcta cgagactggc 1020

gcgtttcaag gcgaacagca gacgagcggc cagcatgcga gccgtgtcgc tctgttgccc 1080

gcgcaacaga ttctcctctt cgttggtgaa aactacctca cttacttttg gtcgagaaga 1140

cgcctgtctg tatacctgcg tgctttccag gttgctggtg cgtccatcca ctcgatggat 1200

agccacaaga ttcacaacga gaagcaccaa gacaaacttc atactcgatc ggcagatgag 1260

ttgcgcctct tcacgtga 1278

<210> 111
<211> 1173
<212> DNA

<213> Phythophtora infestance

<400> 111
atggcggtgt tccacctgta ctcggcgctg aatctgctgt ggatcctatg caacagcgcg 60

tgtatcaatt tcctgcaatt ctgtctttgg tgccttgtgc ggccgtttaa caaggcactt 120

tatcgccgac ttatgggctc cgtggcacaa tcactctggg tagacgtcac atccacgagc 180

ttcccacaga ccaagctctc ggtcactggc gagctgccgt cagaccccac gaagcccgtg 240

atcatcatag cgaaccacca agttgacgcg gactggtggt atatttggca ggccgcgcgt 300

caccaacacg cagctgggaa catcaagatc gtgctcaaag accaactcaa gtacctgccc 360

atcatcggct ggggcatgcg cctctttcag ttcctcttcc tacgacgccg catcgaccag 420

gatgcagagc acatcaagaa gtacatgggc ggactcatca gcgataattt cccttttggg 480

ctcgtgttat tccccgaggg aacgaccatc caccgtgaat acgtggtcaa gtcacaggct 540

tttgcggctc gagaagctcg tcccaagttc gagcgagtgt tgctgccacg cacgaccggg 600

atgcggatca ttctggacgc tgtggcggat gccaaacccg atatttacga cctcactgtg 660

gccttcccgt cgtactcggg tgaagtcccg acgttcgaca tgggatatgg acgcagagtt 720

gacaccgaag tgccgtcgat gaagtcgcta ctggcaggga agcagcctgt gggccgagtg 780

gctttacact caaggaagtt taagtacgag gacgctgcga cagacttgca gggattcttg 840

gatgctcgct ggacggagaa ggaggagcgg atgaactatt tcatcaagca tcagcagttc 900

ccggaaacgg agagcacagt ggagatgcaa ctatcgacct cgatgggagc agttttccgg 960

ctgtggatgg gcatcttgct gtcgtgtgtt gtgcttcccg tcgtcatgat gctcttcttc 1020

ccattgtact tcacgtgggt cgtctactgc ttcgtgtact cggtgtacga ccgcaccacg 1080

aacttctggt ggccgtacat tttcaatctc ttcgtggagc gcgccactaa gacgcacgaa 1140

cactttaagc gtcaccaggc taagtatctg tga 1173

<210> 112
<211> 1110
<212> DNA
<213> Phythophtora infestance

<400> 112
atgggcgtgg ctgttgtggg cgtcgtgttc ctgacgtcgc tagtggtcac gggttggaca 60

ggtgtggcct ggatattgac cccatgtttc ttgctggcgg ctctcccact gccggcgttt 120

ctacagacca aacgcttcta tcgccgcgtc actcgcttca tacaatgggc gtggatgggc 180

caagtgaaat tgtttggaat ccaggttcga gtgctcggcg atgcggagac gaaagctcgt 240

gagagcgaat tatcgaagga tcgagcgcta tggctgtcaa accaccgcac tcgtatcgac 300

tggatgctgc tgtggagcgt cgcgtggcgg acgcggacgc tgcatcagtt gcggatcgtc 360

ttgaaggccc cattacggaa aatgcccatc ttcgggtggg ccatgcagca cttcatcttc 420 atctttctgc aacgccgttg ggctgatgac caagtgaatt tgcgcaagtt gttgccattc 480

ctcacgtcga cagaaccgga ggcttcctat ctccttttcc ccgaaggcac cgatctgagc 540

gagagtaacc tcgaaaagag tgctgtattt gcagagaaga aaagcctttc acctcgtcag 600

tactcgctgt acccacgcac gacgggttgg acatttatgt tcccactgct gcgctcacaa 660

cttaccgctg tgtacgatgt caccatgttc tacgtggact atgccgctaa cgaacgtcca 720

tcggagtcgt cactgcttac cggtcgtatg ccgcgaatga tccatttcta catcgagcga 780

gtggacatct cggttttgcg tgacaaaagt gagactgact tagcggcctg gttggaaaag 840

cgcttcgaac gtaaggagtc tttgctcaag gccttttacg aggacaacgg caagcttcct 900

catggagccg aacctctctt tcaagagaat caaggtactg cgatggtgat gctggtggcg 960

ttttggctca tatccattgg tgctgccaca ctccttggat tgattggcaa cttcatctcg 1020

gtcattgctg cgctggcggt tgtagttgga tacgccacca acacggcata tgggcctggc 1080

gtggacgggt ttctcataaa caactcgtag 1110

<210> 113
<211> 1344
<212> DNA
<213> Phythophtora infestance

<400> 113
atgggacccc gagtggaacc tccaaacagc gggcgctcgc ccacagcgag caagaggcgc 60

atgaagaagt tccgtgacgt tgtgtccccg ttggacccgg cggatgcgcg ctccggtgtg 120

cacagctccg agttccgcgg cttgtacaac ctggcgatgc tgtctggggt gctctacgtg 180

ttcacgacgc tcttcacgaa cctgctaatg acgaacgaac ccatcgactc gaagcttctg 240

ctgtcggtgt tttactcgac gcatttactc gaggtattgg ctacattcgt gtgtcaagct 300

ctgtatgcct acacggccct gatcccagtg tacatggcgg gcacggacaa gccgaaccgc 360

ctgctcatca acatcgtgca ccacacgctt caaagtctgc tcttcttctt cacaatcgtc 420

ttcatcgtct ggcgcgactg gaacctcatc cacgccgtgt cagcgttcat tgaaggtctc 480

gtactattga tgaagatgca ctcctacatc cgcaccaagc tggagatctc acgcactgag 540

aacaaaccgc ccattcctga catcaaggac tttactatgt atttactgat cccgtcgctg 600

gtgtacgaac ctaacttccc acgtacctgt cggattcgct gggcttacct tgctgagaag 660

actttctcgg ttatcatggg gatttcgatg ctatacatca tcgtcacgac ccatgtgatg 720

cctcgcctgg aggattccgg gactgtgaac cctgtgctat cggtcgtgag tcttctgctc 780

cctttcctgg gatgctactt gctcacatgg ttcatcatct ttgagtgcat ctgcaatggc 840

ttcgctgaag tgacttactc agccgaccgg gacttttatg gtgactggtg gaacagcaca 900

acgttcgacg agtttgcgcg caagtggaac aaaccggtgc atgagtttct actacgacat 960 gtatacttgg agacgttgga ctcgtacaag atctcgaaga cttacgccac tatgttcacc 1020

ttcttcatgt ctgctgcact ccacgaatgc gtcttcatcc tcatgttccg cacagtcaga 1080

atgtacttct ttactcttca gatggtccag ttggttacca tcgtgtacgg acgtggcttg 1140

cgtggctcgc ggatgggaaa tatcaccttc tggctcggta tgatcctcgg actcccactt 1200

caagctgtca tttacagtcg cgaatatcac ggtggtgagc ccatctttat ggtcatcatg 1260

atgccagcaa tgatcttcgg gttcggtgga gttctcgttg cttcactgat gcatctaagt 1320

cgtttgagga agaaacaagc ctaa 1344

<210> 114
<211> 927
<212> DNA
<213> Phythophtora infestance

<400> 114
atgacaggcc agcaacacac ttggctgctt ggtgtcggcc tcgcagtggc gacaatctcc 60

ctttgcgtcg ccattcatgc aagcgcctta ataacgattg caactgcatg tgtagctgct 120

tatctccctt catacttgga cggctcagag tacacggggg agcgctactg gccatggttt 180

gccaccttca tcggacacgg catggcgcac attccgggga cgctggaatt cgaggagccc 240

attgacgcct ccaagcaaca catcttttgt tcgcatccac atggactgct ttccacccac 300

cacggacttc tcatgtctgg gcagactgtt cctccattct acgagacggt accgctgtct 360

acacgacgcc acttggctgc gtccgtttgt ttccggatac cattctaccg tgaatatgta 420

ctctggtctg gatgtgttga tgcacgccgt agtgtggcgg aaaagatgct tcgaaatggc 480

aagagtctgg tgatcttagt cggggtatt gcggagcaga tgctctctca gcgtggagac 540

cacacgatct acgtcaaaaa gcgcaagggg cacattcgct tagcactgaa atacggggta 600

cccatcgttc ccggctacgc gtttggagag accgacctgt tcacccactc aagtgtgctg 660

ttgtcgttcc gccaaacgat tgcgaagaag ttttctgtgg cgttgctgct tggacgtgga 720

tactccaagt ggttgttttg gctacctcat aaaggagtga ccatcaacca ggtctttggc 780

aaacccattc cagtcttgaa gaaggacgac ccgagttcgg acgacatcga aaagctgcat 840

caccagtacg agcgcgagct agtgcgcatt tttgacaagt acaaggagaa acatggatac 900

ggaaactgta cgctgcatgt gcgctag 927

<210> 115
<211> 1179
<212> DNA
<213> Phythophtora infestance

<400> 115
atgtcggcag cccaagtgct caacaatgct gcttacggcc gcacatcggc gtggcctgat 60

tcgaataccc gtccggatct gcagacacta cgaggacgct ttctacgacg acttcatctt 120

tcgcttattt atggtctctg ggtgcttggt acgcttttca atgcagcgat gtgggttttc 180

tcgctcgtct gtgtagctca gtgggtttgg agtaccctca tcggtgctaa tgaagctccg 240

attccacttg ccgtgcaagt atttctaagt ctcgtcgcac tctatgagag ttaccatttc 300

gtgactcggc cttcgcatca cccctggcca ttcatgcggc gcttgattcg ctactcgctc 360

cttcactacc cgtacttccg cctcaatgcc acggtcttcg acgagcgcga gcgggccaag 420

caattaagtc aagatggtgc taccaatgac actagcgctt tcaacacgga gatcgctagc 480

aagaccatcg tggagaacga tatttctcca tttgtgaaac ccaacgagag cgccatgttt 540

gcttttcatc cgcacagcgt tctctccaat ggctgggtag ccaatggcgc gaatcacatg 600

agtttcgaac aagctgactg tcgatggctc gtagctgaaa atctctttgg ggtccccctc 660

atgagagact tgctaaactg gatggacttt agtagcgttg ccaagtcaac gttccaacag 720

cgtatgtctg cccgtcaaaa tgtgtgtttg atccctggtg gcttcgaaga agcaacactc 780

tacgaacgag gcaaacatcg tgtgtacatc aagaaacgct ttggcttcat caagctggct 840

ttgcagtatg ggtacaaggt gcacccagtg tacacgttcg gggaggagta cgcttatcac 900

acctttcctt atctgctcaa gttgcgtctc aagctgaacg agttcaagat tcctggagta 960

tttttcttcg gtcttccgca ttgtttcttt ctgcctcgca ccgacgtgga ccttatcact 1020

gtcgttggag aacccttggt cctaccgcgt atcgaacaac cgaccaagga agacgtgcag 1080

aaatatcaag gtcagtacgt cgaggctctg caaaagctgt tcaacaagta caagtctgtg 1140

tacgccgtcg atccgcaagc gcagttggaa atatactaa 1179

<210> 116
<211> 1146
<212> DNA
<213> Phythophtora infestance

<400> 116
atggcgaagc tcacgaatgc ggcttgcggt cgcacatctg cgtggccgga ctttgatact 60

cgcccagagt tgcgaacgct acgagggcga ttcatgcgac gcttcgatct cttcattctc 120

tacggtctct gggtcgtcgg cctcctgttt ctcgcagtaa tgtgggtctt ctcactcttc 180

tgtttggtgc aatggagttg gagacgagct acacacgacc atgctcctcc gatggcattt 240

tcagcccaga tatacctggg tttcatcgtg ctgcacgaaa gctaccacta cctcacaaaa 300

ccttcgttgc atcagtggcc atttatgaga cgtttttttc gacaagtttt tcttcattac 360

ccatacttcc gcctcaacgt cttggttttt gaagagcgtt cgaaaacttc aagtgaaaat 420

ggcaaatgca acaaagaaat tgccagcaag gccgttgaag agaacaatct gtcgccattc 480

gtgacccccg atgatcgcgc tctatttgcc ttccatccgc acggtgtcct ctccagtgga 540 ttcgccttca acggcgcgca ccacatggga ttcttgcatg cccattgtcg ctggctcgta 600

tcggagaatc tcttctggtt ccccgtcatg cgcgacctgt tgaactggat ggacttcagt 660

tgcgtatctc gatcgacttt ccatcgtttc atggccacag gtcaaaatgt gtgtttgatc 720

cctggcggct tcgaagacgc aacactctac gaacgaggca aacatcgtgt gtacatcaag 780

aaacgctttg gctttatcaa gttggctttg cagtatgggt acaaggtgca cccagtgtac 840

acgttcgggg aggagtacgc ttatcacacc tttccttatc tgctcaagtt gcgtctcaag 900

ctgaacgagt tcaagattcc tggagtcttt ttcttcggtc ttccgcattg tttctttctg 960

cctcgcaccg acgtggacct tatcactgtc gttggagaac ccttggtcct gccgcgtatc 1020

gaacaaccga ccaaggaaga cgtgcagaaa taccatggtc agtacgtcga ggctctgcaa 1080

aagctgttca acaagtacaa gtctgtgtac gcagtcgacc cagacgctga acttgaatta 1140

tactga 1146

<210> 117
<211> 852
<212> DNA
<213> Phythophtora infestance

<400> 117
atggaggctt tcgtcccagt gctgctcctc actatcacag cttacatgta cgagttcacg 60

tatcgcggac acccgcacca aacgggctgt agagagcgtc ttgattggat atatggtcac 120

agctttctca ttgagaccgt caagcggtac tttagcgaaa agataattcg catggcaccc 180

ctggatccca agaagcaata tgtactgggc tttcatccac acggcatcac accgacctca 240

gttatgtggc tccagttcag cgcagaatgg cgaaggttgt tcccgaactt ctacgcgcac 300

attttaactg ccggcattat gcatgcactg ccacttgctc gggacatcct tcagttcttg 360

gggtcacgag aagttacccg acaagccttc acatatactc ttcagcacaa cgagagtgtg 420

ttgctggtgc cgggtggcca agccgagatg ttagagcagc gatctggtca gaaggaggtt 480

cgggtgtaca cacatcacaa aggtttcatc cgcctcgcaa tcgagcatgg agtaccgttg 540

gtccccgtcc tcagcttcaa cgagggcgag atgctggaca acatccaggc tcccatgctc 600

cagcgctggt tcgttataaa gctcgcgttc ccattcccat tttcccccta cggtcgtgca 660

ttgctgccga tcccgcgcaa agtacaaatt cctatcgtgg tgggagcacc tctggaggtg 720

ccacacatga agaaacccag ccatgaagat atcgataaag tccacgccag atactttgat 780

gagcttcgtg acatgttcgc aaagtacaag gatgaagctg gatgcggcga ctacaagctc 840

atttacgtct ga 852

<210> 118
<211> 1050
<212> DNA

<213> Phythophtora infestance

<400> 118
atggcgagcg aaactcaggc tgatcctgtc cagacagaca agggcctctt tgtctatgag 60

cctcttggat tcttcgcgga tgatagcaaa gtacccaagt ggatgcagct cctaattact 120

gacgtgttta gcttcgtgac tacgcactac ttcgtgtgga gcttgccatt cctcgcgctg 180

ttctgctacc tacaccagca cgaactcgac tacgtatcgg tcgctatgat tgctctgtat 240

ctgccctcat tcttcagtgg ggcgcagaag acagggaagg gcaacgagtg ggaagccgcg 300

cggacgtcga gtttatgggg cctcatgaac aaatttcttc gcgtcaagat tattcgggag 360

caagagctgg atccgaagaa gaagttcatt ttcggattcc accctcacgg aatcctcgta 420

ctctctcgaa tcgcaggctt cggtcgaaac ttcattgacg tgtgtccggg catcacgact 480

cggttccttg gagcctcggc aatgtattat attccgctag gacgtgaaat gtgtctgtgg 540

atgggtggag tcgatgcctc acgctccaca ggtgaaaagg tgctgaaaga aggcaacagc 600

atcatcgtct accctggcgg cgtacccgag attttcctca cggatccgaa tttaaaggag 660

acccagctcg tgctgaaaaa gcgtctcggg tttatcaagc tcgccatgcg tcagggcgca 720

cagctcgtcc cgacgttcgt ctttggtgaa aagtggctgt acaacatgtg gaccccgccc 780

gaaagtgtga ctaacttttt ccgcaagaca ctcggcatcc ctgttctggt cttctggggg 840

aaattctggt ggatgcccaa ggctccaggc gaaggaaaac gctacggact tgtgtacggg 900

aagcctattg cgacgaagca cgattcaaac ccgagcgacg aagaaatccg tgctgttcat 960

gccgaatacg ttagcgaaat cgagcgcatc ttcagccagt acaaatcgga attcggctac 1020

gacgaggacg agacgctggc catcatttag 1050

<210> 119
<211> 1212
<212> DNA
<213> Phythophtora infestance

<400> 119
atgccgcaag cttgtggacg gacgtctgcg tggctggaca atgacgcgcg tccagagcta 60

cagacgctac atggacgcat tcttcggttt gtgctgctgt ggtacctgtt cggactgtgg 120

attgtcgggc tggcatcgtt cataggtatg tggctcttct cggggctctg cacgatacgg 180

tcgttgttga gtttcctaca caatggaggc agttggactg cagccacgcc gctacctgtt 240

cttgtccaag tgtatctggt tggtatgatc gcgtacgaaa gttatcatta tgtgacgcgg 300

aacgcgctgc atgaatggcc gctaattcga cgcgtggtgc gctacgtgtt cctgcattac 360

ccgtattttc gactgaacgc tgtggttttc gaagagcgag aggatgcgaa gcagaacgtc 420

gagatccaag agccagagca ggagaaggat ggcaacgata gcactaccaa caagagcgac 480

gacgctagat acttcagctc gaaggctgca gctgcagcta tcgaagaaaa cgatgtgacc 540 ccgtacgtcg agccggacaa gcgcgcgtta tttactttcc acccacacgg agtactgacc 600

tgcgggttct cgttcaacgg tgctcatcac atggccttcc agcgtgcggc gtgccgctgg 660

atctcggctg agaacctctt ctacttcccg ataatgcgtg acattttgca ttggatggag 720

ttcagcagta gcaccaaaac cagcatggag aacaccatgc gtacaggtca gaacttatgt 780

ctactgcccg gaggcttcga agaagctacg ctctatcagc gaggcaagca ccgcgtgtac 840

attcagaagc gcttcggatt catcaaactg gcgcttcagc atggctacga catctacccg 900

gcgtacacat tcggcgaaga gtacacctat cacgcgtttc cttatctgca gtggctacgc 960

ttgcaattga accggttccg aatcccgggc gttatcttct tcgggattcc gttctgcttc 1020

ttcatgccac gctcggacgt ggacctcatt accgtcatcg gtaagccgct gcgccttcca 1080

cacattgaca acccgagcag agatgaggtg aaggagaacc acgacaagta cgtcgaggct 1140

ctgcgtgacc tatttgacag gtacaaatgt gtctacgctg ctgaccctga cgccgaatta 1200

gaaattttct ga 1212

<210> 120
<211> 1221
<212> DNA
<213> Phythophtora infestance

<400> 120
atggtcggcg ttgcgcacgc tgctacaggg cgcacgccct tgtggcccaa caataatgct 60

gttcctgagc tgcagacgct gcgcggatac gtggggcggc gcttcttgct gtggtcgctc 120

ttcggtctct ggatctttgg actcggggca tacatcctta tgtggctgta ctccggctgg 180

tgcgttggtc actgggcttg gacagcgctg caaaccaaaa gttgggcgct tgcaacacca 240

ccgccaatta gtgtgcaggt atatctagcg ttcacggcgc tgtacgagag ctaccactac 300

atcacgcgcg attcgctgca tttgtggccg cgcatgaggc gtctggcgcg gcacatcctg 360

ctgcgctacc cgtacttccg tctgaacgtg accattttcg aggaacgcga gcttgagaaa 420

caaaagcagc ggctaaagga cgagcagacc aacaacagcg acgacgccac agtagacacg 480

gagcaggatg aaagtgaaca cctcagtccc gctgcagcta tcaaggctgt tgaagagaac 540

gatatctcac cgtatgtgga gacaggaacc aagaacctgt tcgctttcca tccgcatgga 600

atactgacct gtggcttctc tttcaacggc gcatatcaca tgagcttcga gcgctctgcg 660

tgtcgatggc tgtcggctga gaacctcttc tggttccctc tcgtccgtga ccttctcaac 720

tggatggagt acagcagctg cgcgaaagcc aacatgctca agttcatgcg cagagatcaa 780

aacgtcagca tcattcctgg cggctttgaa gaagccacac tctaccagag aggcaaacat 840

cgcttgtatc ttaaaaagcg cttcgggttc atcaaaattg cattgcaaca tggctacaat 900

gtccatccag tatacacttt cggcgaggaa tacacgtacc acgcgttccc gtacctgcag 960 tcgctgcggc tgcaattgaa ccgacttcag attcctggca caatcttctt cggagaggcc 1020

tcgtgctttt acttgccacg caacgatatc gacctcatca ctgtcgttgg caagtctctg 1080

cgattcccac gaatcgagca cccatcgaag gaagatgtac aaaagtatca agcgcagtac 1140

atagaggcgc tgaggagtct attcgacagc tacaagggcg tgtacgctgt tgatcccaac 1200

gccaccctgg agattttta a 1221

<210> 121
<211> 1551
<212> DNA
<213> Phythophtora infestance

<400> 121
atggacgtgg agaacagtct tttgacgcgg ctagcggcca acgggccgac aatgagcgac 60

gctcccatgc ttctgatggc tgtggtgctg gtgctggcgc tatctggcgt tgtgtccacc 120

gtctcgcagc agcgtcaaaa gcccagcgag gacgagacgc tgcagggccg taagctcacg 180

cgtaagctta gcagcatggg gctatcgacg ttggtgacag agacacctac aaacttgtcc 240

atcccagtgt ctgtattaac tgtcgaaggt catctggcta aggaagacta cgtcgagcgc 300

ctacgtgcgc gtatactaca cgacgccttc ttcctacgct ggcgcagcgt cgtacgtggt 360

gactacaaga caggcgtcta caagtatgtg gaagttcctg gctacgacgt ggcacagaac 420

gtggtggagc acacagttga agagggagag accacgatgt cgtacgttga gtcggcgtta 480

gtaaacaccc cgctggactt tgacaagccg ctctgggaga tgcatgtgat ccacgacccc 540

aagggcaatc ctggtaacac tagcgtcggc tggaaagtgc atcattgtct cggtgacggt 600

gcttcgctgg ctacagccat ggccaagctc agtgaccaga gtgagctctt cgacgccatg 660

gtcgagaagc gcctacaagc caagaagagc ccaaagaccc ccaagccacg caaacccgtg 720

actcagatca ttaaagacat tttggtcttc ctgtacgtct gcatctggtc ggtctacgtg 780

atctcctatc acatgttcgc actcgtgact cgtcgtgaac cggccaccgt ctttaaacgt 840

cccggcggca agcaaaaacg tctgtcgtac aacatgatct actctgtgaa tgccactaag 900

gccgtaggta aacacttccg cgccacagtg aacgacgtga tgcttaatgt cgtagctggt 960

gccatgcgga agaccatgtt gtctgtgggc gagtctgtgg ctccaacact caaggtacgc 1020

tgcgctatcc cagtggacat gcgctccagt acagaagtga tccgccacac tagcaaccgc 1080

ttctcctctc tcgtcattga cctgcccatc ggcgttgagg actctgctca gcgtctgctc 1140

caagtcacgg ctgctatgaa cgatgccaag aattcacttg agaagttctt cgtgtactgg 1200

tcgacccacc tcgtgtcgat gttgccagcg ccgcttatgc gcttgatcgt acactttact 1260

accagtcgta tctctgtggc aacgagcaat gtgcgtgcta gtgtcgtgga agtgagtcta 1320

tgcaagagtc cagtgtcggg cttctacggg ttcgtgcctc caccgccata tgtgaacctt 1380 ggagtagcca tcttgtcaat gggcgatgat ctcggtctta acgttcttgt ggacccatgt 1440

gtcggtgtca acgcgaagca attcctggag tttgcgaagg aagagttcac tgcactgcaa 1500

gaatcggtcg ctgctatgga ggcaaatgcc ggtgacaaga agacaaaata a 1551

<210> 122
<211> 2028
<212> DNA
<213> Phythophtora infestance

<400> 122
atgacactgg acgacgattc ctcagcctcg ggcgtgcgcc agcgcaagcc acacggcggc 60

acctccagtg acaggccatc atcccccgag gccttggcgg aggaggccgt cgcttcggcc 120

ttctcggccc ccaaggatga gcagtctcga accaaggaaa cgtttcaaca tgccgctcgc 180

tcgctcggcc ggacacaaag ttggcacgcg cgggcggccg accacgtggc caggaagcgc 240

atctactcca tcatggccgg cgtcattatt ggtgtcgcgg ccgttatcaa ttttcagaga 300

ttttacctgg agaagcctct gatcagcgaa gactcattgc tcatggtccg ggagatgttt 360

gacaacttta actggtccgt gaacgttaag gaagagctca tggctgcctt cgataaccgg 420

ccacctctta tgggtgcagc cgagattcgg cccggtgtcc agttgttcca agagaacgtg 480

acggccaact cgcctgttgt attggtgccc ggcttcacat ctacgggcct cgagatctgg 540

aacggtagcg aatgcagcaa ggcctatttc agacaacgta tgtggggcac atccaggatg 600

ttgcagcagt ttatgatgaa ccaaaagtgc tggttagagc acatgatgct caaccggtcg 660

tcaggtatgg acccggacgg catcaagtta cgcgcggcca aaggcttaga agcggccgac 720

tatttgatcg gcggcttctg ggtctgggga aagatggtgg agaacttggc cgagatcgga 780

tacgacagca acaatctgta catggccgcg tacgactgga ggctcatgcc gcatcttttg 840

gagaagcgcg acgggtattt tacgaaactc aaatacacta tcgagatggc gcgaatgtcg 900

gccggcggcc acaaggtgat gctggtcacg cactcgtatg ctacgcaagt gtttttccac 960

tttttgaagt gggtagagag tgagaacgga ggcaaaggtg gcgaccagtg ggtggagacc 1020

aaccttgagt ccttcgttaa tattgccggc ccgaccttgg gcgtggtcaa gacgatcagt 1080

gcgttgatgt cgggcgagat gaaggatacg gccgagctgg gcgggctgtc caagttcctc 1140

ggctactttt tcagtgtgtc ggcgcgtacg caactggccc gctcgtggtc gagtgtgttc 1200

tcgatgatgc ctatcggtgg tgaccgtatc tggggcacgg ccgactcggc ccccgacgat 1260

gtggtagcgg cctccccgtt atcgaccgga aagaactcga cgatcgaccc aaggaaggtc 1320

aaagagcacg tggcacgcta cggatcgaat ggccacgtcg ttcggttcgt caatacttca 1380

cacgagaacg tcactatcgg aggcgtacag aagatgctgg gcaaattaga cccgtacctt 1440

gaccagttcc gttcgtggct gagtaccggt attgccgaag atctgtcctt gcctgaatac 1500 gatcaatcca agtactggac gaacccgttg gaggctgctc tacccaaagc tccgagcctc 1560

aatgtgttct gcttttacgg tgtcggcaaa cctgttgagc gaggatacac gtacggagac 1620

aacccgcccg atgaagataa cgcgacagtg aacggcaaac gtgttgctcc gtacgtgttc 1680

aacacggata ccgacgatct tccgtacatc aagggtgggc tcagatactc ggacggagac 1740

ggcacggtgc cgctgatctc tctgggcctc atgtgtgcca gtggctggcg gacgaagaag 1800

ttcaaccccg gcaacgtcga cgtacgtgtt cgtgaatacc gacacaaccc cgtgtccatg 1860

ctgttcgacg cgcgtggcgg acctgagacg gccgatcacg tcgacatcat gggcaaccac 1920

ggtctcatcc gggacgttct actcgtcgcc gctagggcgt acgaccgcgt gcctgaaaac 1980

attacgtcca gcatcatgga gattgccgaa cgtgtcggag agctctaa 2028

<210> 123
<211> 2187
<212> DNA
<213> Phythophtora infestance

<400> 123
atgaagttcg acgacaagaa ggtgctcaat gacacatgga cgcagttcct ggcgctgtgt 60

ctgctgctca tgctggctgt cgactcgctc aaccccatca aggctgtaag taagtttcta 120

ggcgttccgt cgtattactg ggcgctctg tccgtgggta ttatgctagg gctgctgttc 180

cacaacgccg ccgacgtcat ctaccgttcc acacgcgtct tcctcaacag tatcctcagt 240

atctcattta agagtgtgga tctcatcggt ctggataacg taccgaccga cgggcccgtc 300

atcttcaccg gtaaccacgc caaccagttc gtagacggtc ttgtagtcat gatgactagt 360

cctcgtaaag taggcttcat gatcgcagaa aagtcgtggc atttgcctgt cgtgggccac 420

ttggctcgta tcatgggctg catcccggtg gtgcgtcctc aggactctgt agcttctggt 480

gttggcagca tgaagctcgc cagtgaagat cccgtgactg tagctagctc gtccagtggt 540

ggcgctagca gtagtacgcc tcagtggctc gtgcagggcg acggcaccag tttcactaag 600

caggtgacgc ctggagacca gatccgcttc caagggcaga gcgtcaagga ctcggggtcg 660

cctgtgaaga tcgtacaggt tctagacgac acgcagttgc tactgaacgc gccgttgaag 720

agcggcgaag gcaaattagt gcttgagagt gcaccgtttg gtattctcaa gcgtgtggac 780

caatccgtga cgtttgccaa ggtgtacacg cacttgaagc gtgggaactg catcggtatc 840

ttcccggaag gaggctcaca cgaccgtacg gacttgttac cactaaaagc tggtgttgcc 900

gtcatggctc ttggagttaa ggacaagtac aacatcaacg tgccggtggt gcctgtgggc 960

ttgaactact tccgtggcca tcgcttccgt ggccgcgtga cggtggaatt cggcactccg 1020

atcactgtgg accaagcgtt gatggccaag taccaggaag acaagcgtac agcgtgtaac 1080

acgctcttac atcgtgtgga ggagagtatg cgctccgtga tcgtgactac gcccagctac 1140 ggcgtcatgc aggaggtgtt gactgcgcgt cgtctcttcc agcgctctgg agtgcggctg 1200

tcggcaaaag agacacaaga cttgaaccgc cgctttgcag aaggctacaa ggtgttgcag 1260

gatgtgccag aagcccaaga agatctcgta atcttgcaac ataagctgga taactactac 1320

aagacgctgc agaagatggg actcaaggac catcaagtgc cgtatatccc gtggtggaca 1380

attcacgacg tgttgggctc cgcactgtac ggcacgttga tccttctact gtcctccatt 1440

ccgtcgttca tcctgaatgc accggtgggg cttctagctc gttatgtggc gaattcagcg 1500

cagaagaagg cgctggaagg ctccaaggtc aaggtgttgg ctcgcgacgt tattcttagc 1560

aagaagatcc agttctcgat tgtagctgtg cccgtgctgt ggttcattta ttttacgatc 1620

gccgcggtgt tcacggattg gtactggtcg tcaatcatgc tgctgatggt gtcgttcccg 1680

ctattttctt tcttcggtgt acgctcggta gaggctggaa tgatcgagct gaagacggtc 1740

cgtccgttgt tctaccgtct gctaccgacg tacaaggcta cacaggatga gcttcctcgg 1800

caacgtgctg agttgcagaa ggaagtgcgt gagtttgtga agaaatactc gcagtatctg 1860

ggaaaactgg ccgagccaaa gaagctcgac tggagcgagt acatgcacga gcgctcgttg 1920

gtattggctg agaagactga gcaggccgag tcgatcccgt cgcctcctcc ggtacatgag 1980

gaggacgagg agccgcggga aggcgaggct gaagatgata tcggctctcc tgtgcctacg 2040

atcaccaagt tccacgacat cagtatcctg ggcaagtcgg agaactcggt gctggactta 2100

gcaggtctcg aacgctccat gtcttgcccg ccaggatacc aagagctagc ggaggagata 2160

gccaagcaac gtaaagggtc cgtgtag 2187

<210> 124
<211> 1533
<212> DNA
<213> Phythophtora infestance

<400> 124
atgctgtcta cgctactatg gcttgcgctg gccgtcgtgg tccttgctac acagggctac 60

aagatggtgg cgcgcttcct gcgactattg ctacacactt acttccgcaa aatcgtggtt 120

tacggactca acaacttccc gcgtgagggg cctgtgatcc tgtgcccgaa ccaccccaac 180

atgcttgtgg acgccattct cgtcatgacc gaggccgtaa gtcacggtcg caatccgtac 240

gtatgggcca agggttcgct gttcagcaac cctgtcgccg ccttcttcct caagaaattc 300

ggcgccgtgc cggtctatcg tccgcggcgc aaagaggaca gtctcgccga cgtggactca 360

gataagactc ccgagcaact ggaggcggcc aaccgcaaaa tgttcgagca tacgtggcat 420

gtacttgctg gggcaacgt catggtgctt ttccctgaag gaacatcgta cacggctcca 480

aagatgctgt cactgcgtac gggtgttgtg cgtgtcgcga cgggtttcgc taagcattat 540

gaccaaccta tcccgatcat cccgctaggt ctcaactact tcaacaaaga ccacttcagg 600

```
agccagatga cgctggaatt cggtccaccg atggtgatca cgcccgacat ggtgcaaact     660

gaagctttcc aacaggacga acatggcgag gtgaagcgtc tgaccctgga gctagaggag     720

cgcatgcacg atgtgacttt gaatgcatct gacttcagca ctatccacgc tgcgcgaatg     780

atgcgacgcc tctatctaaa cactcctggc cccattgaca ccaacaaaga agtccgtttg     840

acacagtaca ttatcaatat gctggagaag gagccccaag acgacgagca aaaggagcga     900

atcgctacga tccgtgaaaa agttcttcga tacaaagagc aattggaaaa gctgcggttg     960

aaagaccaag aggtgaattt gccgatgccc aaagagaaat cgcttttgca actgtttttg    1020

gagcggattc tgtacctgct tgtgctgctg ccactggcca cgcccgggct tttgttgaat    1080

ttaccctact attttattgg aacgaagatg aacagcctcg caggattcgt ggaatccaag    1140

tcgatgttca agatcttcgc tgctgctgtg ttggtgcctg tacattggct cgtactgatc    1200

cttgcaactt ggtatttcct cggatcatcg tatgcgtatg tgctggctgt tggtttgccg    1260

ctgctgctgt actcgcacat ccgcgtactg gaagagagcc gctccatcgc cgagaacgtg    1320

tatttcctct tcaacatcac agctcacgcc gataaggtgg cggtgcttcg aacggaacgg    1380

gagctgctag cgcaagaagt ccacgagctt gtgactaagt acgtcgatgc caagtttctc    1440

tcagccatac acaagtctct agcgagctcg cccgtgaaca gacgattgcg ccaccgtgcc    1500

tcctccacca gcgacacact gcttactaca tag                                 1533


<210>  125
<211>  520
<212>  PRT
<213>  Phythophtora infestance

<400>  125

Met Asn Cys Gln Arg His Pro Thr His Val Ala His Asp Ile Thr Phe
1               5                   10                  15


Gly Ser Ile Leu Ala Ile Leu Ala Ala Gln Pro Pro Ile Pro Val Ser
            20                  25                  30


Ala Ser His Leu Ala Leu Met Ala Ser His Val Val Ser Ser Leu Ser
        35                  40                  45


Asn Ala Ala Thr Pro Leu Arg Phe Thr Leu Leu Asn Gln Gln Leu Thr
    50                  55                  60


Gln Leu Ser Glu Leu Val Gly Val Pro Val Asp Gln Leu Arg Cys Val
65                  70                  75                  80


Ala Cys Leu Leu Ala Val Tyr Pro Leu Ala Leu Ile Val Arg Lys Leu
                85                  90                  95
```

Pro Ser Val Thr Ala Lys His Trp Leu His Ile Cys Ala Gly Val Ser
100 105 110

Ile Ala Gln Phe Val Tyr Gly Thr Gly Trp Leu His Ser Leu Leu Ser
115 120 125

Ser Leu Val Thr Tyr Ala Leu Val Cys Val Leu Pro Pro Lys Arg Ala
130 135 140

Pro Phe Val Val Phe Leu Ala Asn Met Leu Phe Val Ala Ala Leu His
145 150 155 160

Ile His Arg Met Arg Val Asn Tyr Met Gly Trp Ser Met Asp Ser Thr
165 170 175

Ala Ser Gln Met Leu Leu Leu Ile Lys Leu Thr Ser Phe Ala Phe Asn
180 185 190

Tyr His Asp Gly Val Val Pro Ser Ala Thr Ala Val Gln Asn Gly Asp
195 200 205

Ser Glu His Thr Lys Arg Val Lys Gln Leu Arg Lys Gln Leu Ala Ile
210 215 220

Pro Gln Ile Pro Ser Leu Leu Glu Phe Leu Gly Phe Val Tyr Cys Phe
225 230 235 240

Thr Thr Phe Leu Ala Gly Pro Ala Phe Glu Tyr Lys Glu Tyr Ser Asp
245 250 255

Ala Ile His Gln Ala Arg Phe Val Asp Asn Asn Gly Val Arg Arg Asn
260 265 270

Val Ser Pro Ala Arg Ala Ala Met Ser Lys Leu Val Leu Gly Leu Gly
275 280 285

Leu Met Gly Leu Leu Val Gln Phe Gly Ala Leu Ala Asp Leu Asn Gln
290 295 300

Ile Leu Asn Asp Glu Asn Gln Ser Met Leu Met Lys Trp Gly Arg Leu
305 310 315 320

Phe Val Ala Leu Phe Leu Thr Arg Ala Lys Tyr Tyr Val Ala Trp Lys
325 330 335

Leu Ala Glu Gly Ala Thr Val Leu Thr Gly Thr Gly Phe Glu Gly Phe

```
            340                 345                 350

Asp Glu Gln Asn Asn Pro Lys Gly Trp Asp Gly Val Ser Asn Val Asp
        355                 360                 365

Ile Leu Gly Phe Glu Leu Gly Ala Asn Val Arg Glu Ile Ser Arg Ala
    370                 375                 380

Trp Asn Lys Gly Thr Gln Asn Trp Leu Glu Arg Tyr Val Tyr Thr Arg
385                 390                 395                 400

Thr Gly Asn Ser Leu Leu Ala Thr Tyr Ser Val Ser Ala Leu Trp His
                405                 410                 415

Gly Phe Tyr Pro Gly Tyr Tyr Leu Phe Phe Leu Thr Val Pro Leu Ala
            420                 425                 430

Thr Ser Val Asn Arg Leu Ala Arg Arg His Val Arg Pro Tyr Val Val
        435                 440                 445

Asp Ser Pro Leu Lys Pro Leu Tyr Asp Leu Val Gly Met Ile Cys Thr
    450                 455                 460

Ala Leu Val Val Asn Tyr Leu Ala Val Ser Phe Val Val Leu Ser Trp
465                 470                 475                 480

Glu Asp Ala Val Ala Gly Phe Arg Ser Met Arg Phe Thr Gly His Val
                485                 490                 495

Gly Leu Val Gly Cys Tyr Leu Leu Leu Thr Phe Val Pro Ile Lys Lys
            500                 505                 510

Thr Ala Asn Ser Lys Lys Thr Leu
        515                 520


<210>  126
<211>  456
<212>  PRT
<213>  Phythophtora infestance

<400>  126

Met Asp Arg Val Val Asp Phe Val Glu His Leu Gln Pro Tyr Thr Glu
1               5                   10                  15

Leu Ala Thr Pro Leu Asp Phe Ser Phe Leu His Ala Lys Val Asp Glu
            20                  25                  30

Leu Ser Val Ser Leu Gly Leu Gly Ser Asp Gln Leu Cys Tyr Val Leu
```

```
        35                  40                  45

Cys Leu Phe Ala Ala Tyr Pro Leu Ala Val Val Tyr Lys Leu Leu Pro
    50                  55                  60

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

Ala Gln Phe Val Leu Gly Ser Gly Trp Val His Ser Phe Ile Ser Ser
                85                  90                  95

Phe Leu Thr Tyr Leu Ile Val Lys Phe Gly Pro Ser Lys His Ala Pro
            100                 105                 110

Gly Ile Val Phe Leu Phe Asn Met Leu Tyr Met Ser Ala Ser His Ile
        115                 120                 125

Tyr Arg Leu Tyr Val Asp Tyr Met Gly Trp Thr Leu Asp Phe Thr Gly
    130                 135                 140

Pro Gln Met Leu Leu Val Ile Lys Leu Thr Ser Phe Ala Tyr Asn Tyr
145                 150                 155                 160

Tyr Asp Gly Val Val Asp Lys Thr Phe Glu Lys Lys Gly Ala Glu Met
                165                 170                 175

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

Gln Glu Ile Pro Ser Leu Leu Glu Phe Phe Gly Tyr Val Tyr Ser Phe
        195                 200                 205

Thr Thr Phe Leu Ala Gly Pro Ala Phe Glu Ile Arg Glu Tyr Leu Asp
    210                 215                 220

Val Thr Ser Gly Lys Lys Phe Leu Met Asp Gly Lys Asn Lys Glu Pro
225                 230                 235                 240

Ser Ser Val Leu Ala Ala Phe Ser Lys Phe Leu Val Gly Ser Leu Leu
                245                 250                 255

Met Ala Ala Phe Ala Val Tyr Gly Pro Met Tyr Pro Leu Ser Asn Leu
            260                 265                 270

His Asp Pro Lys Ile Ala Ala Gln Pro Leu Leu Tyr Gln Ile Arg Asp
        275                 280                 285
```

```
Leu Tyr Ile Ala Leu Ile Phe Cys Lys Ala Lys Tyr Tyr Ser Ala Trp
    290                 295                 300

Lys Ile Ala Glu Gly Ala Thr Val Leu Cys Gly Phe Gly Phe Glu Gly
305                 310                 315                 320

Phe Asn Lys Asp Gly Thr Ser Arg Gly Trp Asn Gly Val Ser Asn Met
                325                 330                 335

Asp Ile Leu Gly Phe Glu Phe Ser Gln Ser Ile Arg Ala Ala Ser Arg
            340                 345                 350

Ala Trp Asn Lys Gly Thr Gln Asn Trp Leu Glu Arg Tyr Val Tyr Thr
        355                 360                 365

Arg Thr Gly Asn Ser Leu Met Ala Thr Tyr Phe Ile Ser Ala Phe Trp
    370                 375                 380

His Gly Phe Tyr Pro Gly Tyr Tyr Ile Phe Phe Met Ser Leu Pro Leu
385                 390                 395                 400

Ala Thr Ala Val Asn Arg Leu Ala Phe Lys Arg Leu Arg Pro Arg Phe
                405                 410                 415

Ile Glu Ala Asp Gly Ser Phe Gly Ala Lys Lys Lys Ile Tyr Asp Val
            420                 425                 430

Leu Ser Tyr Leu Leu Thr Leu Phe Ala Met His Tyr Phe Val Met Pro
        435                 440                 445

Phe Gln Val Leu Asn Lys Tyr Leu
    450                 455

<210>  127
<211>  485
<212>  PRT
<213>  Phythophtora infestance

<400>  127

Met Arg Val Thr Arg Arg Ile Arg Arg Leu Ala Glu Ala Trp Ile Val
1               5                   10                  15

Phe Arg Tyr Arg Ala Ala Glu Gln Ser Met Glu Ile Leu Arg Gly Pro
            20                  25                  30

Val Asp Gly Ile Ala Leu Ser Glu Asn Phe Pro Val Asp Gly Phe Arg
        35                  40                  45
```

Leu Met Val Ala Leu Ala Gly Cys Ser Leu Ile Ala Pro Leu Ile His
50 55 60

Leu Thr Arg Gly Glu Thr Ser Arg His Leu Phe Asn Val Ala Val Gly
65 70 75 80

Leu Phe Ala Gly Val Phe Val Phe Asp Leu Ala Val Leu His Thr Ile
85 90 95

Gly Thr Ala Val Val Val Tyr Leu Leu Met Met Val Ala Pro Ser Leu
100 105 110

Trp Gly Ala Leu Cys Cys Arg Cys Cys Trp Arg Thr Ser His Tyr Tyr
115 120 125

Arg Glu Phe Tyr Ser Pro Asp Ile Val Trp Asp Ser Ala Gln Met Ile
130 135 140

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

Leu Pro Thr Glu Lys Lys Thr Pro Thr Met Leu Lys Asn Glu Leu Gln
165 170 175

Glu Ile Pro Glu Leu Ile Pro Tyr Phe Gly Phe Val Phe Phe Phe Pro
180 185 190

Thr Tyr Leu Ala Gly Pro Ala Phe Glu Tyr Lys Asp Tyr Ile Tyr Trp
195 200 205

Met Lys Asp Val Arg Val Ala Pro Phe Met Val His Leu Arg Asn Leu
210 215 220

Val Ile Ser Ala Ala Gly Phe Phe Val Ser Leu Gln Phe Pro Val Glu
225 230 235 240

Glu Ile Asp Ser Pro Asp Phe Phe Pro Lys Ser Ser Trp Ala Val Arg
245 250 255

Cys Leu Arg Met Cys Ile Pro Val Val Leu Phe Arg Phe Arg Tyr Tyr
260 265 270

Leu Ala Trp Ser Leu Ala Glu Ala Ala Ser Ala Ala Ala Gly Val Gly
275 280 285

Tyr Val Gln Ala Thr Gly Lys Trp Asn Gly Ile Thr Asn Asn Asp Leu
290 295 300

Leu Cys Val Glu Leu Pro Thr Asn Phe Arg Val Ala Ile Asn Ser Trp
305 310 315 320

Asn Ile Gly Val Ala Arg Trp Ile Asn Thr Tyr Ile Tyr Gln Arg Val
325 330 335

Gly Leu Thr Lys Ser Gly Lys Ser Thr Met Leu Ser Thr Met Ala Ser
340 345 350

Phe Phe Val Ser Ala Leu Trp His Gly Leu Ser Pro Gly Tyr Tyr Leu
355 360 365

Phe Phe Leu Leu Gly Gly Ile Tyr Ile Glu Val Gly Lys Gln Leu Arg
370 375 380

Arg Arg Leu Arg Pro Tyr Phe His Tyr Thr Glu Asp Arg Lys Ala His
385 390 395 400

Ser His Ala Ile Phe Leu Ser Tyr Phe Ser Gly Thr Ser His Pro Leu
405 410 415

Ala Phe Leu Tyr Asp Ile Ser Gly Met Phe Phe Thr Trp Val Ala Met
420 425 430

Gln Tyr Ala Gly Val Ala Phe Glu Ile Leu Asp Val Arg Arg Cys Leu
435 440 445

Ala Ile Trp Ser Ser Trp Tyr Phe Leu Pro His Leu Val Ser Ile Gly
450 455 460

Leu Leu Val Phe Phe Asn Leu Phe Pro Gln Arg Arg Ser Thr Pro Thr
465 470 475 480

Asp Lys Lys Thr Gln
485

<210> 128
<211> 558
<212> PRT
<213> Phythophtora infestance

<400> 128

Met Ser Thr Thr Ala Leu Leu Gln Ala Ser Thr Ser Pro Pro Pro Ser
1 5 10 15

Arg Glu Pro Glu Tyr Ala Ala Leu Glu Gln Leu Glu Pro Pro Leu Ser
20 25 30

His Ala Ile Asp Met Gly Val Lys Val Ser Pro Ser Glu Ser Ala Ala
35 40 45

Ile Ala Gly Gly Val Tyr Val Thr Ala Ser Ser Ser Cys Gly Ala Ser
50 55 60

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

Glu Lys Ala Lys Met Thr Ile Leu Cys Leu Leu Gly Val Pro Phe Ile
85 90 95

Arg Phe Val Leu Leu Leu Cys Val Gly Ile Leu Leu Val Ile Val Ser
100 105 110

His Leu Ala Leu Ile Gly Tyr Lys Pro Leu Asp Ala His Ser Gly Ala
115 120 125

Arg Pro Pro Leu Pro Arg Trp Arg Arg Ile Val Gly Ser Pro Val Pro
130 135 140

Tyr Leu Leu Arg Ser Leu Met Leu Ile Val Gly Tyr Tyr Trp Val Pro
145 150 155 160

Val Lys Tyr Pro Pro Asn Phe Asn Arg His Ala Met Pro Arg Val Ile
165 170 175

Val Ser Asn His Leu Thr Phe Phe Asp Gly Leu Tyr Ile Phe Thr Leu
180 185 190

Leu Ser Pro Ser Ile Ala Met Lys Thr Asp Val Ala Asn Leu Pro Leu
195 200 205

Ile Ser Arg Ile Val Gln Met Ile Gln Pro Ile Leu Ile Asp Arg Gly
210 215 220

Thr Pro Glu Gly Arg Arg Arg Ala Met Asn Asp Ile Thr Ser His Val
225 230 235 240

Ala Asp Pro Ser Lys Pro Pro Leu Leu Val Phe Pro Glu Gly Thr Thr
245 250 255

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

Gly Val Pro Cys Gln Pro Val Val Leu Arg Tyr Pro Tyr Lys His Phe
275 280 285

```
Asp Leu Ser Trp Pro Pro Gly Val Ser Gly Leu Tyr Leu Ala Leu Arg
    290                 295                 300

Val Leu Cys Gln Val Tyr Asn Arg Leu Glu Val Glu Ile Leu Pro Ala
305                 310                 315                 320

Tyr Tyr Pro Ser Glu Arg Glu Arg Lys Asp Pro Gln Leu Tyr Ala Ile
                325                 330                 335

Asn Val Arg Glu Val Met Ala Lys Ala Leu Gly Val Pro Thr Thr Asn
            340                 345                 350

His Ala Phe Glu Asp Val Ala Met Leu Met Arg Val Gly Asp Tyr Ala
        355                 360                 365

Thr Lys His Val Val Pro Leu Thr Asp Val Gly Glu Val Ile Ser Leu
    370                 375                 380

Thr Ala Leu Lys Arg Gly Asp Val Asp Arg Leu Val Gly Tyr Phe Arg
385                 390                 395                 400

Arg His Asp Leu Asp Lys Asp Gly His Leu Ser Met Gln Glu Leu Arg
                405                 410                 415

Ala Leu Phe Pro Asn Asp Asp Pro Val Ile Val Asp Gln Leu Phe Asp
            420                 425                 430

Leu Val Asp Leu Asp Asp Ser Gly Leu Ile Asp Phe Arg Glu Leu Cys
        435                 440                 445

Leu Ala Leu Arg Ala Leu Asn Pro Gln Asn Ile Asn Glu Gly Asp Asp
    450                 455                 460

Ala Leu Ala Lys Phe Ala Phe Arg Leu Tyr Asp Leu Asp Asn Asn Gly
465                 470                 475                 480

Val Ile Asp Ala Ser Glu Leu Glu Gln Leu Leu Arg Phe Gln Arg Asn
                485                 490                 495

Phe Tyr Gly Val Ser Glu Ala Ser Val Ala Ala Ala Leu Arg Gln Ala
            500                 505                 510

Gln Ala Glu Asn Thr Thr Gly Ile Thr Tyr Asn Arg Phe Glu Gln Leu
        515                 520                 525

Val Leu Gln Asn Pro Glu Val Leu Trp Tyr Val Arg Asp Lys Leu Glu
```

530 535 540

Val Leu Arg Gly Ser Met Arg Glu Ser Ser Leu Glu Ile Pro
545 550 555

<210> 129
<211> 348
<212> PRT
<213> Phythophtora infestance

<400> 129

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

Phe Val Pro Gln Arg Arg Arg Phe Thr Ser Gly Trp Pro Val Thr Ile
20 25 30

Leu Gln Val Ile Ser Gly Ser Ala Leu Ala Leu Val Arg Phe Pro Leu
35 40 45

Val Leu Val Ala Phe Val Ala Leu Phe Leu Val Asn Leu Val Val Ser
50 55 60

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

Glu Trp Leu Leu Cys Ser Leu Leu Leu Leu Leu Phe Gly Val Phe Thr
85 90 95

Ser Asn Gly Ser Thr Arg Val Gly Ser Gly Asp Val Leu Val Cys Asn
100 105 110

Tyr Thr Ser Phe Leu Glu Ile Leu Tyr Leu Ala Thr Arg Phe Ser Pro
115 120 125

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

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

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

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

Asn Gly Lys Ala Val Leu Lys Phe Ile Pro Val Leu Gln Asn Leu Pro

195 200 205

Val Lys Thr Arg Val His Leu Val Ala Phe Arg Tyr Glu Phe Lys Arg
210 215 220

Phe Ser Pro Ser Gln Ser Ala Gly Gly Ala Trp Ser His Leu Phe Trp
225 230 235 240

Thr Ala Phe His Val Tyr His Thr Met Arg Val Thr Val Leu Ser Ala
245 250 255

Lys Asp Leu Asn Leu Asp Asp Leu Thr Pro Thr Lys Leu Pro Ser Asn
260 265 270

Lys Ser Ser Lys Lys Gln Glu Asn Ser Lys Thr Leu Ser Thr Asp Gln
275 280 285

Val Glu Lys Leu Arg Thr Leu Leu Ala Ala Met Leu Arg Thr Lys Thr
290 295 300

Val Asp Leu Gly Pro Glu Asp Ser Val Ser Phe Asn Asn Tyr Trp Lys
305 310 315 320

His Val Asn Ser Gly Gly Arg Gln Pro Ala Ser Gln Phe Thr Asp Arg
325 330 335

Lys Ala Pro His Glu His Ala Gln Trp Ala Lys Arg
340 345

<210> 130
<211> 424
<212> PRT
<213> Phythophtora infestance

<400> 130

Met Ser Phe Ala Thr Pro Ala Gln Val Leu Gln Asp Val Arg Phe Glu
1 5 10 15

Glu Arg Phe Ala Glu Ile Glu Ser Arg Leu Pro Ala Thr Leu Ala Leu
20 25 30

Ala Lys Glu Gly Ser Leu Ala Lys Arg Asn Gln Thr Lys Arg Lys Leu
35 40 45

Tyr His Asp Ser Glu Leu Ile Arg Ile Glu Leu Glu Glu Arg Leu Asn
50 55 60

Glu Leu Gly Ile Glu Ser Gln Trp Val Thr Ala Pro Glu Met Lys Glu

```
65                  70                  75                  80

Ala Asn Glu Lys Leu Asp Ala Val Arg Lys Gln Leu Lys Leu Asp Val
                85                  90                  95

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

Met Leu Thr Met Val Leu Val Leu Val Gly Trp Leu Ser Cys Val Thr
        115                 120                 125

Val Leu Ile Pro Leu Lys Trp Leu Asn Pro Val Leu Lys Lys Met Gly
    130                 135                 140

Val Lys Lys Asn Tyr Leu Pro Met Asp Ile Val Ser Trp Gly Thr Ala
145                 150                 155                 160

Phe Met Val Cys Val Thr Ala Cys Thr Asp Met Lys Ala Glu Gly Val
                165                 170                 175

Glu Asn Leu Leu Asn Leu Lys Asp Ser Val Val Cys Met Phe Ser His
            180                 185                 190

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

Phe Lys Phe Ala Ala Lys Lys Ser Ile Phe Leu Val Pro Phe Leu Gly
    210                 215                 220

Trp Ser Ser Arg Trp Gly Phe Asp Phe Val Ala Ile Asp Arg Ser His
225                 230                 235                 240

Arg Lys Ser Ala Leu Lys Ser Leu Lys Glu Leu Ala Val Ser Val Asn
                245                 250                 255

Glu His Gly Asn Ser Val Cys Ile Ser Pro Glu Gly Thr Arg Ser Lys
            260                 265                 270

Asp Gly Leu Leu Gln Glu Phe Lys Lys Gly Pro Phe Tyr Leu Arg Glu
        275                 280                 285

Asp Thr Lys Lys Asn Val Val Pro Ser Ile Val Phe Gly Ala Tyr Glu
    290                 295                 300

Leu Trp Pro Pro Gly Arg Leu Phe Ser Ile Pro Gly His Thr Leu Val
305                 310                 315                 320
```

```
Arg Tyr Leu Pro Glu Tyr Lys Ser Asp Pro Asn Leu Asn Arg Asn Gln
                325                 330                 335

Asn Arg Leu Ala Leu Arg Arg Ile Tyr Leu Lys Ala Phe Thr Glu Asp
            340                 345                 350

Val Pro Asp Tyr Ile Gly Thr Arg Val Ser Thr Asn Phe Ile Leu Lys
        355                 360                 365

Asn Met Phe Tyr His Tyr Leu Ala Trp Ala Ile Thr Phe Lys Val Thr
    370                 375                 380

Ser Trp Ala Leu Thr Val Ile Ser Leu Val Leu Tyr Trp Leu Asn Ile
385                 390                 395                 400

Thr Tyr Gly Thr Phe Met Leu Phe Ser Leu Val Met Met Val Ala Gly
                405                 410                 415

Glu Ala Leu Met Phe Phe Thr Cys
            420


<210>  131
<211>  425
<212>  PRT
<213>  Phythophtora infestance

<400>  131

Met Ser Gln Ser Asp Glu Cys Gln Ala Thr Gln Thr Ser Val Tyr Pro
1               5                   10                  15

Thr Lys Arg Cys Val Ser Gly Gly Pro Val Val Glu Pro Asp Ala Glu
            20                  25                  30

Pro Val Leu Asn Arg Val Ile His Pro Ser Thr Lys Phe Glu Thr Ala
        35                  40                  45

Trp Thr Trp Ser Gly Cys Ile Ile Gly Cys Ser Tyr Leu Leu Leu Leu
    50                  55                  60

Val Val Cys Ala Phe Leu Asn Thr Thr Phe Val Leu Trp Pro Leu Thr
65                  70                  75                  80

Leu Leu Gln Trp Ser His Leu Leu Ser Thr Arg Ser Cys Arg Trp Ile
                85                  90                  95

Cys Arg Phe Leu Glu Asp Lys Tyr Phe Ala Met Leu Ser Gly Tyr Leu
            100                 105                 110
```

Glu Leu Val Gly Gly Val Lys Ile Ile Ile Thr Gly Asp Glu Glu Leu
115 120 125

Gln Phe Ala His His Glu His Val Leu Leu Ile Cys Asn His Arg Ser
130 135 140

Glu Val Asp Trp Ile Phe Phe Trp Asn Leu Ala Leu Arg Leu Asn Val
145 150 155 160

His Asp Arg Ile Arg Val Met Met Lys Ser Val Ile Arg Tyr Ala Pro
165 170 175

Gly Val Gly Trp Thr Met Met Leu Leu Arg Tyr Pro Tyr Val Asn Arg
180 185 190

Asn Trp Ala Thr Asp Gln Asp Arg Leu Thr Lys Val Ile Glu Ser Tyr
195 200 205

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

Ala Leu Tyr Asp Lys Thr Leu Lys Lys Ser His Glu Phe Ala Ser Lys
225 230 235 240

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

Phe Glu Leu Cys Met Asp Lys Met Asp Pro Asp Tyr Val Val Asp Leu
260 265 270

Thr Val Ala Tyr Pro Glu Leu Met Glu Gly Val Arg Pro Ser Pro Val
275 280 285

Arg Phe Val Arg Gly Gln Phe Pro Thr Glu Val His Met His Val Gln
290 295 300

Arg Tyr His Arg Ser Thr Leu Leu Lys His Lys Asp Arg Met Gly Gln
305 310 315 320

Trp Leu Lys Asp Arg Phe Ala Glu Lys Glu Glu Arg Leu Glu His Phe
325 330 335

Tyr Glu Thr Gly Ala Phe Gln Gly Glu Gln Gln Thr Ser Gly Gln His
340 345 350

Ala Ser Arg Val Ala Leu Leu Pro Ala Gln Gln Ile Leu Leu Phe Val
355 360 365

Gly Glu Asn Tyr Leu Thr Tyr Phe Trp Ser Arg Arg Arg Leu Ser Val
    370   375   380

Tyr Leu Arg Ala Phe Gln Val Ala Gly Ala Ser Ile His Ser Met Asp
385   390   395   400

Ser His Lys Ile His Asn Glu Lys His Gln Asp Lys Leu His Thr Arg
                405   410   415

Ser Ala Asp Glu Leu Arg Leu Phe Thr
            420   425

<210> 132
<211> 390
<212> PRT
<213> Phythophtora infestance

<400> 132

Met Ala Val Phe His Leu Tyr Ser Ala Leu Asn Leu Leu Trp Ile Leu
1   5   10   15

Cys Asn Ser Ala Cys Ile Asn Phe Leu Gln Phe Cys Leu Trp Cys Leu
            20   25   30

Val Arg Pro Phe Asn Lys Ala Leu Tyr Arg Arg Leu Met Gly Ser Val
        35   40   45

Ala Gln Ser Leu Trp Val Asp Val Thr Ser Thr Ser Phe Pro Gln Thr
    50   55   60

Lys Leu Ser Val Thr Gly Glu Leu Pro Ser Asp Pro Thr Lys Pro Val
65   70   75   80

Ile Ile Ile Ala Asn His Gln Val Asp Ala Asp Trp Trp Tyr Ile Trp
                85   90   95

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

Lys Asp Gln Leu Lys Tyr Leu Pro Ile Ile Gly Trp Gly Met Arg Leu
        115   120   125

Phe Gln Phe Leu Phe Leu Arg Arg Arg Ile Asp Gln Asp Ala Glu His
    130   135   140

Ile Lys Lys Tyr Met Gly Gly Leu Ile Ser Asp Asn Phe Pro Phe Trp
145   150   155   160

Leu Val Leu Phe Pro Glu Gly Thr Thr Ile His Arg Glu Tyr Val Val
165 170 175

Lys Ser Gln Ala Phe Ala Ala Arg Glu Ala Arg Pro Lys Phe Glu Arg
180 185 190

Val Leu Leu Pro Arg Thr Thr Gly Met Arg Ile Ile Leu Asp Ala Val
195 200 205

Ala Asp Ala Lys Pro Asp Ile Tyr Asp Leu Thr Val Ala Phe Pro Ser
210 215 220

Tyr Ser Gly Glu Val Pro Thr Phe Asp Met Gly Tyr Gly Arg Arg Val
225 230 235 240

Asp Thr Glu Val Pro Ser Met Lys Ser Leu Leu Ala Gly Lys Gln Pro
245 250 255

Val Gly Arg Val Ala Leu His Ser Arg Lys Phe Lys Tyr Glu Asp Ala
260 265 270

Ala Thr Asp Leu Gln Gly Phe Leu Asp Ala Arg Trp Thr Glu Lys Glu
275 280 285

Glu Arg Met Asn Tyr Phe Ile Lys His Gln Gln Phe Pro Glu Thr Glu
290 295 300

Ser Thr Val Glu Met Gln Leu Ser Thr Ser Met Gly Ala Val Phe Arg
305 310 315 320

Leu Trp Met Gly Ile Leu Leu Ser Cys Val Val Leu Pro Val Val Met
325 330 335

Met Leu Phe Phe Pro Leu Tyr Phe Thr Trp Val Val Tyr Cys Phe Val
340 345 350

Tyr Ser Val Tyr Asp Arg Thr Thr Asn Phe Trp Trp Pro Tyr Ile Phe
355 360 365

Asn Leu Phe Val Glu Arg Ala Thr Lys Thr His Glu His Phe Lys Arg
370 375 380

His Gln Ala Lys Tyr Leu
385 390

<210> 133
<211> 369

<212> PRT
<213> Phythophtora infestance

<400> 133

```
Met Gly Val Ala Val Val Gly Val Val Phe Leu Thr Ser Leu Val Val
1               5                   10                  15

Thr Gly Trp Thr Gly Val Ala Trp Ile Leu Thr Pro Cys Phe Leu Leu
            20                  25                  30

Ala Ala Leu Pro Leu Pro Ala Phe Leu Gln Thr Lys Arg Phe Tyr Arg
        35                  40                  45

Arg Val Thr Arg Phe Ile Gln Trp Ala Trp Met Gly Gln Val Lys Leu
    50                  55                  60

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

Glu Ser Glu Leu Ser Lys Asp Arg Ala Leu Trp Leu Ser Asn His Arg
                85                  90                  95

Thr Arg Ile Asp Trp Met Leu Leu Trp Ser Val Ala Trp Arg Thr Arg
            100                 105                 110

Thr Leu His Gln Leu Arg Ile Val Leu Lys Ala Pro Leu Arg Lys Met
        115                 120                 125

Pro Ile Phe Gly Trp Ala Met Gln His Phe Ile Phe Ile Phe Leu Gln
    130                 135                 140

Arg Arg Trp Ala Asp Asp Gln Val Asn Leu Arg Lys Leu Leu Pro Phe
145                 150                 155                 160

Leu Thr Ser Thr Glu Pro Glu Ala Ser Tyr Leu Leu Phe Pro Glu Gly
                165                 170                 175

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

Lys Lys Ser Leu Ser Pro Arg Gln Tyr Ser Leu Tyr Pro Arg Thr Thr
        195                 200                 205

Gly Trp Thr Phe Met Phe Pro Leu Leu Arg Ser Gln Leu Thr Ala Val
    210                 215                 220

Tyr Asp Val Thr Met Phe Tyr Val Asp Tyr Ala Ala Asn Glu Arg Pro
225                 230                 235                 240
```

Ser Glu Ser Ser Leu Leu Thr Gly Arg Met Pro Arg Met Ile His Phe
245 250 255

Tyr Ile Glu Arg Val Asp Ile Ser Val Leu Arg Asp Lys Ser Glu Thr
260 265 270

Asp Leu Ala Ala Trp Leu Glu Lys Arg Phe Glu Arg Lys Glu Ser Leu
275 280 285

Leu Lys Ala Phe Tyr Glu Asp Asn Gly Lys Leu Pro His Gly Ala Glu
290 295 300

Pro Leu Phe Gln Glu Asn Gln Gly Thr Ala Met Val Met Leu Val Ala
305 310 315 320

Phe Trp Leu Ile Ser Ile Gly Ala Ala Thr Leu Leu Gly Leu Ile Gly
325 330 335

Asn Phe Ile Ser Val Ile Ala Ala Leu Ala Val Val Val Gly Tyr Ala
340 345 350

Thr Asn Thr Ala Tyr Gly Pro Gly Val Asp Gly Phe Leu Ile Asn Asn
355 360 365

Ser

<210> 134
<211> 447
<212> PRT
<213> Phythophtora infestance

<400> 134

Met Gly Pro Arg Val Glu Pro Pro Asn Ser Gly Arg Ser Pro Thr Ala
1 5 10 15

Ser Lys Arg Arg Met Lys Lys Phe Arg Asp Val Val Ser Pro Leu Asp
20 25 30

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

Tyr Asn Leu Ala Met Leu Ser Gly Val Leu Tyr Val Phe Thr Thr Leu
50 55 60

Phe Thr Asn Leu Leu Met Thr Asn Glu Pro Ile Asp Ser Lys Leu Leu
65 70 75 80

```
Leu Ser Val Phe Tyr Ser Thr His Leu Leu Glu Val Leu Ala Thr Phe
                85                  90                  95

Val Cys Gln Ala Leu Tyr Ala Tyr Thr Ala Leu Ile Pro Val Tyr Met
            100                 105                 110

Ala Gly Thr Asp Lys Pro Asn Arg Leu Leu Ile Asn Ile Val His His
        115                 120                 125

Thr Leu Gln Ser Leu Leu Phe Phe Phe Thr Ile Val Phe Ile Val Trp
    130                 135                 140

Arg Asp Trp Asn Leu Ile His Ala Val Ser Ala Phe Ile Glu Gly Leu
145                 150                 155                 160

Val Leu Leu Met Lys Met His Ser Tyr Ile Arg Thr Lys Leu Glu Ile
                165                 170                 175

Ser Arg Thr Glu Asn Lys Pro Pro Ile Pro Asp Ile Lys Asp Phe Thr
            180                 185                 190

Met Tyr Leu Leu Ile Pro Ser Leu Val Tyr Glu Pro Asn Phe Pro Arg
        195                 200                 205

Thr Cys Arg Ile Arg Trp Ala Tyr Leu Ala Glu Lys Thr Phe Ser Val
    210                 215                 220

Ile Met Gly Ile Ser Met Leu Tyr Ile Ile Val Thr Thr His Val Met
225                 230                 235                 240

Pro Arg Leu Glu Asp Ser Gly Thr Val Asn Pro Val Leu Ser Val Val
                245                 250                 255

Ser Leu Leu Leu Pro Phe Leu Gly Cys Tyr Leu Leu Thr Trp Phe Ile
            260                 265                 270

Ile Phe Glu Cys Ile Cys Asn Gly Phe Ala Glu Val Thr Tyr Ser Ala
        275                 280                 285

Asp Arg Asp Phe Tyr Gly Asp Trp Trp Asn Ser Thr Thr Phe Asp Glu
    290                 295                 300

Phe Ala Arg Lys Trp Asn Lys Pro Val His Glu Phe Leu Leu Arg His
305                 310                 315                 320

Val Tyr Leu Glu Thr Leu Asp Ser Tyr Lys Ile Ser Lys Thr Tyr Ala
```

```
                325                 330                 335

Thr Met Phe Thr Phe Phe Met Ser Ala Ala Leu His Glu Cys Val Phe
            340                 345                 350

Ile Leu Met Phe Arg Thr Val Arg Met Tyr Phe Phe Thr Leu Gln Met
        355                 360                 365

Val Gln Leu Val Thr Ile Val Tyr Gly Arg Gly Leu Arg Gly Ser Arg
    370                 375                 380

Met Gly Asn Ile Thr Phe Trp Leu Gly Met Ile Leu Gly Leu Pro Leu
385                 390                 395                 400

Gln Ala Val Ile Tyr Ser Arg Glu Tyr His Gly Gly Glu Pro Ile Phe
                405                 410                 415

Met Val Ile Met Met Pro Ala Met Ile Phe Gly Phe Gly Gly Val Leu
            420                 425                 430

Val Ala Ser Leu Met His Leu Ser Arg Leu Arg Lys Lys Gln Ala
        435                 440                 445


<210>  135
<211>  308
<212>  PRT
<213>  Phythophtora infestance

<400>  135

Met Thr Gly Gln Gln His Thr Trp Leu Leu Gly Val Gly Leu Ala Val
1               5                   10                  15

Ala Thr Ile Ser Leu Cys Val Ala Ile His Ala Ser Ala Leu Ile Thr
            20                  25                  30

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

Ser Glu Tyr Thr Gly Glu Arg Tyr Trp Pro Trp Phe Ala Thr Phe Ile
    50                  55                  60

Gly His Gly Met Ala His Ile Pro Gly Thr Leu Glu Phe Glu Glu Pro
65                  70                  75                  80

Ile Asp Ala Ser Lys Gln His Ile Phe Cys Ser His Pro His Gly Leu
                85                  90                  95

Leu Ser Thr His His Gly Leu Leu Met Ser Gly Gln Thr Val Pro Pro
```

```
            100                 105                 110

Phe Tyr Glu Thr Val Pro Leu Ser Thr Arg Arg His Leu Ala Ala Ser
        115                 120                 125

Val Cys Phe Arg Ile Pro Phe Tyr Arg Glu Tyr Val Leu Trp Ser Gly
    130                 135                 140

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

Lys Ser Leu Val Ile Leu Val Gly Gly Ile Ala Glu Gln Met Leu Ser
                165                 170                 175

Gln Arg Gly Asp His Thr Ile Tyr Val Lys Lys Arg Lys Gly His Ile
            180                 185                 190

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

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

Gln Thr Ile Ala Lys Lys Phe Ser Val Ala Leu Leu Leu Gly Arg Gly
225                 230                 235                 240

Tyr Ser Lys Trp Leu Phe Trp Leu Pro His Lys Gly Val Thr Ile Asn
                245                 250                 255

Gln Val Phe Gly Lys Pro Ile Pro Val Leu Lys Lys Asp Asp Pro Ser
            260                 265                 270

Ser Asp Asp Ile Glu Lys Leu His His Gln Tyr Glu Arg Glu Leu Val
        275                 280                 285

Arg Ile Phe Asp Lys Tyr Lys Glu Lys His Gly Tyr Gly Asn Cys Thr
    290                 295                 300

Leu His Val Arg
305

<210>  136
<211>  392
<212>  PRT
<213>  Phythophtora infestance

<400>  136

Met Ser Ala Ala Gln Val Leu Asn Asn Ala Ala Tyr Gly Arg Thr Ser
```

```
1               5                   10                  15

Ala Trp Pro Asp Ser Asn Thr Arg Pro Asp Leu Gln Thr Leu Arg Gly
            20                  25                  30

Arg Phe Leu Arg Arg Leu His Leu Ser Leu Ile Tyr Gly Leu Trp Val
        35                  40                  45

Leu Gly Thr Leu Phe Asn Ala Ala Met Trp Val Phe Ser Leu Val Cys
    50                  55                  60

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

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

Ser Tyr His Phe Val Thr Arg Pro Ser His His Pro Trp Pro Phe Met
            100                 105                 110

Arg Arg Leu Ile Arg Tyr Ser Leu Leu His Tyr Pro Tyr Phe Arg Leu
        115                 120                 125

Asn Ala Thr Val Phe Asp Glu Arg Glu Arg Ala Lys Gln Leu Ser Gln
    130                 135                 140

Asp Gly Ala Thr Asn Asp Thr Ser Ala Phe Asn Thr Glu Ile Ala Ser
145                 150                 155                 160

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

Ser Ala Met Phe Ala Phe His Pro His Ser Val Leu Ser Asn Gly Trp
            180                 185                 190

Val Ala Asn Gly Ala Asn His Met Ser Phe Glu Gln Ala Asp Cys Arg
        195                 200                 205

Trp Leu Val Ala Glu Asn Leu Phe Gly Val Pro Leu Met Arg Asp Leu
    210                 215                 220

Leu Asn Trp Met Asp Phe Ser Ser Val Ala Lys Ser Thr Phe Gln Gln
225                 230                 235                 240

Arg Met Ser Ala Arg Gln Asn Val Cys Leu Ile Pro Gly Gly Phe Glu
                245                 250                 255
```

```
Glu Ala Thr Leu Tyr Glu Arg Gly Lys His Arg Val Tyr Ile Lys Lys
            260                 265                 270

Arg Phe Gly Phe Ile Lys Leu Ala Leu Gln Tyr Gly Tyr Lys Val His
        275                 280                 285

Pro Val Tyr Thr Phe Gly Glu Glu Tyr Ala Tyr His Thr Phe Pro Tyr
    290                 295                 300

Leu Leu Lys Leu Arg Leu Lys Leu Asn Glu Phe Lys Ile Pro Gly Val
305                 310                 315                 320

Phe Phe Phe Gly Leu Pro His Cys Phe Phe Leu Pro Arg Thr Asp Val
                325                 330                 335

Asp Leu Ile Thr Val Val Gly Glu Pro Leu Val Leu Pro Arg Ile Glu
            340                 345                 350

Gln Pro Thr Lys Glu Asp Val Gln Lys Tyr Gln Gly Gln Tyr Val Glu
        355                 360                 365

Ala Leu Gln Lys Leu Phe Asn Lys Tyr Lys Ser Val Tyr Ala Val Asp
    370                 375                 380

Pro Gln Ala Gln Leu Glu Ile Tyr
385                 390


<210>  137
<211>  381
<212>  PRT
<213>  Phythophtora infestance

<400>  137

Met Ala Lys Leu Thr Asn Ala Ala Cys Gly Arg Thr Ser Ala Trp Pro
1               5                   10                  15

Asp Phe Asp Thr Arg Pro Glu Leu Arg Thr Leu Arg Gly Arg Phe Met
            20                  25                  30

Arg Arg Phe Asp Leu Phe Ile Leu Tyr Gly Leu Trp Val Val Gly Leu
        35                  40                  45

Leu Phe Leu Ala Val Met Trp Val Phe Ser Leu Phe Cys Leu Val Gln
    50                  55                  60

Trp Ser Trp Arg Arg Ala Thr His Asp His Ala Pro Pro Met Ala Phe
65                  70                  75                  80
```

```
Ser Ala Gln Ile Tyr Leu Gly Phe Ile Val Leu His Glu Ser Tyr His
                85                  90                  95

Tyr Leu Thr Lys Pro Ser Leu His Gln Trp Pro Phe Met Arg Arg Phe
            100                 105                 110

Phe Arg Gln Val Phe Leu His Tyr Pro Tyr Phe Arg Leu Asn Val Leu
        115                 120                 125

Val Phe Glu Glu Arg Ser Lys Thr Ser Ser Glu Asn Gly Lys Cys Asn
    130                 135                 140

Lys Glu Ile Ala Ser Lys Ala Val Glu Glu Asn Asn Leu Ser Pro Phe
145                 150                 155                 160

Val Thr Pro Asp Asp Arg Ala Leu Phe Ala Phe His Pro His Gly Val
                165                 170                 175

Leu Ser Ser Gly Phe Ala Phe Asn Gly Ala His His Met Gly Phe Leu
            180                 185                 190

His Ala His Cys Arg Trp Leu Val Ser Glu Asn Leu Phe Trp Phe Pro
        195                 200                 205

Val Met Arg Asp Leu Leu Asn Trp Met Asp Phe Ser Cys Val Ser Arg
    210                 215                 220

Ser Thr Phe His Arg Phe Met Ala Thr Gly Gln Asn Val Cys Leu Ile
225                 230                 235                 240

Pro Gly Gly Phe Glu Asp Ala Thr Leu Tyr Glu Arg Gly Lys His Arg
                245                 250                 255

Val Tyr Ile Lys Lys Arg Phe Gly Phe Ile Lys Leu Ala Leu Gln Tyr
            260                 265                 270

Gly Tyr Lys Val His Pro Val Tyr Thr Phe Gly Glu Glu Tyr Ala Tyr
        275                 280                 285

His Thr Phe Pro Tyr Leu Leu Lys Leu Arg Leu Lys Leu Asn Glu Phe
    290                 295                 300

Lys Ile Pro Gly Val Phe Phe Phe Gly Leu Pro His Cys Phe Phe Leu
305                 310                 315                 320

Pro Arg Thr Asp Val Asp Leu Ile Thr Val Val Gly Glu Pro Leu Val
                325                 330                 335
```

```
Leu Pro Arg Ile Glu Gln Pro Thr Lys Glu Asp Val Gln Lys Tyr His
            340                 345                 350

Gly Gln Tyr Val Glu Ala Leu Gln Lys Leu Phe Asn Lys Tyr Lys Ser
        355                 360                 365

Val Tyr Ala Val Asp Pro Asp Ala Glu Leu Glu Leu Tyr
    370                 375                 380


<210>  138
<211>  283
<212>  PRT
<213>  Phythophtora infestance

<400>  138

Met Glu Ala Phe Val Pro Val Leu Leu Leu Thr Ile Thr Ala Tyr Met
1               5                   10                  15

Tyr Glu Phe Thr Tyr Arg Gly His Pro His Gln Thr Gly Cys Arg Glu
            20                  25                  30

Arg Leu Asp Trp Ile Tyr Gly His Ser Phe Leu Ile Glu Thr Val Lys
        35                  40                  45

Arg Tyr Phe Ser Glu Lys Ile Ile Arg Met Ala Pro Leu Asp Pro Lys
    50                  55                  60

Lys Gln Tyr Val Leu Gly Phe His Pro His Gly Ile Thr Pro Thr Ser
65                  70                  75                  80

Val Met Trp Leu Gln Phe Ser Ala Glu Trp Arg Arg Leu Phe Pro Asn
                85                  90                  95

Phe Tyr Ala His Ile Leu Thr Ala Gly Ile Met His Ala Leu Pro Leu
            100                 105                 110

Ala Arg Asp Ile Leu Gln Phe Leu Gly Ser Arg Glu Val Thr Arg Gln
        115                 120                 125

Ala Phe Thr Tyr Thr Leu Gln His Asn Glu Ser Val Leu Leu Val Pro
    130                 135                 140

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

Arg Val Tyr Thr His His Lys Gly Phe Ile Arg Leu Ala Ile Glu His
                165                 170                 175
```

Gly Val Pro Leu Val Pro Val Leu Ser Phe Asn Glu Gly Glu Met Leu
180 185 190

Asp Asn Ile Gln Ala Pro Met Leu Gln Arg Trp Phe Val Ile Lys Leu
195 200 205

Ala Phe Pro Phe Pro Phe Phe Pro Tyr Gly Arg Ala Leu Leu Pro Ile
210 215 220

Pro Arg Lys Val Gln Ile Pro Ile Val Val Gly Ala Pro Leu Glu Val
225 230 235 240

Pro His Met Lys Lys Pro Ser His Glu Asp Ile Asp Lys Val His Ala
245 250 255

Arg Tyr Phe Asp Glu Leu Arg Asp Met Phe Ala Lys Tyr Lys Asp Glu
260 265 270

Ala Gly Cys Gly Asp Tyr Lys Leu Ile Tyr Val
275 280

<210> 139
<211> 349
<212> PRT
<213> Phythophtora infestance

<400> 139

Met Ala Ser Glu Thr Gln Ala Asp Pro Val Gln Thr Asp Lys Gly Leu
1 5 10 15

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

Lys Trp Met Gln Leu Leu Ile Thr Asp Val Phe Ser Phe Val Thr Thr
35 40 45

His Tyr Phe Val Trp Ser Leu Pro Phe Leu Ala Leu Phe Cys Tyr Leu
50 55 60

His Gln His Glu Leu Asp Tyr Val Ser Val Ala Met Ile Ala Leu Tyr
65 70 75 80

Leu Pro Ser Phe Phe Ser Gly Ala Gln Lys Thr Gly Lys Gly Asn Glu
85 90 95

Trp Glu Ala Ala Arg Thr Ser Ser Leu Trp Gly Leu Met Asn Lys Phe
100 105 110

Leu Arg Val Lys Ile Ile Arg Glu Gln Glu Leu Asp Pro Lys Lys Lys
115 120 125

Phe Ile Phe Gly Phe His Pro His Gly Ile Leu Val Leu Ser Arg Ile
130 135 140

Ala Gly Phe Gly Arg Asn Phe Ile Asp Val Cys Pro Gly Ile Thr Thr
145 150 155 160

Arg Phe Leu Gly Ala Ser Ala Met Tyr Tyr Ile Pro Leu Gly Arg Glu
165 170 175

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

Lys Val Leu Lys Glu Gly Asn Ser Ile Ile Val Tyr Pro Gly Gly Val
195 200 205

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

Leu Lys Lys Arg Leu Gly Phe Ile Lys Leu Ala Met Arg Gln Gly Ala
225 230 235 240

Gln Leu Val Pro Thr Phe Val Phe Gly Glu Lys Trp Leu Tyr Asn Met
245 250 255

Trp Thr Pro Pro Glu Ser Val Thr Asn Phe Phe Arg Lys Thr Leu Gly
260 265 270

Ile Pro Val Leu Val Phe Trp Gly Lys Phe Trp Trp Met Pro Lys Ala
275 280 285

Pro Gly Glu Gly Lys Arg Tyr Gly Leu Val Tyr Gly Lys Pro Ile Ala
290 295 300

Thr Lys His Asp Ser Asn Pro Ser Asp Glu Glu Ile Arg Ala Val His
305 310 315 320

Ala Glu Tyr Val Ser Glu Ile Glu Arg Ile Phe Ser Gln Tyr Lys Ser
325 330 335

Glu Phe Gly Tyr Asp Glu Asp Glu Thr Leu Ala Ile Ile
340 345

<210> 140
<211> 403

```
<212>  PRT
<213>  Phythophtora infestance

<400>  140

Met Pro Gln Ala Cys Gly Arg Thr Ser Ala Trp Leu Asp Asn Asp Ala
1               5                   10                  15

Arg Pro Glu Leu Gln Thr Leu His Gly Arg Ile Leu Arg Phe Val Leu
            20                  25                  30

Leu Trp Tyr Leu Phe Gly Leu Trp Ile Val Gly Leu Ala Ser Phe Ile
        35                  40                  45

Gly Met Trp Leu Phe Ser Gly Leu Cys Thr Ile Arg Ser Leu Leu Ser
    50                  55                  60

Phe Leu His Asn Gly Gly Ser Trp Thr Ala Ala Thr Pro Leu Pro Val
65                  70                  75                  80

Leu Val Gln Val Tyr Leu Val Gly Met Ile Ala Tyr Glu Ser Tyr His
                85                  90                  95

Tyr Val Thr Arg Asn Ala Leu His Glu Trp Pro Leu Ile Arg Arg Val
            100                 105                 110

Val Arg Tyr Val Phe Leu His Tyr Pro Tyr Phe Arg Leu Asn Ala Val
        115                 120                 125

Val Phe Glu Glu Arg Glu Asp Ala Lys Gln Asn Val Glu Ile Gln Glu
    130                 135                 140

Pro Glu Gln Glu Lys Asp Gly Asn Asp Ser Thr Thr Asn Lys Ser Asp
145                 150                 155                 160

Asp Ala Arg Tyr Phe Ser Ser Lys Ala Ala Ala Ala Ala Ile Glu Glu
                165                 170                 175

Asn Asp Val Thr Pro Tyr Val Glu Pro Asp Lys Arg Ala Leu Phe Thr
            180                 185                 190

Phe His Pro His Gly Val Leu Thr Cys Gly Phe Ser Phe Asn Gly Ala
        195                 200                 205

His His Met Ala Phe Gln Arg Ala Ala Cys Arg Trp Ile Ser Ala Glu
    210                 215                 220

Asn Leu Phe Tyr Phe Pro Ile Met Arg Asp Ile Leu His Trp Met Glu
225                 230                 235                 240
```

Phe Ser Ser Ser Thr Lys Thr Ser Met Glu Asn Thr Met Arg Thr Gly
245 250 255

Gln Asn Leu Cys Leu Leu Pro Gly Gly Phe Glu Glu Ala Thr Leu Tyr
260 265 270

Gln Arg Gly Lys His Arg Val Tyr Ile Gln Lys Arg Phe Gly Phe Ile
275 280 285

Lys Leu Ala Leu Gln His Gly Tyr Asp Ile Tyr Pro Ala Tyr Thr Phe
290 295 300

Gly Glu Glu Tyr Thr Tyr His Ala Phe Pro Tyr Leu Gln Trp Leu Arg
305 310 315 320

Leu Gln Leu Asn Arg Phe Arg Ile Pro Gly Val Ile Phe Phe Gly Ile
325 330 335

Pro Phe Cys Phe Phe Met Pro Arg Ser Asp Val Asp Leu Ile Thr Val
340 345 350

Ile Gly Lys Pro Leu Arg Leu Pro His Ile Asp Asn Pro Ser Arg Asp
355 360 365

Glu Val Lys Glu Asn His Asp Lys Tyr Val Glu Ala Leu Arg Asp Leu
370 375 380

Phe Asp Arg Tyr Lys Cys Val Tyr Ala Ala Asp Pro Asp Ala Glu Leu
385 390 395 400

Glu Ile Phe

<210> 141
<211> 406
<212> PRT
<213> Phythophtora infestance

<400> 141

Met Val Gly Val Ala His Ala Ala Thr Gly Arg Thr Pro Leu Trp Pro
1 5 10 15

Asn Asn Asn Ala Val Pro Glu Leu Gln Thr Leu Arg Gly Tyr Val Gly
20 25 30

Arg Arg Phe Leu Leu Trp Ser Leu Phe Gly Leu Trp Ile Phe Gly Leu
35 40 45

```
Gly Ala Tyr Ile Leu Met Trp Leu Tyr Ser Gly Trp Cys Val Gly His
    50                  55                  60

Trp Ala Trp Thr Ala Leu Gln Thr Lys Ser Trp Ala Leu Ala Thr Pro
65                  70                  75                  80

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

Ser Tyr His Tyr Ile Thr Arg Asp Ser Leu His Leu Trp Pro Arg Met
            100                 105                 110

Arg Arg Leu Ala Arg His Ile Leu Leu Arg Tyr Pro Tyr Phe Arg Leu
        115                 120                 125

Asn Val Thr Ile Phe Glu Glu Arg Glu Leu Glu Lys Gln Lys Gln Arg
    130                 135                 140

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

Glu Gln Asp Glu Ser Glu His Leu Ser Pro Ala Ala Ala Ile Lys Ala
                165                 170                 175

Val Glu Glu Asn Asp Ile Ser Pro Tyr Val Glu Thr Gly Thr Lys Asn
            180                 185                 190

Leu Phe Ala Phe His Pro His Gly Ile Leu Thr Cys Gly Phe Ser Phe
        195                 200                 205

Asn Gly Ala Tyr His Met Ser Phe Glu Arg Ser Ala Cys Arg Trp Leu
    210                 215                 220

Ser Ala Glu Asn Leu Phe Trp Phe Pro Leu Val Arg Asp Leu Leu Asn
225                 230                 235                 240

Trp Met Glu Tyr Ser Ser Cys Ala Lys Ala Asn Met Leu Lys Phe Met
                245                 250                 255

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

Thr Leu Tyr Gln Arg Gly Lys His Arg Leu Tyr Leu Lys Lys Arg Phe
        275                 280                 285

Gly Phe Ile Lys Ile Ala Leu Gln His Gly Tyr Asn Val His Pro Val
```

290 295 300

Tyr Thr Phe Gly Glu Glu Tyr Thr Tyr His Ala Phe Pro Tyr Leu Gln
305 310 315 320

Ser Leu Arg Leu Gln Leu Asn Arg Leu Gln Ile Pro Gly Thr Ile Phe
325 330 335

Phe Gly Glu Ala Ser Cys Phe Tyr Leu Pro Arg Asn Asp Ile Asp Leu
340 345 350

Ile Thr Val Val Gly Lys Ser Leu Arg Phe Pro Arg Ile Glu His Pro
355 360 365

Ser Lys Glu Asp Val Gln Lys Tyr Gln Ala Gln Tyr Ile Glu Ala Leu
370 375 380

Arg Ser Leu Phe Asp Ser Tyr Lys Gly Val Tyr Ala Val Asp Pro Asn
385 390 395 400

Ala Thr Leu Glu Ile Phe
405

<210> 142
<211> 516
<212> PRT
<213> Phythophtora infestance

<400> 142

Met Asp Val Glu Asn Ser Leu Leu Thr Arg Leu Ala Ala Asn Gly Pro
1 5 10 15

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

Ala Leu Ser Gly Val Val Ser Thr Val Ser Gln Gln Arg Gln Lys Pro
35 40 45

Ser Glu Asp Glu Thr Leu Gln Gly Arg Lys Leu Thr Arg Lys Leu Ser
50 55 60

Ser Met Gly Leu Ser Thr Leu Val Thr Glu Thr Pro Thr Asn Leu Ser
65 70 75 80

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

Tyr Val Glu Arg Leu Arg Ala Arg Ile Leu His Asp Ala Phe Phe Leu

```
            100                 105                 110

Arg Trp Arg Ser Val Val Arg Gly Asp Tyr Lys Thr Gly Val Tyr Lys
        115                 120                 125

Tyr Val Glu Val Pro Gly Tyr Asp Val Ala Gln Asn Val Val Glu His
    130                 135                 140

Thr Val Glu Glu Gly Glu Thr Thr Met Ser Tyr Val Glu Ser Ala Leu
145                 150                 155                 160

Val Asn Thr Pro Leu Asp Phe Asp Lys Pro Leu Trp Glu Met His Val
                165                 170                 175

Ile His Asp Pro Lys Gly Asn Pro Gly Asn Thr Ser Val Gly Trp Lys
            180                 185                 190

Val His His Cys Leu Gly Asp Gly Ala Ser Leu Ala Thr Ala Met Ala
        195                 200                 205

Lys Leu Ser Asp Gln Ser Glu Leu Phe Asp Ala Met Val Glu Lys Arg
    210                 215                 220

Leu Gln Ala Lys Lys Ser Pro Lys Thr Pro Lys Pro Arg Lys Pro Val
225                 230                 235                 240

Thr Gln Ile Ile Lys Asp Ile Leu Val Phe Leu Tyr Val Cys Ile Trp
                245                 250                 255

Ser Val Tyr Val Ile Ser Tyr His Met Phe Ala Leu Val Thr Arg Arg
            260                 265                 270

Glu Pro Ala Thr Val Phe Lys Arg Pro Gly Gly Lys Gln Lys Arg Leu
        275                 280                 285

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

His Phe Arg Ala Thr Val Asn Asp Val Met Leu Asn Val Val Ala Gly
305                 310                 315                 320

Ala Met Arg Lys Thr Met Leu Ser Val Gly Glu Ser Val Ala Pro Thr
                325                 330                 335

Leu Lys Val Arg Cys Ala Ile Pro Val Asp Met Arg Ser Ser Thr Glu
            340                 345                 350
```

Val Ile Arg His Thr Ser Asn Arg Phe Ser Ser Leu Val Ile Asp Leu
355 360 365

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

Ala Met Asn Asp Ala Lys Asn Ser Leu Glu Lys Phe Phe Val Tyr Trp
385 390 395 400

Ser Thr His Leu Val Ser Met Leu Pro Ala Pro Leu Met Arg Leu Ile
405 410 415

Val His Phe Thr Thr Ser Arg Ile Ser Val Ala Thr Ser Asn Val Arg
420 425 430

Ala Ser Val Val Glu Val Ser Leu Cys Lys Ser Pro Val Ser Gly Phe
435 440 445

Tyr Gly Phe Val Pro Pro Pro Pro Tyr Val Asn Leu Gly Val Ala Ile
450 455 460

Leu Ser Met Gly Asp Asp Leu Gly Leu Asn Val Leu Val Asp Pro Cys
465 470 475 480

Val Gly Val Asn Ala Lys Gln Phe Leu Glu Phe Ala Lys Glu Glu Phe
485 490 495

Thr Ala Leu Gln Glu Ser Val Ala Ala Met Glu Ala Asn Ala Gly Asp
500 505 510

Lys Lys Thr Lys
515

<210> 143
<211> 675
<212> PRT
<213> Phythophtora infestance

<400> 143

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

Pro His Gly Gly Thr Ser Ser Asp Arg Pro Ser Ser Pro Glu Ala Leu
20 25 30

Ala Glu Glu Ala Val Ala Ser Ala Phe Ser Ala Pro Lys Asp Glu Gln
35 40 45

```
Ser Arg Thr Lys Glu Thr Phe Gln His Ala Ala Arg Ser Leu Gly Arg
    50                  55                  60

Thr Gln Ser Trp His Ala Arg Ala Ala Asp His Val Ala Arg Lys Arg
65                  70                  75                  80

Ile Tyr Ser Ile Met Ala Gly Val Ile Ile Gly Val Ala Ala Val Ile
                85                  90                  95

Asn Phe Gln Arg Phe Tyr Leu Glu Lys Pro Leu Ile Ser Glu Asp Ser
            100                 105                 110

Leu Leu Met Val Arg Glu Met Phe Asp Asn Phe Asn Trp Ser Val Asn
        115                 120                 125

Val Lys Glu Glu Leu Met Ala Ala Phe Asp Asn Arg Pro Pro Leu Met
    130                 135                 140

Gly Ala Ala Glu Ile Arg Pro Gly Val Gln Leu Phe Gln Glu Asn Val
145                 150                 155                 160

Thr Ala Asn Ser Pro Val Val Leu Val Pro Gly Phe Thr Ser Thr Gly
                165                 170                 175

Leu Glu Ile Trp Asn Gly Ser Glu Cys Ser Lys Ala Tyr Phe Arg Gln
            180                 185                 190

Arg Met Trp Gly Thr Ser Arg Met Leu Gln Gln Phe Met Met Asn Gln
        195                 200                 205

Lys Cys Trp Leu Glu His Met Met Leu Asn Arg Ser Ser Gly Met Asp
    210                 215                 220

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

Tyr Leu Ile Gly Gly Phe Trp Val Trp Gly Lys Met Val Glu Asn Leu
                245                 250                 255

Ala Glu Ile Gly Tyr Asp Ser Asn Asn Leu Tyr Met Ala Ala Tyr Asp
            260                 265                 270

Trp Arg Leu Met Pro His Leu Leu Glu Lys Arg Asp Gly Tyr Phe Thr
        275                 280                 285

Lys Leu Lys Tyr Thr Ile Glu Met Ala Arg Met Ser Ala Gly Gly His
    290                 295                 300
```

Lys Val Met Leu Val Thr His Ser Tyr Ala Thr Gln Val Phe Phe His
305 310 315 320

Phe Leu Lys Trp Val Glu Ser Glu Asn Gly Gly Lys Gly Gly Asp Gln
325 330 335

Trp Val Glu Thr Asn Leu Glu Ser Phe Val Asn Ile Ala Gly Pro Thr
340 345 350

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

Asp Thr Ala Glu Leu Gly Gly Leu Ser Lys Phe Leu Gly Tyr Phe Phe
370 375 380

Ser Val Ser Ala Arg Thr Gln Leu Ala Arg Ser Trp Ser Ser Val Phe
385 390 395 400

Ser Met Met Pro Ile Gly Gly Asp Arg Ile Trp Gly Thr Ala Asp Ser
405 410 415

Ala Pro Asp Asp Val Val Ala Ala Ser Pro Leu Ser Thr Gly Lys Asn
420 425 430

Ser Thr Ile Asp Pro Arg Lys Val Lys Glu His Val Ala Arg Tyr Gly
435 440 445

Ser Asn Gly His Val Val Arg Phe Val Asn Thr Ser His Glu Asn Val
450 455 460

Thr Ile Gly Gly Val Gln Lys Met Leu Gly Lys Leu Asp Pro Tyr Leu
465 470 475 480

Asp Gln Phe Arg Ser Trp Leu Ser Thr Gly Ile Ala Glu Asp Leu Ser
485 490 495

Leu Pro Glu Tyr Asp Gln Ser Lys Tyr Trp Thr Asn Pro Leu Glu Ala
500 505 510

Ala Leu Pro Lys Ala Pro Ser Leu Asn Val Phe Cys Phe Tyr Gly Val
515 520 525

Gly Lys Pro Val Glu Arg Gly Tyr Thr Tyr Gly Asp Asn Pro Pro Asp
530 535 540

Glu Asp Asn Ala Thr Val Asn Gly Lys Arg Val Ala Pro Tyr Val Phe
545 550 555 560

Asn Thr Asp Thr Asp Asp Leu Pro Tyr Ile Lys Gly Gly Leu Arg Tyr
565 570 575

Ser Asp Gly Asp Gly Thr Val Pro Leu Ile Ser Leu Gly Leu Met Cys
580 585 590

Ala Ser Gly Trp Arg Thr Lys Lys Phe Asn Pro Gly Asn Val Asp Val
595 600 605

Arg Val Arg Glu Tyr Arg His Asn Pro Val Ser Met Leu Phe Asp Ala
610 615 620

Arg Gly Gly Pro Glu Thr Ala Asp His Val Asp Ile Met Gly Asn His
625 630 635 640

Gly Leu Ile Arg Asp Val Leu Leu Val Ala Ala Arg Ala Tyr Asp Arg
645 650 655

Val Pro Glu Asn Ile Thr Ser Ser Ile Met Glu Ile Ala Glu Arg Val
660 665 670

Gly Glu Leu
675

<210> 144
<211> 728
<212> PRT
<213> Phythophtora infestance

<400> 144

Met Lys Phe Asp Asp Lys Lys Val Leu Asn Asp Thr Trp Thr Gln Phe
1 5 10 15

Leu Ala Leu Cys Leu Leu Leu Met Leu Ala Val Asp Ser Leu Asn Pro
20 25 30

Ile Lys Ala Val Ser Lys Phe Leu Gly Val Pro Ser Tyr Tyr Trp Gly
35 40 45

Ala Leu Ser Val Gly Ile Met Leu Gly Leu Leu Phe His Asn Ala Ala
50 55 60

Asp Val Ile Tyr Arg Ser Thr Arg Val Phe Leu Asn Ser Ile Leu Ser
65 70 75 80

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

Asp Gly Pro Val Ile Phe Thr Gly Asn His Ala Asn Gln Phe Val Asp
100 105 110

Gly Leu Val Val Met Met Thr Ser Pro Arg Lys Val Gly Phe Met Ile
115 120 125

Ala Glu Lys Ser Trp His Leu Pro Val Val Gly His Leu Ala Arg Ile
130 135 140

Met Gly Cys Ile Pro Val Val Arg Pro Gln Asp Ser Val Ala Ser Gly
145 150 155 160

Val Gly Ser Met Lys Leu Ala Ser Glu Asp Pro Val Thr Val Ala Ser
165 170 175

Ser Ser Ser Gly Gly Ala Ser Ser Ser Thr Pro Gln Trp Leu Val Gln
180 185 190

Gly Asp Gly Thr Ser Phe Thr Lys Gln Val Thr Pro Gly Asp Gln Ile
195 200 205

Arg Phe Gln Gly Gln Ser Val Lys Asp Ser Gly Ser Pro Val Lys Ile
210 215 220

Val Gln Val Leu Asp Asp Thr Gln Leu Leu Leu Asn Ala Pro Leu Lys
225 230 235 240

Ser Gly Glu Gly Lys Leu Val Leu Glu Ser Ala Pro Phe Gly Ile Leu
245 250 255

Lys Arg Val Asp Gln Ser Val Thr Phe Ala Lys Val Tyr Thr His Leu
260 265 270

Lys Arg Gly Asn Cys Ile Gly Ile Phe Pro Glu Gly Gly Ser His Asp
275 280 285

Arg Thr Asp Leu Leu Pro Leu Lys Ala Gly Val Ala Val Met Ala Leu
290 295 300

Gly Val Lys Asp Lys Tyr Asn Ile Asn Val Pro Val Val Pro Val Gly
305 310 315 320

Leu Asn Tyr Phe Arg Gly His Arg Phe Arg Gly Arg Val Thr Val Glu
325 330 335

Phe Gly Thr Pro Ile Thr Val Asp Gln Ala Leu Met Ala Lys Tyr Gln

340 345 350

Glu Asp Lys Arg Thr Ala Cys Asn Thr Leu Leu His Arg Val Glu Glu
355 360 365

Ser Met Arg Ser Val Ile Val Thr Thr Pro Ser Tyr Gly Val Met Gln
370 375 380

Glu Val Leu Thr Ala Arg Arg Leu Phe Gln Arg Ser Gly Val Arg Leu
385 390 395 400

Ser Ala Lys Glu Thr Gln Asp Leu Asn Arg Arg Phe Ala Glu Gly Tyr
405 410 415

Lys Val Leu Gln Asp Val Pro Glu Ala Gln Glu Asp Leu Val Ile Leu
420 425 430

Gln His Lys Leu Asp Asn Tyr Tyr Lys Thr Leu Gln Lys Met Gly Leu
435 440 445

Lys Asp His Gln Val Pro Tyr Ile Pro Trp Trp Thr Ile His Asp Val
450 455 460

Leu Gly Ser Ala Leu Tyr Gly Thr Leu Ile Leu Leu Leu Ser Ser Ile
465 470 475 480

Pro Ser Phe Ile Leu Asn Ala Pro Val Gly Leu Leu Ala Arg Tyr Val
485 490 495

Ala Asn Ser Ala Gln Lys Lys Ala Leu Glu Gly Ser Lys Val Lys Val
500 505 510

Leu Ala Arg Asp Val Ile Leu Ser Lys Lys Ile Gln Phe Ser Ile Val
515 520 525

Ala Val Pro Val Leu Trp Phe Ile Tyr Phe Thr Ile Ala Ala Val Phe
530 535 540

Thr Asp Trp Tyr Trp Ser Ser Ile Met Leu Leu Met Val Ser Phe Pro
545 550 555 560

Leu Phe Ser Phe Phe Gly Val Arg Ser Val Glu Ala Gly Met Ile Glu
565 570 575

Leu Lys Thr Val Arg Pro Leu Phe Tyr Arg Leu Leu Pro Thr Tyr Lys
580 585 590

Ala Thr Gln Asp Glu Leu Pro Arg Gln Arg Ala Glu Leu Gln Lys Glu
595 600 605

Val Arg Glu Phe Val Lys Lys Tyr Ser Gln Tyr Leu Gly Lys Leu Ala
610 615 620

Glu Pro Lys Lys Leu Asp Trp Ser Glu Tyr Met His Glu Arg Ser Leu
625 630 635 640

Val Leu Ala Glu Lys Thr Glu Gln Ala Glu Ser Ile Pro Ser Pro Pro
645 650 655

Pro Val His Glu Glu Asp Glu Glu Pro Arg Glu Gly Glu Ala Glu Asp
660 665 670

Asp Ile Gly Ser Pro Val Pro Thr Ile Thr Lys Phe His Asp Ile Ser
675 680 685

Ile Leu Gly Lys Ser Glu Asn Ser Val Leu Asp Leu Ala Gly Leu Glu
690 695 700

Arg Ser Met Ser Cys Pro Pro Gly Tyr Gln Glu Leu Ala Glu Glu Ile
705 710 715 720

Ala Lys Gln Arg Lys Gly Ser Val
725

<210> 145
<211> 510
<212> PRT
<213> Phythophtora infestance

<400> 145

Met Leu Ser Thr Leu Leu Trp Leu Ala Leu Ala Val Val Val Leu Ala
1 5 10 15

Thr Gln Gly Tyr Lys Met Val Ala Arg Phe Leu Arg Leu Leu Leu His
20 25 30

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

Glu Gly Pro Val Ile Leu Cys Pro Asn His Pro Asn Met Leu Val Asp
50 55 60

Ala Ile Leu Val Met Thr Glu Ala Val Ser His Gly Arg Asn Pro Tyr
65 70 75 80

Val Trp Ala Lys Gly Ser Leu Phe Ser Asn Pro Val Ala Ala Phe Phe
85 90 95

Leu Lys Lys Phe Gly Ala Val Pro Val Tyr Arg Pro Arg Arg Lys Glu
100 105 110

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

Ala Ala Asn Arg Lys Met Phe Glu His Thr Trp His Val Leu Ala Gly
130 135 140

Gly Asn Val Met Val Leu Phe Pro Glu Gly Thr Ser Tyr Thr Ala Pro
145 150 155 160

Lys Met Leu Ser Leu Arg Thr Gly Val Val Arg Val Ala Thr Gly Phe
165 170 175

Ala Lys His Tyr Asp Gln Pro Ile Pro Ile Ile Pro Leu Gly Leu Asn
180 185 190

Tyr Phe Asn Lys Asp His Phe Arg Ser Gln Met Thr Leu Glu Phe Gly
195 200 205

Pro Pro Met Val Ile Thr Pro Asp Met Val Gln Thr Glu Ala Phe Gln
210 215 220

Gln Asp Glu His Gly Glu Val Lys Arg Leu Thr Leu Glu Leu Glu Glu
225 230 235 240

Arg Met His Asp Val Thr Leu Asn Ala Ser Asp Phe Ser Thr Ile His
245 250 255

Ala Ala Arg Met Met Arg Arg Leu Tyr Leu Asn Thr Pro Gly Pro Ile
260 265 270

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

Glu Lys Glu Pro Gln Asp Asp Glu Gln Lys Glu Arg Ile Ala Thr Ile
290 295 300

Arg Glu Lys Val Leu Arg Tyr Lys Glu Gln Leu Glu Lys Leu Arg Leu
305 310 315 320

Lys Asp Gln Glu Val Asn Leu Pro Met Pro Lys Glu Lys Ser Leu Leu
325 330 335

Gln Leu Phe Leu Glu Arg Ile Leu Tyr Leu Leu Val Leu Leu Pro Leu
340 345 350

Ala Thr Pro Gly Leu Leu Leu Asn Leu Pro Tyr Tyr Phe Ile Gly Thr
355 360 365

Lys Met Asn Ser Leu Ala Gly Phe Val Glu Ser Lys Ser Met Phe Lys
370 375 380

Ile Phe Ala Ala Ala Val Leu Val Pro Val His Trp Leu Val Leu Ile
385 390 395 400

Leu Ala Thr Trp Tyr Phe Leu Gly Ser Ser Tyr Ala Tyr Val Leu Ala
405 410 415

Val Gly Leu Pro Leu Leu Leu Tyr Ser His Ile Arg Val Leu Glu Glu
420 425 430

Ser Arg Ser Ile Ala Glu Asn Val Tyr Phe Leu Phe Asn Ile Thr Ala
435 440 445

His Ala Asp Lys Val Ala Val Leu Arg Thr Glu Arg Glu Leu Leu Ala
450 455 460

Gln Glu Val His Glu Leu Val Thr Lys Tyr Val Asp Ala Lys Phe Leu
465 470 475 480

Ser Ala Ile His Lys Ser Leu Ala Ser Ser Pro Val Asn Arg Arg Leu
485 490 495

Arg His Arg Ala Ser Ser Thr Ser Asp Thr Leu Leu Thr Thr
500 505 510

<210> 146
<211> 26802
<212> DNA
<213> Artificial

<220>
<223> Plant Expression Plasmid

<400> 146
ttgacataca aatggacgaa cggataaacc ttttcacgcc cttttaaata tccgattatt 60

ctaataaacg ctcttttctc ttaggtttac ccgccaatat atcctgtcaa acactgatag 120

tttaaactga aggcgggaaa cgacaatctg atcactgatt agtaactaag gcctttaatt 180

aatctagagg cgcgccgggc cccctgcagg gagctcggcc ggccaattta aattgatatc 240

ggtacatcga ttacgccaag ctatcaactt tgtatagaaa agttgccatg attacgccaa 300

gcttggccac taaggccaat ttcgcgccct gcagcaaatt tacacattgc cactaaacgt 360
ctaaaccctt gtaatttgtt tttgttttac tatgtgtgtt atgtatttga tttgcgataa 420
atttttatat ttggtactaa atttataaca ccttttatgc taacgtttgc caacacttag 480
caatttgcaa gttgattaat tgattctaaa ttatttttgt cttctaaata catatactaa 540
tcaactggaa atgtaaatat ttgctaatat ttctactata ggagaattaa agtgagtgaa 600
tatggtacca caaggtttgg agatttaatt gttgcaatgc tgcatggatg gcatatacac 660
caaacattca ataattcttg aggataataa tggtaccaca caagatttga ggtgcatgaa 720
cgtcacgtgg acaaaaggtt tagtaatttt tcaagacaac aatgttacca cacacaagtt 780
ttgaggtgca tgcatggatg ccctgtggaa agtttaaaaa tattttggaa atgatttgca 840
tggaagccat gtgtaaaacc atgacatcca cttggaggat gcaataatga agaaaactac 900
aaatttacat gcaactagtt atgcatgtag tctatataat gaggattttg caatactttc 960
attcatacac actcactaag ttttacacga ttataatttc ttcatagcca gtactgttta 1020
agcttcactg tctctgaatc ggcaaaggta aacgtatcaa ttattctaca aaccctttta 1080
tttttctttt gaattaccgt cttcattggt tatatgataa cttgataagt aaagcttcaa 1140
taattgaatt tgatctgtgt ttttttggcc ttaatactaa atccttacat aagctttgtt 1200
gcttctcctc ttgtgagttg agtgttaagt tgtaataatg gttcactttc agctttagaa 1260
gaaaccatgg aagttgttga gaggttctac ggagagttgg atggaaaggt ttcccaagga 1320
gtgaacgctt tgttgggatc tttcggagtt gagttgactg ataccccaac tactaaggga 1380
ttgccactcg ttgattctcc aactccaatt gtgttgggag tgtctgttta cttgaccatc 1440
gtgatcggag gattgctttg gatcaaggct agagatctca agccaagagc ttctgagcca 1500
ttcttgttgc aagctttggt gttggtgcac aacttgttct gcttcgcttt gtctctttac 1560
atgtgcgtgg gtatcgctta ccaagctatc acctggagat attccttgtg ggaaacgct 1620
tataacccaa agcacaagga gatggctatc ctcgtttacc tcttctacat gtccaagtac 1680
gtggagttca tggataccgt gatcatgatc ctcaagagat ccaccagaca gatttctttc 1740
ctccacgtgt accaccactc ttctatctcc cttatctggt gggctattgc tcaccacgct 1800
ccaggaggag aggcttattg gagtgctgct ctcaactctg gagtgcacgt gttgatgtac 1860
gcttactact tcttggctgc ttgcttgaga tcttccccaa agctcaagaa caagtacctc 1920
ttctggggaa gatacctcac ccaattccag atgttccagt tcatgctcaa cttggtgcaa 1980
gcttactacg atatgaaaac caacgctcca tatccacaat ggctcatcaa gatcctcttc 2040
tactacatga tctccctctt gttcctcttc ggaaacttct acgtgcaaaa gtacatcaag 2100
ccatccgatg gaaagcaaaa gggagctaag accgagtgat cgacaagctc gagtttctcc 2160

ataataatgt gtgagtagtt cccagataag ggaattaggg ttcctatagg gtttcgctca 2220
tgtgttgagc atataagaaa cccttagtat gtatttgtat ttgtaaaata cttctatcaa 2280
taaaatttct aattcctaaa accaaaatcc agtactaaaa tccagatccc ccgaattaat 2340
tcggcgttaa ttcagggccg gccaaagtag gcgcctacta ccggtaattc ccgggattag 2400
cggccgctag tctgtgcgca cttgtatcct gcaggttagg ccggccatta gcagatattt 2460
ggtgtctaaa tgtttatttt gtgatatgtt catgtttgaa atggtggttt cgaaaccagg 2520
gacaacgttg ggatctgata gggtgtcaaa gagtattatg gattgggaca atttcggtca 2580
tgagttgcaa attcaagtat atcgttcgat tatgaaaatt ttcgaagaat atcccatttg 2640
agagagtctt tacctcatta atgtttttag attatgaaat tttatcatag ttcatcgtag 2700
tctttttggt gtaaaggctg taaaaagaaa ttgttcactt ttgttttcgt ttatgtgaag 2760
gctgtaaaag attgtaaaag actattttgg tgttttggat aaaatgatag tttttataga 2820
ttcttttgct tttagaagaa atacatttga aatttttttcc atgttgagta taaaataccg 2880
aaatcgattg aagatcatag aaatatttta actgaaaaca aatttataac tgattcaatt 2940
ctctccattt ttatacctat ttaaccgtaa tcgattctaa tagatgatcg atttttttata 3000
taatcctaat taaccaacgg catgtattgg ataattaacc gatcaactct cacccctaat 3060
agaatcagta ttttccttcg acgttaattg atcctacact atgtaggtca tatccatcgt 3120
tttaattttt ggccaccatt caattctgtc ttgcctttag ggatgtgaat atgaacggcc 3180
aaggtaagag aataaaaata atccaaatta aagcaagaga ggccaagtaa gataatccaa 3240
atgtacactt gtcattgcca aaattagtaa aatactcggc atattgtatt cccacacatt 3300
attaaaatac cgtatatgta ttggctgcat ttgcatgaat aatactacgt gtaagcccaa 3360
aagaacccac gtgtagccca tgcaaagtta acactcacga ccccattcct cagtctccac 3420
tatataaacc caccatcccc aatctcacca aacccaccac acaactcaca actcactctc 3480
acaccttaaa gaaccaatca ccaccaaaaa atttcacgat ttggaatttg attcctgcga 3540
tcacaggtat gacaggttag attttgtttt gtatagttgt atacatactt ctttgtgatg 3600
ttttgtttac ttaatcgaat ttttggagtg ttttaaggtc tctcgtttag aaatcgtgga 3660
aaatatcact gtgtgtgtgt tcttatgatt cacagtgttt atgggtttca tgttctttgt 3720
tttatcattg aatgggaaga aatttcgttg ggatacaaat ttctcatgtt cttactgatc 3780
gttattagga gtttggggaa aaaggaagag tttttttggt tggttcgagt gattatgagg 3840
ttatttctgt atttgattta tgagttaatg gtcgttttaa tgttgtagac catgggaaaa 3900
ggatctgagg gaagatctgc tgctagagag atgactgctg aggctaacgg agataagaga 3960
aagaccatcc tcattgaggg agtgttgtac gatgctacca acttcaaaca cccaggaggt 4020
tccattatta acttcctcac cgagggagaa gctggagttg atgctaccca agcttacaga 4080

gagttccatc agagatccgg aaaggctgat aagtacctca agtccctccc aaagttggat 4140

gcttctaagg tggagtctag gttctctgct aaggagcagg ctagaaggga cgctatgacc 4200

agggattacg ctgctttcag agaggagttg gttgctgagg gatacttcga tccatctatc 4260

ccacacatga tctacagagt ggtggagatt gtggctttgt tcgctttgtc tttctggttg 4320

atgtctaagg cttctccaac ctctttggtt ttgggagtgg tgatgaacgg aatcgctcaa 4380

ggaagatgcg gatgggttat gcacgagatg ggacacggat ctttcactgg agttatctgg 4440

ctcgatgata ggatgtgcga gttcttctac ggagttggat gtggaatgtc tggacactac 4500

tggaagaacc agcactctaa gcaccacgct gctccaaaca gattggagca cgatgtggat 4560

ttgaacacct tgccactcgt tgctttcaac gagagagttg tgaggaaggt taagccagga 4620

tctttgttgg ctttgtggct cagagttcag gcttatttgt tcgctccagt gtcttgcttg 4680

ttgatcggat tgggatggac cttgtacttg cacccaagat atatgctcag gaccaagaga 4740

cacatggagt ttgtgtggat cttcgctaga tatatcggat ggttctcctt gatgggagct 4800

ttgggatatt ctcctggaac ttctgtggga atgtacctct gctctttcgg acttggatgc 4860

atctacatct tcctccaatt cgctgtgtct cacacccact tgccagttac caacccagag 4920

gatcaattgc actggcttga gtacgctgct gatcacaccg tgaacatctc taccaagtct 4980

tggttggtta cctggtggat gtctaacctc aacttccaaa tcgagcacca cttgttccca 5040

accgctccac aattcaggtt caaggagatc tctccaagag ttgaggctct cttcaagaga 5100

cacaacctcc cttactacga tttgccatac acctctgctg tttctactac cttcgctaac 5160

ctctactctg ttggacactc tgttggagct gataccaaga agcaggattg actgctttaa 5220

tgagatatgc gagacgccta tgatcgcatg atatttgctt tcaattctgt tgtgcacgtt 5280

gtaaaaaacc tgagcatgtg tagctcagat ccttaccgcc ggtttcggtt cattctaatg 5340

aatatatcac ccgttactat cgtattttta tgaataatat tctccgttca atttactgat 5400

tgtgtcgacg cgatcgcgtg caaacactgt acggaccgtg gcctaatagg ccggtaccca 5460

agtttgtaca aaaaagcagg ctccatgatt acgccaagct tggccactaa ggccaattta 5520

aatctactag gccggccatc gacggcccgg actgtatcca acttctgatc tttgaatctc 5580

tctgttccaa catgttctga aggagttcta agacttttca gaaagcttgt aacatgcttt 5640

gtagactttc tttgaattac tcttgcaaac tctgattgaa cctacgtgaa aactgctcca 5700

gaagttctaa ccaaattccg tcttgggaag gcccaaaatt tattgagtac ttcagtttca 5760

tggacgtgtc ttcaaagatt tataacttga aatcccatca tttttaagag aagttctgtt 5820

ccgcaatgtc ttagatctca ttgaaatcta caactcttgt gtcagaagtt cttccagaat 5880

caacttgcat catggtgaaa atctggccag aagttctgaa cttgtcatat ttcttaacag 5940

ttagaaaaat ttctaagtgt ttagaatttt gacttttcca aagcaaactt gacttttgac 6000
tttcttaata aaacaaactt catattctaa catgtcttga tgaaatgtga ttcttgaaat 6060
ttgatgttga tgcaaaagtc aaagtttgac ttttcagtgt gcaattgacc attttgctct 6120
tgtgccaatt ccaaacctaa attgatgtat cagtgctgca aacttgatgt catggaagat 6180
cttatgagaa aattcttgaa gactgagagg aaaaattttg tagtacaaca caaagaatcc 6240
tgtttttcat agtcggacta gacacattaa cataaaacac cacttcattc gaagagtgat 6300
tgaagaagga aatgtgcagt tacctttctg cagttcataa gagcaactta cagacacttt 6360
tactaaaata ctacaaagag gaagatttta acaacttaga gaagtaatgg gagttaaaga 6420
gcaacacatt aagggggagt gttaaaatta atgtgttgta accaccacta cctttagtaa 6480
gtattataag aaaattgtaa tcatcacatt ataattattg tccttattta aaattatgat 6540
aaagttgtat cattaagatt gagaaaacca aatagtcctc gtcttgattt ttgaattatt 6600
gttttctatg ttacttttct tcaagcctat ataaaaactt tgtaatgcta aattgtatgc 6660
tggaaaaaaa tgtgtaatga attgaataga aattatggta tttcaaagtc caaaatccat 6720
caatagaaat ttagtacaaa acgtaactca aaaatattct cttattttaa attttacaac 6780
aatataaaaa tattctctta ttttaaattt tacaataata taatttatca cctgtcacct 6840
ttagaatacc accaacaata ttaatactta gatattttat tcttaataat tttgagatct 6900
ctcaatatat ctgatattta ttttatattt gtgtcatatt ttcttatgtt ttagagttaa 6960
cccttatatc ttggtcaaac tagtaattca atatatgagt ttgtgaagga cacattgaca 7020
tcttgaaaca ttggttttaa ccttgttgga atgttaaagg taataaaaca ttcagaatta 7080
tgaccatcta ttaatatact tcctttgtct tttaaaaaag tgtgcatgaa aatgctctat 7140
ggtaagctag agtgtcttgc tggcctgtgt atatcaattc catttccaga tggtagaaac 7200
tgccactacg aataattagt cataagacac gtatgttaac acacgtcccc ttgcatgttt 7260
tttgccatat attccgtctc tttctttttc ttcacgtata aaacaatgaa ctaattaata 7320
gagcgatcaa gctgaacagt tctttgcttt cgaagttgcc gcaacctaaa caggtttttc 7380
cttcttcttt cttcttatta actacgacct tgtcctttgc ctatgtaaaa ttactaggtt 7440
ttcatcagtt acactgatta agttcgttat agtggaagat aaaatgccct caaagcattt 7500
tgcaggatat ctttgatttt tcaaagatat ggaactgtag agtttgatag tgttcttgaa 7560
tgtggttgca tgaagttttt ttggtctgca tgttattttt tcctcgaaat atgttttgag 7620
tccaacaagt gattcacttg ggattcagaa agttgttttc tcaatatgta acagtttttt 7680
tctatggaga aaaatcatag ggaccgttgg ttttggcttc tttaattttg agctcagatt 7740
aaacccattt tacccggtgt tcttggcaga attgaaaaca gtacgtagta ccgcgcctac 7800
catgtgtgtt gagaccgaga acaacgatgg aatccctact gtggagatcg ctttcgatgg 7860

agagagagaa agagctgagg ctaacgtgaa gttgtctgct gagaagatgg aacctgctgc 7920
tttggctaag accttcgcta gaagatacgt ggttatcgag ggagttgagt acgatgtgac 7980
cgatttcaaa catcctggag gaaccgtgat tttctacgct ctctctaaca ctggagctga 8040
tgctactgag gctttcaagg agttccacca cagatctaga aaggctagga aggctttggc 8100
tgctttgcct tctagacctg ctaagaccgc taaagtggat gatgctgaga tgctccagga 8160
tttcgctaag tggagaaagg agttggagag ggacggattc ttcaagcctt ctcctgctca 8220
tgttgcttac agattcgctg agttggctgc tatgtacgct ttgggaacct acttgatgta 8280
cgctagatac gttgtgtcct ctgtgttggt ttacgcttgc ttcttcggag ctagatgtgg 8340
atgggttcaa cacgagggag gacactcttc tttgaccgga aacatctggt gggataagag 8400
aatccaagct ttcactgctg gattcggatt ggctggatct ggagatatgt ggaactccat 8460
gcacaacaag caccacgcta ctcctcaaaa agtgaggcac gatatggatt tggataccac 8520
tcctgctgtt gctttcttca acaccgctgt ggaggataat agacctaggg gattctctaa 8580
gtactggctc agattgcaag cttggacctt cattcctgtg acttctggat tggtgttgct 8640
cttctggatg ttcttcctcc acccttctaa ggctttgaag ggaggaaagt acgaggagct 8700
tgtgtggatg ttggctgctc acgtgattag aacctggacc attaaggctg ttactggatt 8760
caccgctatg caatcctacg gactcttctt ggctacttct tgggtttccg gatgctactt 8820
gttcgctcac ttctctactt ctcacaccca cttggatgtt gttcctgctg atgagcactt 8880
gtcttgggtt aggtacgctg tggatcacac cattgatatc gatccttctc agggatgggt 8940
taactggttg atgggatact tgaactgcca agtgattcac cacctcttcc cttctatgcc 9000
tcaattcaga caacctgagg tgtccagaag attcgttgct ttcgctaaga agtggaacct 9060
caactacaag gtgatgactt atgctggagc ttggaaggct actttgggaa acctcgataa 9120
tgtgggaaag cactactacg tgcacggaca acactctgga aagaccgctt gattaattaa 9180
ggccgcctcg accgtacccc ctgcagatag actatactat gttttagcct gcctgctggc 9240
tagctactat gttatgttat gttgtaaaat aaacacctgc taaggtatat ctatctatat 9300
tttagcatgg ctttctcaat aaattgtctt tccttatcgt ttactatctt atacctaata 9360
atgaaataat aatatcacat atgaggaacg gggcaggttt aggcatatat atacgagtgt 9420
agggcggagt gggggcgcc tactaccggt aattcccggg attagcggcc gctagtctgt 9480
gcgcacttgt atcctgcagg ttaggccggc cacacgggca ggacataggg actactacaa 9540
gcatagtatg cttcagacaa agagctagga aagaactctt gatggaggtt aagagaaaaa 9600
agtgctagag gggcatagta atcaaacttg tcaaaaccgt catcatgatg agggatgaca 9660
taatataaaa agttgactaa ggtcttggta gtactctttg attagtatta tatattggtg 9720

agaacatgag tcaagaggag acaagaaacc gaggaaccat agtttagcaa caagatggaa 9780
gttgcaaagt tgagctagcc gctcgattag ttacatctcc taagcagtac tacaaggaat 9840
ggtctctata ctttcatgtt tagcacatgg tagtgcggat tgacaagtta gaaacagtgc 9900
ttaggagaca aagagtcagt aaaggtattg aaagagtgaa gttgatgctc gacaggtcag 9960
gagaagtccc tccgccagat ggtgactacc aaggggttgg tatcagctga gacccaaata 10020
agattcttcg gttgaaccag tggttcgacc gagactctta gggtgggatt tcactgtaag 10080
atttgtgcat tttgttgaat ataaattgac aattttttt atttaattat agattattta 10140
gaatgaatta catatttagt ttctaacaag gatagcaatg gatgggtatg ggtacaggtt 10200
aaacatatct attacccacc catctagtcg tcgggtttta cacgtaccca cccgtttaca 10260
taaaccagac cggaatttta aaccgtaccc gtccgttagc gggtttcaga tttacccgtt 10320
taatcgggta aaacctgatt actaaatata tatttttat ttgataaaca aaacaaaaat 10380
gttaatattt tcatattgga tgcaatttta agaaacacat attcataaat ttccatattt 10440
gtaggaaaat aaaaagaaaa atatattcaa gaacacaaat ttcaccgaca tgacttttat 10500
tacagagttg gaattagatc taacaattga aaaattaaaa ttaagataga atatgttgag 10560
gaacatgaca tagtataatg ctgggttacc cgtcgggtag gtatcgaggc ggatactact 10620
aaatccatcc cactcgctat ccgataatca ctggtttcgg gtatacccat tcccgtcaac 10680
aggccttttt aaccggataa tttcaactta tagtgaatga attttgaata aatagttaga 10740
ataccaaaat cctggattgc atttgcaatc aaattttgtg aaccgttaaa ttttgcatgt 10800
acttgggata gatataatag aaccgaattt tcattagttt aatttataac ttactttgtt 10860
caaagaaaaa aaatatctat ccaatttact tataataaaa aataatctat ccaagttact 10920
tattataatc aacttgtaaa aaggtaagaa tacaaatgtg gtagcgtacg tgtgattata 10980
tgtgacgaaa tgttatatct aacaaaagtc caaattccca tggtaaaaaa aatcaaaatg 11040
catggcaggc tgtttgtaac cttggaataa gatgttggcc aattctggag ccgccacgta 11100
cgcaagactc agggccacgt tctcttcatg caaggatagt agaacaccac tccacccacc 11160
tcctatatta gacctttgcc caaccctccc caactttccc atcccatcca caaagaaacc 11220
gacattttta tcataaatct ggtgcttaaa cactctggtg agttctagta cttctgctat 11280
gatcgatctc attaccattt cttaaatttc tctccctaaa tattccgagt tcttgatttt 11340
tgataacttc aggttttctc tttttgataa atctggtctt tccatttttt tttttttgtg 11400
gttaatttag tttcctatgt tcttcgattg tattatgcat gatctgtgtt tggattctgt 11460
tagattatgt attggtgaat atgtatgtgt ttttgcatgt ctggttttgg tcttaaaaat 11520
gttcaaatct gatgatttga ttgaagcttt tttagtgttg gtttgattct tctcaaaact 11580
actgttaatt tactatcatg ttttccaact ttgattcatg atgacacttt tgttctgctt 11640

tgttataaaa ttttggttgg tttgattttg taattatagt gtaattttgt taggaatgaa 11700
catgttttaa tactctgttt tcgatttgtc acacattcga attattaatc gataatttaa 11760
ctgaaaattc atggttctag atcttgttgt catcagatta tttgtttcga taattcatca 11820
aatatgtagt ccttttgctg atttgcgact gtttcatttt ttctcaaaat tgtttttttgt 11880
taagtttatc taacagttat cgttgtcaaa agtctctttc attttgcaaa atcttctttt 11940
ttttttgtt tgtaactttg ttttttaagc tacacattta gtctgtaaaa tagcatcgag 12000
gaacagttgt cttagtagac ttgcatgttc ttgtaacttc tatttgtttc agtttgttga 12060
tgactgcttt gattttgtag gtcaaaggcg cgccctacca tggatgctta taacgctgct 12120
atggataaga ttggagctgc tatcatcgat tggagtgatc cagatggaaa gttcagagct 12180
gatagggagg attggtggtt gtgcgatttc agatccgcta tcaccattgc tctcatctac 12240
atcgctttcg tgatcttggg atctgctgtg atgcaatctc tcccagctat ggacccatac 12300
cctatcaagt tcctctacaa cgtgtctcaa atcttcctct gcgcttacat gactgttgag 12360
gctggattcc tcgcttatag gaacggatac accgttatgc catgcaacca cttcaacgtg 12420
aacgatccac cagttgctaa cttgctctgg ctcttctaca tctccaaagt gtgggatttc 12480
tgggatacca tcttcattgt gctcggaaag aagtggagac aactctcttt cttgcacgtg 12540
taccaccaca ccaccatctt cctcttctac tggttgaacg ctaacgtgct ctacgatgga 12600
gatatcttct tgaccatcct cctcaacgga ttcattcaca ccgtgatgta cacctactac 12660
ttcatctgca tgcacaccaa ggattctaag accggaaagt ctttgccaat ctggtggaag 12720
tcatctttga ccgctttcca actcttgcaa ttcaccatca tgatgtccca agctacctac 12780
ttggttttcc acggatgcga taaggtttcc ctcagaatca ccatcgtgta cttcgtgtac 12840
attctctccc ttttcttcct cttcgctcag ttcttcgtgc aatcctacat ggctccaaag 12900
aagaagaagt ccgcttgatg ttaattaagg ccgcagatat cagatctggt cgacctagag 12960
gatccccggc cgcaaagata ataacaaaag cctactatat aacgtacatg caagtattgt 13020
atgatattaa tgtttttacg tacgtgtaaa caaaaataat tacgtttgta acgtatggtg 13080
atgatgtggt gcactaggtg taggccttgt attaataaaa agaagtttgt tctatataga 13140
gtggtttagt acgacgattt atttactagt cggattggaa tagagaaccg aattcttcaa 13200
tccttgcttt tgatcaagaa ttgaaaccga atcaaatgta aaagttgata tatttgaaaa 13260
acgtattgag cttatgaaaa tgctaatact ctcatctgta tggaaaagtg actttaaaac 13320
cgaacttaaa agtgacaaaa ggggaatatc gcatcaaacc gaatgaaacc gatggcgcct 13380
accggtatcg gtccgattgc ggccgcttaa agggcgaatt cgtttaaaca ctgtacggac 13440
cgtggcctaa taggccggta ccacccagct ttcttgtaca aagtggccat gattacgcca 13500

agcttggcca ctaaggccaa tttaaatcta ctaggccggc cataaggatg acctacccat 13560
tcttgagaca aatgttacat tttagtatca gagtaaaatg tgtacctata actcaaattc 13620
gattgacatg tatccattca acataaaatt aaaccagcct gcacctgcat ccacatttca 13680
agtattttca aaccgttcgg ctcctatcca ccgggtgtaa caagacggat tccgaatttg 13740
gaagattttg actcaaattc ccaatttata ttgaccgtga ctaaatcaac tttaacttct 13800
ataattctga ttaagctccc aatttatatt cccaacggca ctacctccaa aatttataga 13860
ctctcatccc cttttaaacc aacttagtaa acgttttttt tttaatttta tgaagttaag 13920
tttttacctt gtttttaaaa agaatcgttc ataagatgcc atgccagaac attagctaca 13980
cgttacacat agcatgcagc cgcggagaat tgtttttctt cgccacttgt cactcccttc 14040
aaacacctaa gagcttctct ctcacagcac acacatacaa tcacatgcgt gcatgcatta 14100
ttacacgtga tcgccatgca aatctccttt atagcctata aattaactca tcggcttcac 14160
tctttactca aaccaaaact catcaataca aacaagatta aaaacatttc acgatttgga 14220
atttgattcc tgcgatcaca ggtatgacag gttagatttt gttttgtata gttgtataca 14280
tacttctttg tgatgttttg tttacttaat cgaatttttg gagtgtttta aggtctctcg 14340
tttagaaatc gtggaaaata tcactgtgtg tgtgttctta tgattcacag tgtttatggg 14400
tttcatgttc tttgttttat cattgaatgg gaagaaattt cgttgggata caaatttctc 14460
atgttcttac tgatcgttat taggagtttg gggaaaaagg aagagttttt ttggttggtt 14520
cgagtgatta tgaggttatt tctgtatttg atttatgagt taatggtcgt tttaatgttg 14580
tagaccgcca tggctatttt gaaccctgag gctgattctg ctgctaacct cgctactgat 14640
tctgaggcta agcaaagaca attggctgag gctggataca ctcatgttga gggtgctcct 14700
gctcctttgc ctttggagtt gcctcatttc tctctcagag atctcagagc tgctattcct 14760
aagcactgct tcgagagatc tttcgtgacc tccacctact acatgatcaa gaacgtgttg 14820
acttgcgctg ctttgttcta cgctgctacc ttcattgata gagctggagc tgctgcttat 14880
gttttgtggc ctgtgtactg gttcttccag ggatcttact tgactggagt gtgggttatc 14940
gctcatgagt gtggacatca ggcttattgc tcttctgagg tggtgaacaa cttgattgga 15000
ctcgtgttgc attctgcttt gttggtgcct taccactctt ggagaatctc tcacagaaag 15060
caccattcca acactggatc ttgcgagaac gatgaggttt tcgttcctgt gaccagatct 15120
gtgttggctt cttcttggaa cgagaccttg gaggattctc ctctctacca actctaccgt 15180
atcgtgtaca tgttggttgt tggatggatg cctggatacc tcttcttcaa cgctactgga 15240
cctactaagt actggggaaa gtctaggtct cacttcaacc cttactccgc tatctatgct 15300
gatagggaga gatggatgat cgtgctctcc gatattttct tggtggctat gttggctgtt 15360
ttggctgctt tggtgcacac tttctccttc aacaccatgg tgaagttcta cgtggtgcct 15420

tacttcattg tgaacgctta cttggtgttg attacctacc tccaacacac cgatacctac 15480
atccctcatt tcagagaggg agagtggaat tggttgagag gagctttgtg cactgtggat 15540
agatcatttg gtccattcct cgattctgtg gtgcatagaa tcgtggatac ccatgtttgc 15600
caccacatct tctccaagat gcctttctat cattgcgagg aggctaccaa cgctattaag 15660
cctctcctcg gaaagttcta cttgaaggat accactcctg ttcctgttgc tctctggaga 15720
tcttacaccc attgcaagtt cgttgaggat gatggaaagg tggtgttcta caagaacaag 15780
ctctagttaa ttaataattg attggttcga gtattatggc attgggaaaa ctgtttttct 15840
tgtaccattt gttgtgcttg taatttactg tgttttttat tcggttttcg ctatcgaact 15900
gtgaaatgga aatggatgga gaagagttaa tgaatgatat ggtccttttg ttcattctca 15960
aattaatatt atttgttttt tctcttattt gttgtgtgtt gaatttgaaa ttataagaga 16020
tatgcaaaca ttttgttttg agtaaaaatg tgtcaaatcg tggcctctaa tgaccgaagt 16080
taatatgagg agtaaaacac ttgtagttgt accattatgc ttattcacta ggcaacaaat 16140
atattttcag acctagaaaa gctgcaaatg ttactgaata caagtatgtc ctcttgtgtt 16200
ttagacattt atgaactttc ctttatgtaa ttttccagaa tccttgtcag attctaatca 16260
ttgctttata attatagtta tactcatgga tttgtagttg agtatgaaaa tatttttttaa 16320
tgcattttat gacttgccaa ttgattgaca acatgcatca atggcgccta ctaccggtaa 16380
ttcccgggat tagcggccgc tagtctgtgc gcacttgtat cctgcaggtc aatcgtttaa 16440
acactgtacg gaccgtggcc taataggccg gtacccaact ttattataca tagttgataa 16500
ttcactggcc ggatgtaccg aattcgcggc cgcaagcttg tacactagta cgcgtcaatt 16560
ggcgatcgcg gatctgagat gaaaccggtg attatcagaa ccttttatgg tctttgtatg 16620
catatggtaa aaaaacttag tttgcaattt cctgtttgtt ttggtaattt gagtttcttt 16680
tagttgttga tctgcctgct tttggtttta cgtcagacta ctactgctgt tgttgtttgg 16740
tttcctttct ttcattttat aaataaataa tccggttcgg tttactcctt gtgactggct 16800
cagtttggtt attgcgaaat gcgaatggta aattgagtaa ttgaaattcg ttattagggt 16860
tctaagctgt tttaacagtc actgggttaa tatctctcga atcttgcatg gaaaatgctc 16920
ttaccattgg tttttaattg aaatgtgctc atatgggccg tggtttccaa attaaataaa 16980
actacgatgt catcgagaag taaaatcaac tgtgtccaca ttatcagttt tgtgtatacg 17040
atgaaatagg gtaattcaaa atctagcttg atatgccttt tggttcattt taaccttctg 17100
taaacatttt ttcagatttt gaacaagtaa atccaaaaaa aaaaaaaaaa aatctcaact 17160
caacactaaa ttattttaat gtataaaaga tgcttaaaac atttggctta aaagaaagaa 17220
gctaaaaaca tagagaactc ttgtaaattg aagtatgaaa atatactgaa ttgggtatta 17280

tatgaatttt tctgatttag gattcacatg atccaaaaag gaaatccaga agcactaatc 17340

agacattgga agtaggaata tttcaaaaag tttttttttt taagtaagtg acaaaagctt 17400

ttaaaaaata gaaaagaaac tagtattaaa gttgtaaatt taataaacaa aagaaatttt 17460

ttatattttt tcatttcttt ttccagcatg aggttatgat ggcaggatgt ggatttcatt 17520

tttttccttt tgatagcctt ttaattgatc tattataatt gacgaaaaaa tattagttaa 17580

ttatagatat attttaggta gtattagcaa tttacacttc caaaagacta tgtaagttgt 17640

aaatatgatg cgttgatctc ttcatcattc aatggttagt caaaaaaata aaagcttaac 17700

tagtaaacta aagtagtcaa aaattgtact ttagtttaaa atattacatg aataatccaa 17760

aacgacattt atgtgaaaca aaaacaatat agatccatta ccctgttatc cctagagggg 17820

aaaattcgaa tccaaaaatt acggatatga atataggcat atccgtatcc gaattatccg 17880

tttgacagct agcaacgatt gtacaattgc ttctttaaaa aaggaagaaa gaaagaaaga 17940

aaagaatcaa catcagcgtt aacaaacggc cccgttacgg cccaaacggt catatagagt 18000

aacggcgtta agcgttgaaa gactcctatc gaaatacgta accgcaaacg tgtcatagtc 18060

agatcccctc ttccttcacc gcctcaaaca caaaaataat cttctacagc ctatatatac 18120

aacccccccct tctatctctc ctttctcaca attcatcatc tttctttctc tacccccaat 18180

tttaagaaat cctctcttct cctcttcatt ttcaaggtaa atctctctct ctctctctct 18240

ctctgttatt ccttgtttta attaggtatg tattattgct agtttgttaa tctgcttatc 18300

ttatgtatgc cttatgtgaa tatctttatc ttgttcatct catccgttta gaagctataa 18360

atttgttgat ttgactgtgt atctacacgt ggttatgttt atatctaatc agatatgaat 18420

ttcttcatat tgttgcgttt gtgtgtacca atccgaaatc gttgattttt ttcatttaat 18480

cgtgtagcta attgtacgta tacatatgga tctacgtatc aattgttcat ctgtttgtgt 18540

ttgtatgtat acagatctga aaacatcact tctctcatct gattgtgttg ttacatacat 18600

agatatagat ctgttatatc atttttttta ttaattgtgt atatatatat gtgcatagat 18660

ctggattaca tgattgtgat tatttacatg attttgttat ttacgtatgt atatatgtag 18720

atctggactt tttggagttg ttgacttgat tgtatttgtg tgtgtatatg tgtgttctga 18780

tcttgatatg ttatgtatgt gcagctgaac catggcggcg gcaacaacaa caacaacaac 18840

atcttcttcg atctccttct ccaccaaacc atctccttcc tcctccaaat caccattacc 18900

aatctccaga ttctccctcc cattctccct aaaccccaac aaatcatcct cctcctcccg 18960

ccgccgcggt atcaaatcca gctctccctc ctccatctcc gccgtgctca acacaaccac 19020

caatgtcaca accactccct ctccaaccaa acctaccaaa cccgaaacat tcatctcccg 19080

attcgctcca gatcaacccc gcaaaggcgc tgatatcctc gtcgaagctt tagaacgtca 19140

aggcgtagaa accgtattcg cttaccctgg aggtacatca atggagattc accaagcctt 19200

aacccgctct tcctcaatcc gtaacgtcct tcctcgtcac gaacaaggag gtgtattcgc 19260
agcagaagga tacgctcgat cctcaggtaa accaggtatc tgtatagcca cttcaggtcc 19320
cggagctaca aatctcgtta gcggattagc cgatgcgttg ttagatagtg ttcctcttgt 19380
agcaatcaca ggacaagtcc ctcgtcgtat gattggtaca gatgcgtttc aagagactcc 19440
gattgttgag gtaacgcgtt cgattacgaa gcataactat cttgtgatgg atgttgaaga 19500
tatccctagg attattgagg aagctttctt tttagctact tctggtagac ctggacctgt 19560
tttggttgat gttcctaaag atattcaaca acagcttgcg attcctaatt gggaacaggc 19620
tatgagatta cctggttata tgtctaggat gcctaaacct ccggaagatt ctcatttgga 19680
gcagattgtt aggttgattt ctgagtctaa gaagcctgtg ttgtatgttg gtggtggttg 19740
tttgaattct agcgatgaat tgggtaggtt tgttgagctt acggggatcc ctgttgcgag 19800
tacgttgatg ggggctggat cttatccttg tgatgatgag ttgtcgttac atatgcttgg 19860
aatgcatggg actgtgtatg caaattacgc tgtggagcat agtgatttgt tgttggcgtt 19920
tggggtaagg tttgatgatc gtgtcacggg taagcttgag gcttttgcta gtagggctaa 19980
gattgttcat attgatattg actcggctga gattgggaag aataagactc ctcatgtgtc 20040
tgtgtgtggt gatgttaagc tggctttgca agggatgaat aaggttcttg agaaccgagc 20100
ggaggagctt aagcttgatt ttggagtttg gaggaatgag ttgaacgtac agaaacagaa 20160
gtttccgttg agctttaaga cgtttgggga agctattcct ccacagtatg cgattaaggt 20220
ccttgatgag ttgactgatg gaaaagccat aataagtact ggtgtcgggc aacatcaaat 20280
gtgggcggcg cagttctaca attacaagaa accaaggcag tggctatcat caggaggcct 20340
tggagctatg ggatttggac ttcctgctgc gattggagcg tctgttgcta accctgatgc 20400
gatagttgtg gatattgacg gagatggaag ctttataatg aatgtgcaag agctagccac 20460
tattcgtgta gagaatcttc cagtgaaggt acttttatta aacaaccagc atcttggcat 20520
ggttatgcaa tgggaagatc ggttctacaa agctaaccga gctcacacat ttctcgggga 20580
tccggctcag gaggacgaga tattcccgaa catgttgctg tttgcagcag cttgcgggat 20640
tccagcggcg agggtgacaa agaaagcaga tctccgagaa gctattcaga caatgctgga 20700
tacaccagga ccttacctgt tggatgtgat ttgtccgcac caagaacatg tgttgccgat 20760
gatcccgaat ggtggcactt tcaacgatgt cataacggaa ggagatggcc ggattaaata 20820
ctgataggga taacagggta atctcgacga gatgaaaccg gtgattatca gaacctttta 20880
tggtctttgt atgcatatgg taaaaaaact tagtttgcaa tttcctgttt gttttggtaa 20940
tttgagtttc ttttagttgt tgatctgcct gctttttggt ttacgtcaga ctactactgc 21000
tgttgttgtt tggtttcctt tctttcattt tataaataaa taatccggtt cggtttactc 21060

cttgtgactg gctcagtttg gttattgcga aatgcgaatg gtaaattgag taattgaaat 21120
tcgttattag ggttctaagc tgttttaaca gtcactgggt taatatctct cgaatcttgc 21180
atggaaaatg ctcttaccat tggtttttaa ttgaaatgtg ctcatatggg ccgtggtttc 21240
caaattaaat aaaactacga tgtcatcgag aagtaaaatc aactgtgtcc acattatcag 21300
ttttgtgtat acgatgaaat agggtaattc aaaatctagc ttgatatgcc ttttggttca 21360
ttttaacctt ctgtaaacat tttttcagat tttgaacaag taaatccaaa aaaaaaaaaa 21420
aaaaatctca actcaacact aaattatttt aatgtataaa agatgcttaa aacatttggc 21480
ttaaaagaaa gaagctaaaa acatagagaa ctcttgtaaa ttgaagtatg aaaatatact 21540
gaattgggta ttatatgaat ttttctgatt taggattcac atgatccaaa aaggaaatcc 21600
agaagcacta atcagacatt ggaagtagga atatttcaaa aagttttttt tttttaagta 21660
agtgacaaaa gcttttaaaa aatagaaaag aaactagtat taaagttgta aatttaataa 21720
acaaaagaaa tttttttatat tttttcattt ctttttccag catgaggtta tgatggcagg 21780
atgtggattt catttttttc cttttgatag ccttttaatt gatctattat aattgacgaa 21840
aaaatattag ttaattatag atatatttta ggtagtatta gcaatttaca cttccaaaag 21900
actatgtaag ttgtaaatat gatgcgttga tctcttcatc attcaatggt tagtcaaaaa 21960
aataaaagct taactagtaa actaaagtag tcaaaaattg tactttagtt taaaatatta 22020
catgaataat ccaaaacgac atttatgtga aacaaaaaca atatgtcgag gcgatcgcag 22080
tacttaatca gtgatcagta actaaattca gtacattaaa gacgtccgca atgtgttatt 22140
aagttgtcta agcgtcaatt tgtttacacc acaatatatc ctgccaccag ccagccaaca 22200
gctccccgac cggcagctcg gcacaaaatc actgatcatc taaaaaggtg atgtgtattt 22260
gagtaaaaca gcttgcgtca tgcggtcgct gcgtatatga tgcgatgagt aaataaacaa 22320
atacgcaagg ggaacgcatg aaggttatcg ctgtacttaa ccagaaaggc gggtcaggca 22380
agacgaccat cgcaacccat ctagcccgcg ccctgcaact cgccggggcc gatgttctgt 22440
tagtcgattc cgatccccag ggcagtgccc gcgattgggc ggccgtgcgg gaagatcaac 22500
cgctaaccgt tgtcggcatc gaccgcccga cgattgaccg cgacgtgaag gccatcggcc 22560
ggcgcgactt cgtagtgatc gacggagcgc cccaggcggc ggacttggct gtgtccgcga 22620
tcaaggcagc cgacttcgtg ctgattccgg tgcagccaag cccttacgac atttgggcca 22680
ccgccgacct ggtggagctg gttaagcagc gcattgaggt cacggatgga aggctacaag 22740
cggcctttgt cgtgtcgcgg gcgatcaaag gcacgcgcat cggcggtgag gttgccgagg 22800
cgctggccgg gtacgagctg cccattcttg agtcccgtat cacgcagcgc gtgagctacc 22860
caggcactgc cgccgccggc acaaccgttc ttgaatcaga acccgagggc gacgctgccc 22920
gcgaggtcca ggcgctggcc gctgaaatta aatcaaaact catttgagtt aatgaggtaa 22980

agagaaaatg agcaaaagca caaacacgct aagtgccggc cgtccgagcg cacgcagcag 23040
caaggctgca acgttggcca gcctggcaga cacgccagcc atgaagcggg tcaactttca 23100
gttgccggcg gaggatcaca ccaagctgaa gatgtacgcg gtacgccaag gcaagaccat 23160
taccgagctg ctatctgaat acatcgcgca gctaccagag taaatgagca aatgaataaa 23220
tgagtagatg aattttagcg gctaaaggag gcggcatgga aaatcaagaa caaccaggca 23280
ccgacgccgt ggaatgcccc atgtgtggag gaacgggcgg ttggccaggc gtaagcggct 23340
gggttgtctg ccggccctgc aatggcactg gaacccccaa gcccgaggaa tcggcgtgag 23400
cggtcgcaaa ccatccggcc cggtacaaat cggcgcggcg ctgggtgatg acctggtgga 23460
gaagttgaag gccgcgcagg ccgcccagcg gcaacgcatc gaggcagaag cacgccccgg 23520
tgaatcgtgg caaggggccg ctgatcgaat ccgcaaagaa tcccggcaac cgccggcagc 23580
cggtgcgccg tcgattagga agccgcccaa gggcgacgag caaccagatt ttttcgttcc 23640
gatgctctat gacgtgggca cccgcgatag tcgcagcatc atggacgtgg ccgttttccg 23700
tctgtcgaag cgtgaccgac gagctggcga ggtgatccgc tacgagcttc cagacgggca 23760
cgtagaggtt tccgcaggcc ccgccggcat ggccagtgtg tgggattacg acctggtact 23820
gatggcggtt tcccatctaa ccgaatccat gaaccgatac cgggaaggga agggagacaa 23880
gcccggccgc gtgttccgtc cacacgttgc ggacgtactc aagttctgcc ggcgagccga 23940
tggcggaaag cagaaagacg acctggtaga aacctgcatt cggttaaaca ccacgcacgt 24000
tgccatgcag cgtaccaaga aggccaagaa cggccgcctg gtgacggtat ccgagggtga 24060
agccttgatt agccgctaca agatcgtaaa gagcgaaacc gggcggccgg agtacatcga 24120
gatcgagctt gctgattgga tgtaccgcga gatcacagaa ggcaagaacc cggacgtgct 24180
gacggttcac cccgattact ttttgatcga ccccggcatc ggccgttttc tctaccgcct 24240
ggcacgccgc gccgcaggca aggcagaagc cagatggttg ttcaagacga tctacgaacg 24300
cagtggcagc gccggagagt tcaagaagtt ctgtttcacc gtgcgcaagc tgatcgggtc 24360
aaatgacctg ccggagtacg atttgaagga ggaggcgggg caggctggcc cgatcctagt 24420
catgcgctac cgcaacctga tcgagggcga agcatccgcc ggttcctaat gtacggagca 24480
gatgctaggg caaattgccc tagcagggga aaaaggtcga aaaggtctct ttcctgtgga 24540
tagcacgtac attgggaacc caaagccgta cattgggaac cggaacccgt acattgggaa 24600
cccaaagccg tacattggga accggtcaca catgtaagtg actgatataa aagagaaaaa 24660
aggcgatttt tccgcctaaa actctttaaa acttattaaa actcttaaaa cccgcctggc 24720
ctgtgcataa ctgtctggcc agcgcacagc cgaagagctg caaaaagcgc ctacccttcg 24780
gtcgctgcgc tccctacgcc ccgccgcttc gcgtcggcct atcgcggcct atgcggtgtg 24840

aaataccgca cagatgcgta aggagaaaat accgcatcag gcgctcttcc gcttcctcgc 24900
tcactgactc gctgcgctcg gtcgttcggc tgcggcgagc ggtatcagct cactcaaagg 24960
cggtaatacg gttatccaca gaatcagggg ataacgcagg aaagaacatg tgagcaaaag 25020
gccagcaaaa ggccaggaac cgtaaaaagg ccgcgttgct ggcgtttttc cataggctcc 25080
gcccccctga cgagcatcac aaaaatcgac gctcaagtca gaggtggcga aacccgacag 25140
gactataaag ataccaggcg tttccccctg gaagctccct cgtgcgctct cctgttccga 25200
ccctgccgct taccggatac ctgtccgcct ttctcccttc gggaagcgtg gcgctttctc 25260
atagctcacg ctgtaggtat ctcagttcgg tgtaggtcgt tcgctccaag ctgggctgtg 25320
tgcacgaacc ccccgttcag cccgaccgct gcgccttatc cggtaactat cgtcttgagt 25380
ccaacccggt aagacacgac ttatcgccac tggcagcagc cactggtaac aggattagca 25440
gagcgaggta tgtaggcggt gctacagagt tcttgaagtg gtggcctaac tacggctaca 25500
ctagaaggac agtatttggt atctgcgctc tgctgaagcc agttaccttc ggaaaaagag 25560
ttggtagctc ttgatccggc aaacaaacca ccgctggtag cggtggtttt tttgtttgca 25620
agcagcagat tacgcgcaga aaaaaaggat ctcaagaaga tcctttgatc ttttctacgg 25680
ggtccttcaa ctcatcgata gtttggctgt gagcaattat gtgcttagtg catctaacgc 25740
ttgagttaag ccgcgccgcg aagcggcgtc ggcttgaacg aatttctagc tagacattat 25800
ttgccaacga ccttcgtgat ctcgcccttg acatagtgga caaattcttc gagctggtcg 25860
gcccgggacg cgagacggtc ttcttcttgg cccagatagg cttggcgcgc ttcgaggatc 25920
acgggctggt attgcgccgg aaggcgctcc atcgcccagt cggcggcgac atccttcggc 25980
gcgatcttgc cggtaaccgc cgagtaccaa atccggctca gcgtaaggac cacattgcgc 26040
tcatcgcccg cccaatccgg cggggagttc cacagggtca gcgtctcgtt cagtgcttcg 26100
aacagatcct gttccggcac cgggtcgaaa agttcctcgg ccgcggggcc gacgagggcc 26160
acgctatgct cccgggcctt ggtgagcagg atcgccagat caatgtcgat ggtggccggt 26220
tcaaagatac ccgccagaat atcattacgc tgccattcgc cgaactggag ttcgcgtttg 26280
gccggatagc gccaggggat gatgtcatcg tgcaccacaa tcgtcacctc aaccgcgcgc 26340
aggatttcgc tctcgccggg ggaggcggac gtttccagaa ggtcgttgat aagcgcgcgg 26400
cgcgtggtct cgtcgagacg gacggtaacg gtgacaagca ggtcgatgtc cgaatggggc 26460
ttaaggccgc cgtcaacggc gctaccatac agatgcacgg cgaggagggt cggttcgagg 26520
tggcgctcga tgacacccac gacttccgac agctgggtgg acacctcggc gatgaccgct 26580
tcacccatga tgtttaactt tgttttaggg cgactgccct gctgcgtaac atcgttgctg 26640
ctccataaca tcaaacatcg acccacggcg taacgcgctt gctgcttgga tgcccgaggc 26700
atagactgta ccccaaaaaa acagtcataa caagccatga aaaccgccac tgcgttccat 26760

gaatattcaa acaaacacat acagcgcgac ttatcatgga ta 26802

<210> 147
<211> 2254
<212> DNA
<213> Vicia faba; Arabidopsis

<400> 147
tcgacggccc ggactgtatc caacttctga tctttgaatc tctctgttcc aacatgttct 60

gaaggagttc taagactttt cagaaagctt gtaacatgct ttgtagactt tctttgaatt 120

actcttgcaa actctgattg aacctacgtg aaaactgctc cagaagttct aaccaaattc 180

cgtcttggga aggcccaaaa tttattgagt acttcagttt catggacgtg tcttcaaaga 240

tttataactt gaaatcccat catttttaag agaagttctg ttccgcaatg tcttagatct 300

cattgaaatc tacaactctt gtgtcagaag ttcttccaga atcaacttgc atcatggtga 360

aaatctggcc agaagttctg aacttgtcat atttcttaac agttagaaaa atttctaagt 420

gtttagaatt ttgacttttc caaagcaaac ttgacttttg actttcttaa taaaacaaac 480

ttcatattct aacatgtctt gatgaaatgt gattcttgaa atttgatgtt gatgcaaaag 540

tcaaagtttg acttttcagt gtgcaattga ccattttgct cttgtgccaa ttccaaacct 600

aaattgatgt atcagtgctg caaacttgat gtcatggaag atcttatgag aaaattcttg 660

aagactgaga ggaaaaattt tgtagtacaa cacaaagaat cctgtttttc atagtcggac 720

tagacacatt aacataaaac accacttcat tcgaagagtg attgaagaag gaaatgtgca 780

gttacctttc tgcagttcat aagagcaact tacagacact tttactaaaa tactacaaag 840

aggaagattt taacaactta gagaagtaat gggagttaaa gagcaacaca ttaaggggga 900

gtgttaaaat taatgtgttg taaccaccac tacctttagt aagtattata agaaaattgt 960

aatcatcaca ttataattat tgtccttatt taaaattatg ataaagttgt atcattaaga 1020

ttgagaaaac caaatagtcc tcgtcttgat ttttgaatta ttgttttcta tgttactttt 1080

cttcaagcct atataaaaac tttgtaatgc taaattgtat gctggaaaaa aatgtgtaat 1140

gaattgaata gaaattatgg tatttcaaag tccaaaatcc atcaatagaa atttagtaca 1200

aaacgtaact caaaaatatt ctcttatttt aaattttaca acaatataaa aatattctct 1260

tattttaaat tttacaataa tataatttat cacctgtcac ctttagaata ccaccaacaa 1320

tattaatact tagatatttt attcttaata attttgagat ctctcaatat atctgatatt 1380

tattttatat ttgtgtcata ttttcttatg ttttagagtt aacccttata tcttggtcaa 1440

actagtaatt caatatatga gtttgtgaag gacacattga catcttgaaa cattggtttt 1500

aaccttgttg gaatgttaaa ggtaataaaa cattcagaat tatgaccatc tattaatata 1560

cttcctttgt cttttaaaaa agtgtgcatg aaaatgctct atggtaagct agagtgtctt 1620

```
gctggcctgt gtatatcaat tccatttcca gatggtagaa actgccacta cgaataatta   1680
gtcataagac acgtatgtta acacacgtcc ccttgcatgt tttttgccat atattccgtc   1740
tctttctttt tcttcacgta taaaacaatg aactaattaa tagagcgatc aagctgaaca   1800
gttctttgct ttcgaagttg ccgcaaccta aacaggtttt tccttcttct ttcttcttat   1860
taactacgac cttgtccttt gcctatgtaa aattactagg ttttcatcag ttacactgat   1920
taagttcgtt atagtggaag ataaaatgcc ctcaaagcat tttgcaggat atctttgatt   1980
tttcaaagat atggaactgt agagtttgat agtgttcttg aatgtggttg catgaagttt   2040
ttttggtctg catgttattt tttcctcgaa atatgttttg agtccaacaa gtgattcact   2100
tgggattcag aaagttgttt tctcaatatg taacagtttt tttctatgga gaaaaatcat   2160
agggaccgtt ggttttggct tctttaattt tgagctcaga ttaaacccat tttacccggt   2220
gttcttggca gaattgaaaa cagtacgtag tacc                                2254
```

<210> 148
<211> 2568
<212> DNA
<213> Linum usitatissimum; Arabidopsis

<400> 148

```
cacgggcagg acatagggac tactacaagc atagtatgct tcagacaaag agctaggaaa     60
gaactcttga tggaggttaa gagaaaaaag tgctagaggg gcatagtaat caaacttgtc    120
aaaaccgtca tcatgatgag ggatgacata atataaaaag ttgactaagg tcttggtagt    180
actctttgat tagtattata tattggtgag aacatgagtc aagaggagac aagaaaccga    240
ggaaccatag tttagcaaca agatggaagt tgcaaagttg agctagccgc tcgattagtt    300
acatctccta agcagtacta caaggaatgg tctctatact ttcatgttta gcacatggta    360
gtgcggattg acaagttaga aacagtgctt aggagacaaa gagtcagtaa aggtattgaa    420
agagtgaagt tgatgctcga caggtcagga gaagtccctc cgccagatgg tgactaccaa    480
ggggttggta tcagctgaga cccaaataag attcttcggt tgaaccagtg gttcgaccga    540
gactcttagg gtgggatttc actgtaagat ttgtgcattt tgttgaatat aaattgacaa    600
tttttttat ttaattatag attatttaga atgaattaca tatttagttt ctaacaagga     660
tagcaatgga tgggtatggg tacaggttaa acatatctat tacccaccca tctagtcgtc    720
gggttttaca cgtacccacc cgtttacata aaccagaccg gaattttaaa ccgtacccgt    780
ccgttagcgg gtttcagatt tacccgttta atcgggtaaa acctgattac taaatatata    840
ttttttattt gataaacaaa acaaaaatgt taatattttc atattggatg caattttaag    900
aaacacatat tcataaattt ccatatttgt aggaaaataa aaagaaaaat atattcaaga    960
acacaaattt caccgacatg acttttatta cagagttgga attagatcta acaattgaaa   1020
```

aattaaaatt aagatagaat atgttgagga acatgacata gtataatgct gggttacccg 1080

tcgggtaggt atcgaggcgg atactactaa atccatccca ctcgctatcc gataatcact 1140

ggtttcgggt atacccattc ccgtcaacag gcctttttaa ccggataatt tcaacttata 1200

gtgaatgaat tttgaataaa tagttagaat accaaaatcc tggattgcat ttgcaatcaa 1260

attttgtgaa ccgttaaatt ttgcatgtac ttgggataga tataatagaa ccgaattttc 1320

attagtttaa tttataactt actttgttca aagaaaaaaa atatctatcc aatttactta 1380

taataaaaaa taatctatcc aagttactta ttataatcaa cttgtaaaaa ggtaagaata 1440

caaatgtggt agcgtacgtg tgattatatg tgacgaaatg ttatatctaa caaaagtcca 1500

aattcccatg gtaaaaaaaa tcaaaatgca tggcaggctg tttgtaacct tggaataaga 1560

tgttggccaa ttctggagcc gccacgtacg caagactcag ggccacgttc tcttcatgca 1620

aggatagtag aacaccactc cacccacctc ctatattaga cctttgccca accctcccca 1680

actttcccat cccatccaca aagaaaccga catttttatc ataaatctgg tgcttaaaca 1740

ctctggtgag ttctagtact tctgctatga tcgatctcat taccatttct taaatttctc 1800

tccctaaata ttccgagttc ttgatttttg ataacttcag gttttctctt tttgataaat 1860

ctggtctttc catttttttt tttttgtggt taatttagtt tcctatgttc ttcgattgta 1920

ttatgcatga tctgtgtttg gattctgtta gattatgtat tggtgaatat gtatgtgttt 1980

ttgcatgtct ggttttggtc ttaaaaatgt tcaaatctga tgatttgatt gaagcttttt 2040

tagtgttggt ttgattcttc tcaaaactac tgttaattta ctatcatgtt ttccaacttt 2100

gattcatgat gacacttttg ttctgctttg ttataaaatt ttggttggtt tgattttgta 2160

attatagtgt aattttgtta ggaatgaaca tgttttaata ctctgttttc gatttgtcac 2220

acattcgaat tattaatcga taatttaact gaaaattcat ggttctagat cttgttgtca 2280

tcagattatt tgtttcgata attcatcaaa tatgtagtcc ttttgctgat ttgcgactgt 2340

ttcatttttt ctcaaaattg ttttttgtta agtttatcta acagttatcg ttgtcaaaag 2400

tctctttcat tttgcaaaat cttctttttt tttttgtttg taactttgtt ttttaagcta 2460

cacatttagt ctgtaaaata gcatcgagga acagttgtct tagtagactt gcatgttctt 2520

gtaacttcta tttgtttcag tttgttgatg actgctttga ttttgtag 2568

<210> 149
<211> 1041
<212> DNA
<213> Brassica napus; Arabidopsis

<400> 149
taaggatgac ctacccattc ttgagacaaa tgttacattt tagtatcaga gtaaaatgtg 60

tacctataac tcaaattcga ttgacatgta tccattcaac ataaaattaa accagcctgc 120

```
acctgcatcc acatttcaag tattttcaaa ccgttcggct cctatccacc gggtgtaaca    180
agacggattc cgaatttgga agattttgac tcaaattccc aatttatatt gaccgtgact    240
aaatcaactt taacttctat aattctgatt aagctcccaa tttatattcc caacggcact    300
acctccaaaa tttatagact ctcatcccct tttaaaccaa cttagtaaac gttttttttt    360
taattttatg aagttaagtt tttaccttgt ttttaaaaag aatcgttcat aagatgccat    420
gccagaacat tagctacacg ttacacatag catgcagccg cggagaattg tttttcttcg    480
ccacttgtca ctcccttcaa acacctaaga gcttctctct cacagcacac acatacaatc    540
acatgcgtgc atgcattatt acacgtgatc gccatgcaaa tctcctttat agcctataaa    600
ttaactcatc ggcttcactc tttactcaaa ccaaaactca tcaatacaaa caagattaaa    660
aacatttcac gatttggaat ttgattcctg cgatcacagg tatgacaggt tagattttgt    720
tttgtatagt tgtatacata cttctttgtg atgttttgtt tacttaatcg aatttttgga    780
gtgttttaag gtctctcgtt tagaaatcgt ggaaaatatc actgtgtgtg tgttcttatg    840
attcacagtg tttatgggtt tcatgttctt tgttttatca ttgaatggga agaaatttcg    900
ttgggataca aatttctcat gttcttactg atcgttatta ggagtttggg gaaaaaggaa    960
gagttttttt ggttggttcg agtgattatg aggttatttc tgtatttgat ttatgagtta   1020
atggtcgttt taatgttgta g                                             1041
```

```
<210>  150
<211>  46
<212>  DNA
<213>  Artificial

<220>
<223>  Primer

<400>  150
gcaacttcga aagcaaagaa ctgttcagct tgatcgctct attaat                    46


<210>  151
<211>  46
<212>  DNA
<213>  Artificial

<220>
<223>  Primer

<400>  151
attaatagag cgatcaagct gaacagttct ttgctttcga agttgc                    46


<210>  152
<211>  48
<212>  DNA
<213>  Artificial
```

<220>
<223> Primer

<400> 152
actcaccaga gtgtttaagc accagattta tgataaaaat gtcggttt 48

<210> 153
<211> 48
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 153
aaaccgacat ttttatcata aatctggtgc ttaaacactc tggtgagt 48

<210> 154
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 154
tcaaattcca aatcgtgaaa tgtttttaat cttgtttgta ttga 44

<210> 155
<211> 44
<212> DNA
<213> Artificial

<220>
<223> Primer

<400> 155
tcaatacaaa caagattaaa aacatttcac gatttggaat ttga 44

Claims

1. A polynucleotide comprising a seed specific promoter and a heterologous expression enhancing element (NEENA) functionally linked to said promoter, and further comprising a nucleic acid sequence to be expressed under the control of said promoter, wherein the NEENA is selected from

i) a nucleic acid molecule as shown in the nucleic acid sequence of SEQ ID NO. 7,
ii) a nucleic acid molecule having at least 80% sequence identity to the nucleic acid sequence of i), wherein said nucleic acid molecule enhances the expression of the nucleic acid sequence to be expressed under the control of said promoter, and
iii) a nucleic acid molecule of at least 100 consecutive bases of a nucleic acid sequence of i) or ii) which enhances the expression of the nucleic acid sequence to be expressed under the control of said promoter.

2. The polynucleotide of claim 1, wherein the nucleic acid sequence to be expressed under the control of said promoter encodes a polypeptide having desaturase or elongase activity.

3. The polynucleotide of claim 2, further comprising a nucleic acid sequence encoding a polypeptide having

i) beta-ketoacyl reductase activity,
ii) dehydratase activity, and/or
iii) enoyl-CoA reductase activity,

wherein the nucleic acid sequences defined in i) to iii) are heterologous to said polypeptide having desaturase or elongase activity.

4. The polynucleotide of claim 2 or 3, further comprising at least one nucleic acid sequence encoding a polypeptide having acyltransferase activity, wherein the nucleic acid sequence is heterologous to said polypeptide having desaturase, elongase, beta-ketoacyl reductase, dehydratase or enoyl-CoA reductase activity.

5. The polynucleotide of any of claim 2 to 4, further comprising a terminator operatively linked to said nucleic acid sequence encoding a polypeptide having desaturase or elongase activity.

6. An expression construct comprising the polynucleotide of any of claims 1 to 5, wherein the promoter is functional in a part of a plant or plant cell, and wherein the promoter is functionally linked to a nucleotide sequence of interest to be expressed in said part of a plant or plant cell.

7. A vector comprising the polynucleotide of any of claims 1 to 5 or the expression construct of claim 6.

8. A host cell or transgenic plant or part thereof, comprising the polynucleotide of any of claims 1 to 5 or the expression construct of claim 6 or the vector of claim 7.

9. A method for seed-specific enhancement of gene expression, comprising the steps of

i) transforming a plant cell with a polynucleotide according to any of claims 1 to 5 , and
ii) expressing the nucleic acid sequence to be expressed.

10. Use of a nucleic acid molecule selected from

i) a nucleic acid molecule as shown in the nucleic acid sequence of SEQ ID NO. 7,
ii) a nucleic acid molecule having at least 80% sequence identity to the nucleic acid sequence of i), wherein said nucleic acid molecule enhances the expression of the nucleic acid sequence to be expressed under the control of a seed-specific promoter,
ii) a nucleic acid molecule of at least 100 consecutive bases of a nucleic acid sequence of i) or ii) which enhances the expression of the nucleic acid sequence to be expressed under the control of a seed-specific promoter for

- enhancing the expression of a nucleic acid sequence to be expressed, or
- enhancing the expression of a polypeptide having desaturase or elongase activity.

11. Use of the host cell or transgenic plant or part thereof according to claim 8 for

- producing a polyunsaturated fatty acid, or
- producing foodstuffs, animal feeds, seeds, propagation material, pharmaceuticals or fine chemicals.

12. Use of claim 11, wherein the polyunsaturated fatty acid is arachidonic acid, eicosapentaenoic acid or docosahexaenoic acid.

Figure 1: Schematical figure of the different enzymatic activities leading to the production of ARA, EPA and DHA.

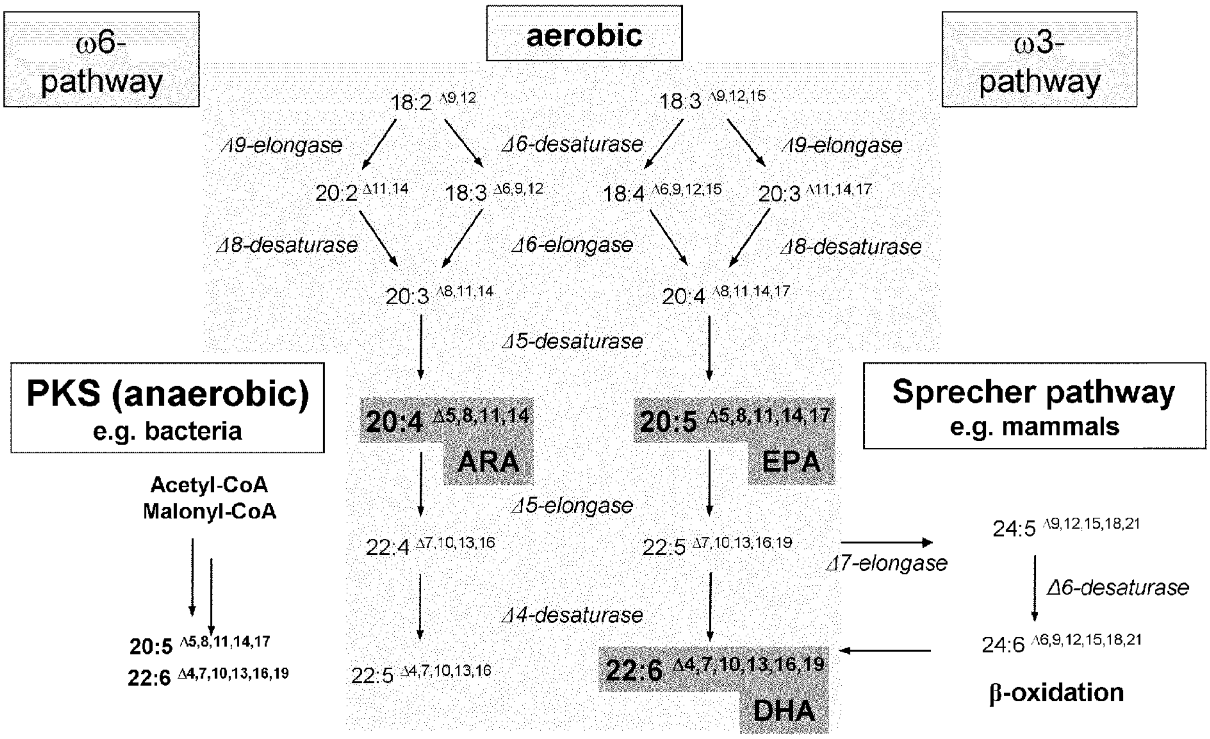


Figure 2 Strategy employed for stepwise buildup of plant expression plasmids of the invention

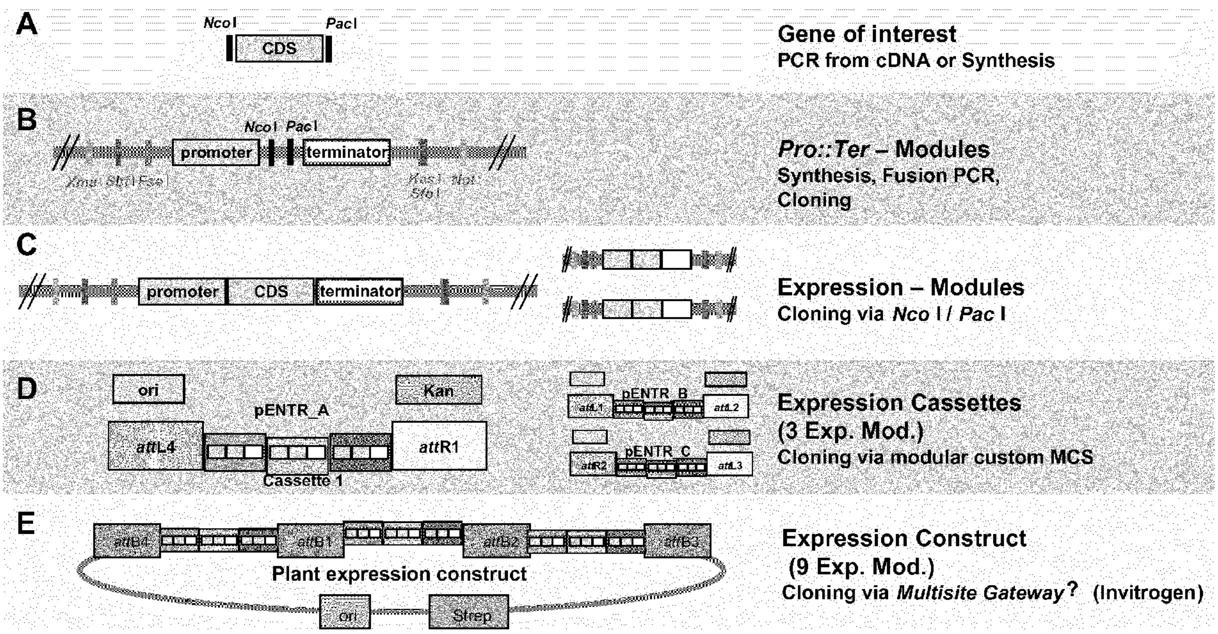


Figure 3 A – D: Orientation and combination of the functional elements (promotor, NEENA, gene, terminator) of the plant expression VC-LJB913-1qcz (SEQ-ID 33), VC-LJB1327-1qcz (SEQ-ID 34), VC-LJB2003-1qcz (SEQ-ID 35) and VC-LJB2197(SEQ_ID 146).

Figure A

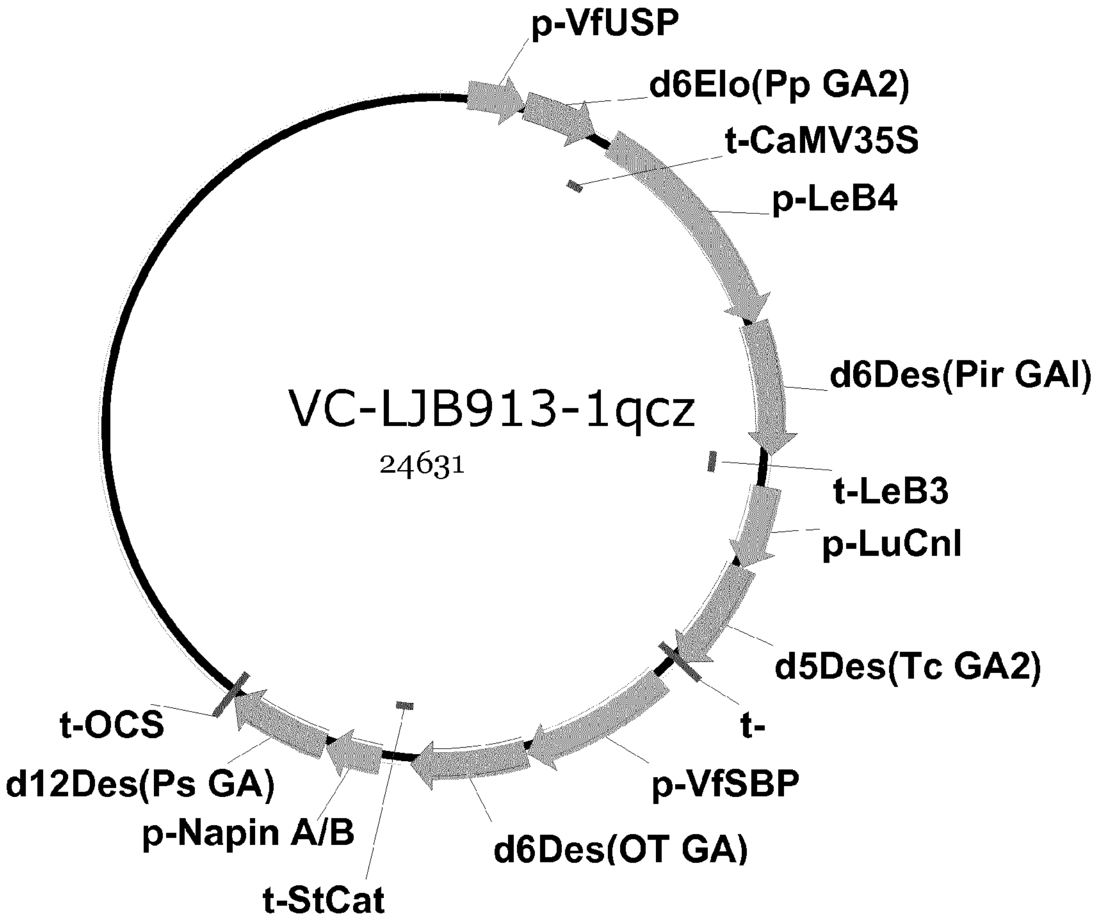


Figure B

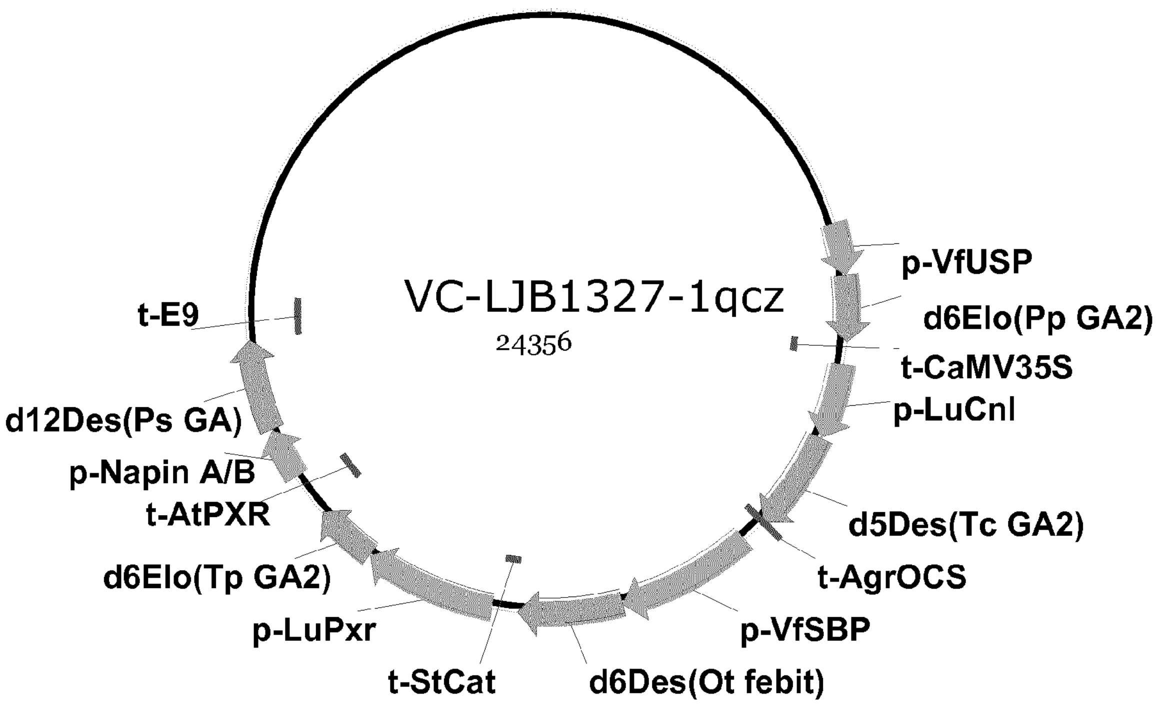

VC-LJB1327-1qcz
24356
p-VfUSP
d6Elo(Pp GA2)
t-CaMV35S
p-LuCnl
d5Des(Tc GA2)
t-AgrOCS
p-VfSBP
d6Des(Ot febit)
t-StCat
p-LuPxr
d6Elo(Tp GA2)
t-AtPXR
p-Napin A/B
d12Des(Ps GA)
t-E9

Figure C

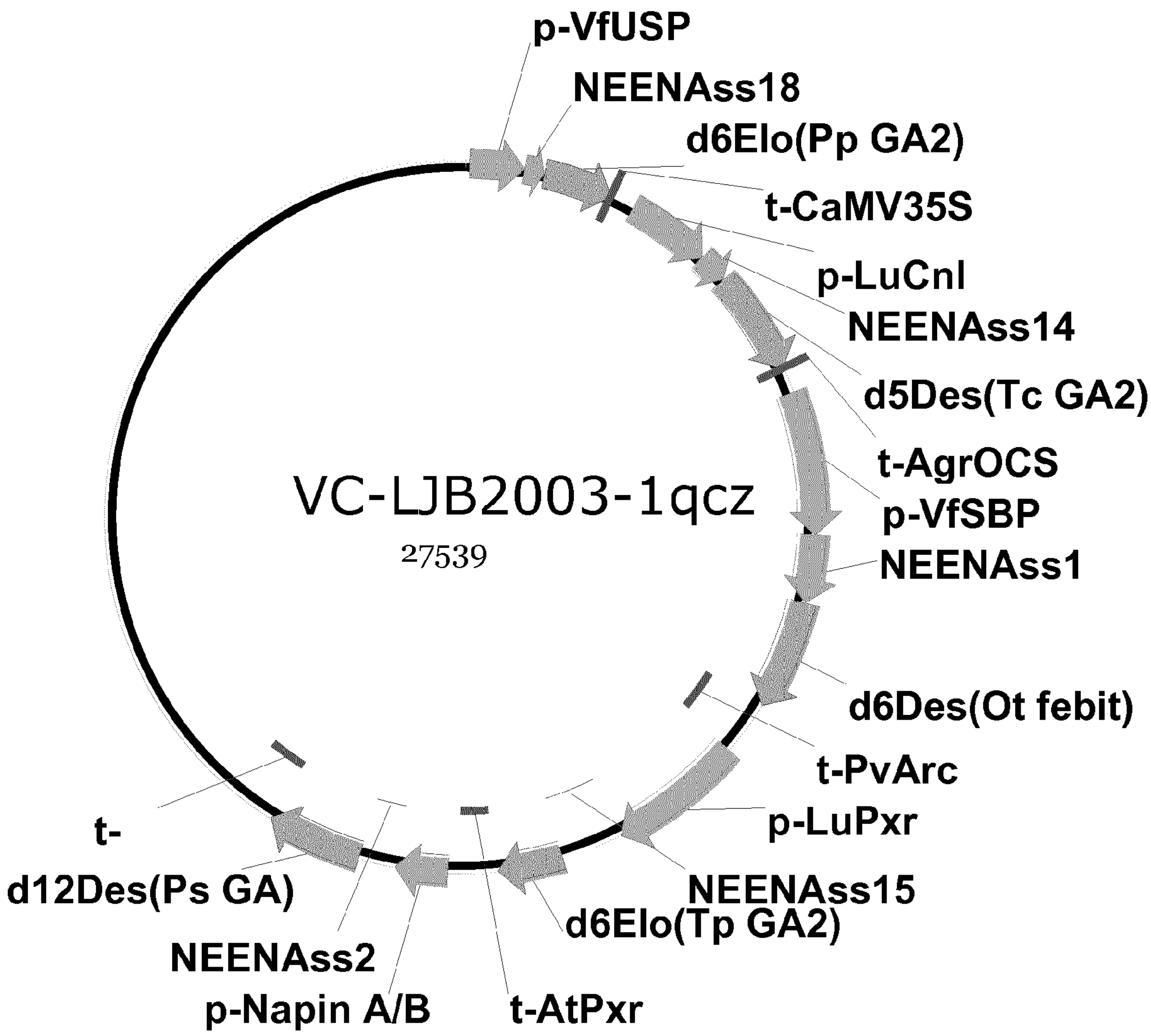
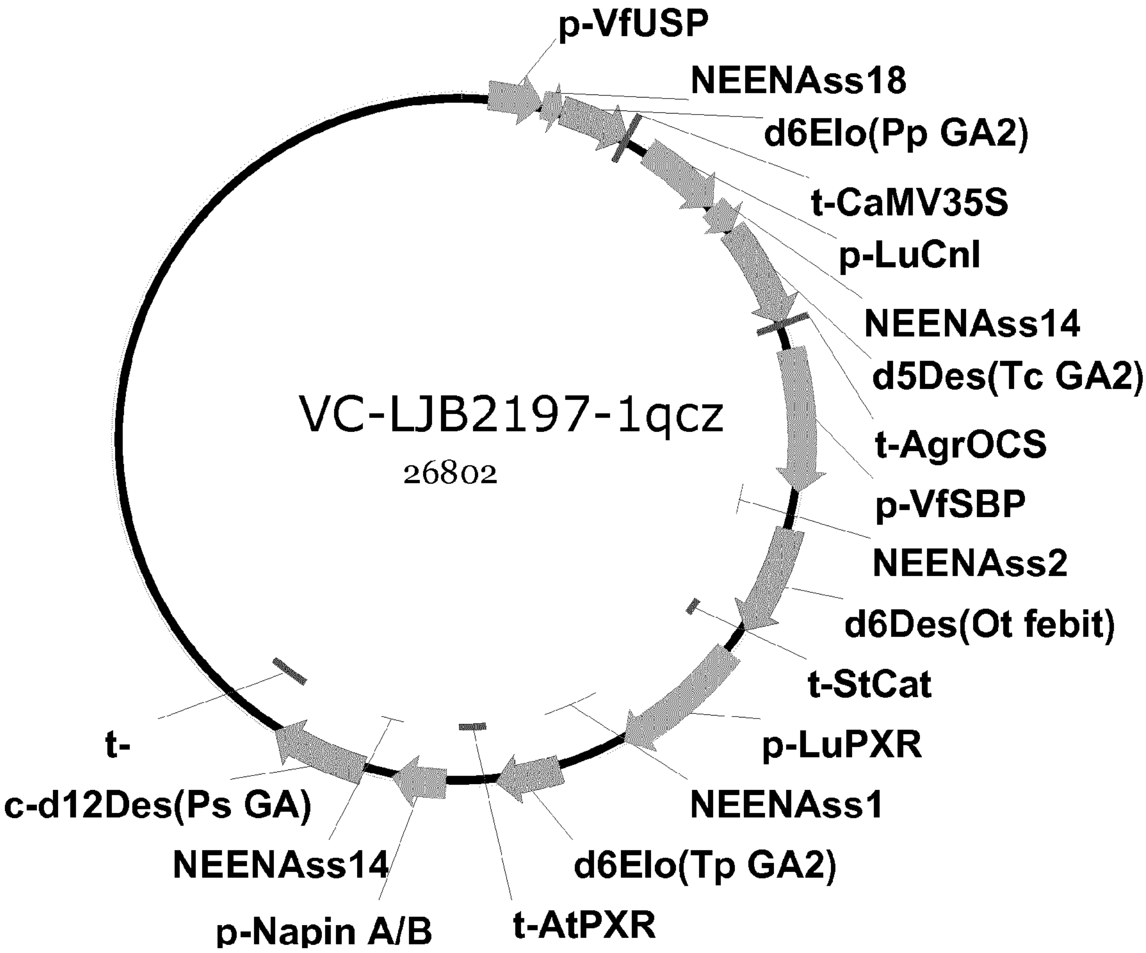

p-VfUSP
NEENAss18
d6Elo(Pp GA2)
t-CaMV35S
p-LuCnl
NEENAss14
d5Des(Tc GA2)
t-AgrOCS
p-VfSBP
NEENAss1
d6Des(Ot febit)
t-PvArc
p-LuPxr
NEENAss15
d6Elo(Tp GA2)
t-AtPxr
p-Napin A/B
NEENAss2
t-
d12Des(Ps GA)
VC-LJB2003-1qcz
27539

Figure D


VC-LJB2197-1qcz
26802
p-VfUSP
NEENAss18
d6Elo(Pp GA2)
t-CaMV35S
p-LuCnl
NEENAss14
d5Des(Tc GA2)
t-AgrOCS
p-VfSBP
NEENAss2
d6Des(Ot febit)
t-StCat
p-LuPXR
NEENAss1
d6Elo(Tp GA2)
t-AtPXR
p-Napin A/B
NEENAss14
c-d12Des(Ps GA)
t-

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 17 5906

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2008/104559 A1 (NORDDEUTSCHE PFLANZENZUCHT [DE]; UNIV GOETTINGEN GEORG AUGUST [DE]; AB) 4 September 2008 (2008-09-04) * claims 1-14; pages 48 (lines 14-18) and 68-70; Examples 8 and 13; Figure 12 * -----	1-12	INV. C12N15/82 A01H5/00 A01H5/10
A	WO 2008/009600 A1 (BASF PLANT SCIENCE GMBH [DE]; GEIGER MICHAEL [DE]; BAUER JOERG [DE]; C) 24 January 2008 (2008-01-24) * claims 1, 3, and 11-15; abstract; pages 16, 18, 20-26; Example 3 * -----	1-12	
A	EP 1 645 633 A2 (SUNGENE GMBH [DE]) 12 April 2006 (2006-04-12) * Paragraphs [0162]-[0172] and [0227] * -----	1-12	
A	DATABASE EMBL [Online] 7 April 1999 (1999-04-07), "Arabidopsis thaliana chromosome 1 BAC T23K8 sequence, complete sequence.", XP002764461, retrieved from EBI accession no. EM_STD:AC007230 Database accession no. AC007230 * the whole document * -----	1-12	TECHNICAL FIELDS SEARCHED (IPC) C12N
A	WO 99/67389 A2 (CANADA AGRICULTURE [CA]; MIKI BRIAN [CA]; OUELLET THERESE [CA]; HATTOR) 29 December 1999 (1999-12-29) * claims 1, 4-7, 10, 14-18, 24, 40-42, 47-52, 62, 64, 65 * -----	1-12	
	-/--		

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 November 2016	Kurz, Birgit

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 17 5906

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CHEN Z-L ET AL: "A DNA SEQUENCE ELEMENT THAT CONFERS SEED-SPECIFIC ENHANCEMENT TO A CONSTITUTIVE PROMOTER", EMBO JOURNAL, OXFORD UNIVERSITY PRESS, SURREY, GB, vol. 7, no. 2, 1 January 1988 (1988-01-01), pages 297-302, XP009140094, ISSN: 0261-4189 * abstract; page 298; Figure 1 * -----	1-12	
A	THOMAS M S ET AL: "IDENTIFICATION OF AN ENHANCER ELEMENT FOR THE ENDOSPERM-SPECIFIC EXPRESSION OF HIGH MOLECULAR WEIGHT GLUTENIN", PLANT CELL, AMERICAN SOCIETY OF PLANT PHYSIOLOGISTS, ROCKVILLE, MD, US, vol. 2, no. 12, 1 December 1990 (1990-12-01), pages 1171-1180, XP002049700, ISSN: 1040-4651, DOI: DOI:10.1105/TPC.2.12.1171 * abstract; pages 1172, 1173, 1175, 1176; Figure 1 * -----	1-12	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 November 2016	Kurz, Birgit

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 17 5906

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-11-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008104559 A1	04-09-2008	NONE	
WO 2008009600 A1	24-01-2008	AU 2007276257 A1	24-01-2008
		CA 2658273 A1	24-01-2008
		DE 102006034313 A1	24-01-2008
		EP 2046960 A1	15-04-2009
		US 2009172837 A1	02-07-2009
		WO 2008009600 A1	24-01-2008
EP 1645633 A2	12-04-2006	EP 1645633 A2	12-04-2006
		EP 2163632 A1	17-03-2010
		EP 2166097 A1	24-03-2010
		EP 2166098 A1	24-03-2010
WO 9967389 A2	29-12-1999	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2006003186 A **[0007]**
- WO 2007098042 A **[0007]**
- WO 2009016202 A **[0040] [0070]**
- WO 2004076617 A **[0043]**
- WO 2006069936 A **[0043]**
- WO 2004087902 A **[0043]**
- EP 0388186 A1 **[0054]**
- EP 0335528 A1 **[0054]**
- WO 9321334 I **[0054]**
- EP 0249676 A1 **[0054]**
- US 5608152 A **[0054] [0064]**
- WO 9845461 A **[0054] [0064]**
- US 5504200 A **[0054] [0064]**
- WO 9113980 A **[0054] [0064]**
- WO 9515389 A **[0054] [0064]**
- WO 9523230 A **[0054] [0064]**
- WO 9916890 A **[0054] [0064]**
- US 20030159174 A **[0063]**
- US 5352605 A **[0064]**
- WO 8402913 A **[0064]**
- US 4962028 A **[0064]**
- WO 9519443 A **[0064]**
- US 5187267 A **[0064]**
- WO 9612814 A **[0064]**
- EP 0375091 A **[0064]**
- WO 9516783 A **[0064]**
- WO 9706250 A **[0064]**
- WO 9946394 A **[0064]**
- WO 2007042510 A **[0070]**
- WO 2008006202 A **[0070]**
- WO 200185968 A **[0070]**
- WO 2008040787 A **[0070]**
- WO 2006100241 A **[0070]**
- WO 2006069710 A **[0070]**
- WO 2004090123 A **[0070]**
- WO 2002026946 A **[0070]**
- WO 2004057001 A **[0070]**
- WO 2002057465 A **[0070]**
- WO 2000075341 A **[0070]**
- WO 2003072784 A **[0070]**
- WO 200102591 A **[0070]**
- EP 1790731 A **[0070]**
- WO 200034439 A **[0070]**
- WO 2007093776 A **[0070]**
- WO 2005083053 A **[0070]**
- WO 2008022963 A **[0070]**
- WO 2005012316 A **[0070]**
- WO 2003064638 A **[0070]**
- WO 2009016208 A **[0070]**
- WO 2001059128 A **[0070]**
- WO 2002077213 A **[0070]**
- US 5565350 A **[0106]**
- WO 0015815 A **[0106]**

Non-patent literature cited in the description

- **CRAWFORD, M.A. et al.** *Am. J. Clin. Nutr.,* 1997, vol. 66, 1032S-1041S **[0012]**
- **GIUSTO, N.M. et al.** *Prog. Lipid Res.,* 2000, vol. 39, 315-391 **[0012]**
- **MARTINETZ, M.** *J. Pediatr.,* 1992, vol. 120, S129-S138 **[0012]**
- **HORROCKS, L.A. ; YEO, Y.K.** *Pharmacol. Res.,* 1999, vol. 40, 211-215 **[0012]**
- **SPECTOR, A.A.** *Lipids,* 1999, vol. 34, S1-S3 **[0012]**
- **XIE et al.** Bidirectionalization of polar promoters in plants. *Nature Biotechnology,* 2001, vol. 19, 677-679 **[0023]**
- Current Protocols in Molecular Biology. John Wiley & Sons, 1989, 6.3.1-6.3.6 **[0045] [0108]**
- **SAMBROOK et al.** Molecular Cloning. Cold Spring Harbor Laboratory, 1989 **[0045]**
- Nucleic Acids Hybridization: A Practical Approach. IRL Press at Oxford University Press, 1985 **[0045]**
- Essential Molecular Biology: A Practical Approach. IRL Press at Oxford University Press, 1991 **[0045]**
- **NEEDLEMAN.** *J. Mol. Biol.,* 1970, 444-453 **[0045]**
- **RICE,P. ; LONGDEN,I. ; BLEASBY,A.** EMBOSS: The European Molecular Biology Open Software Suite. *Trends in Genetic,* 2000, vol. 16 (6), 276-277 **[0045]**
- **RICE,P. ; LONGDEN,I. ; BLEASBY,A.** EMBOSS: The European Molecular Biology Open Software Suite. *Trends in Genetics,* 2000, vol. 16 (6), 276-277 **[0045]**
- **ALTSCHUL.** *J. Mol. Biol.,* 1990, vol. 215, 403-10 **[0045]**
- **ALTSCHUL.** *Nucleic Acids Res.,* 1997, vol. 25 (17), 3389-3402 **[0045]**
- **FRANCK.** *Cell,* 1980, vol. 21, 285-294 **[0054] [0064]**
- **WARD.** *Plant. Mol. Biol.,* 1993, vol. 22 **[0054]**
- **GATZ.** *Plant J.,* 1992, vol. 2, 397-404 **[0054] [0064]**

- **STOCKHAUS.** *EMBO J.,* 1989, vol. 8, 2445 **[0054]**
- **BAEUMLEIN et al.** *Plant J.,* 1992, vol. 2 (2), 233-239 **[0054]**
- **LOKE.** *Plant Physiol,* 2005, vol. 138, 1457-1468 **[0057]**
- **SAMBROOK et al.** Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press, 1989 **[0059]**
- Agrobacterium protocols. Methods in Molecular Biology. Humana Press, 1995, vol. 44 **[0059]**
- **HELLENS et al.** *Trends in Plant Science,* 2000, vol. 5, 446-451 **[0060] [0144]**
- Plant Molecular Biology and Biotechnology. CRC Press, 1993, 71-119 **[0060]**
- Vectors for Gene Transfer in Higher Plants. **F.F. WHITE.** Transgenic Plants, vol. 1, Engineering and Utilization. Academic Press, 1993, vol. 1, 15-38 **[0060]**
- Techniques for Gene Transfer. **B. JENES et al.** Transgenic Plants, vol. 1, Engineering and Utilization. Academic Press, 1993, vol. 1, 128-143 **[0060]**
- **POTRYKUS.** *Annu. Rev. Plant Physiol. Plant Molec. Biol.,* 1991, vol. 42, 205-225 **[0060]**
- **SMITH.** *Gene,* 1988, vol. 67, 31-40 **[0061]**
- **AMANN.** *Gene,* 1988, vol. 69, 301-315 **[0061]**
- **STUDIER.** *Methods in Enzymology,* 1990, vol. 185, 60-89 **[0061]**
- **BALDARI.** *Embo J.,* 1987, vol. 6, 229-234 **[0061]**
- **KURJAN.** *Cell,* 1982, vol. 30, 933-943 **[0061]**
- **SCHULTZ.** *Gene,* 1987, vol. 54, 113-123 **[0061]**
- Gene transfer systems and vector development for filamentous fungi. **VAN DEN HONDEL, C.A.M.J.J. ; PUNT, P.J. et al.** Applied Molecular Genetics of fungi. Cambridge University Press, 1991, 1-28 **[0061]**
- More Gene Manipulations in Fungi. Academic Press, 396-428 **[0061]**
- **SMITH.** *Mol. Cell Biol,* 1983, vol. 3, 2156-2165 **[0061]**
- **LUCKLOW.** *Virology,* 1989, vol. 170, 31-39 **[0061]**
- Cloning Vectors. Elsevier, 1985 **[0062]**
- **FALCIATORE.** *Marine Biotechnology,* 1999, vol. 1 (3), 239-251 **[0064]**
- **BECKER.** *Plant Mol. Biol.,* 1992, vol. 20, 1195-1197 **[0064]**
- **BEVAN.** *Nucl. Acids Res,* 1984, vol. 12, 8711-8721 **[0064]**
- Vectors for Gene Transfer in Higher Plants. Transgenic Plants, Vol. 1, Engineering and Utilization. Academic Press, 1993, vol. 1, 15-38 **[0064]**
- **GIELEN.** *EMBO J.,* 1984, vol. 3, 835 **[0064]**
- **GALLIE.** *Nucl. Acids Research,* 1987, vol. 15, 8693-8711 **[0064]**
- **BENFEY.** *EMBO J.,* 1989, vol. 8, 2195-2202 **[0064]**
- **KERMODE.** *Crit. Rev. Plant Sci.,* 1996, vol. 15 (4), 285-423 **[0064]**
- **GATZ.** *Annu. Rev. Plant Physiol. Plant Mol. Biol.,* 1997, vol. 48, 89-108 **[0064]**
- **WARD.** *Plant Mol. Biol.,* 1993, vol. 22, 361-366 **[0064]**
- **BAEUMLEIN.** *Mol. Gen. Genet.,* 1991, vol. 225 (3), 459-67 **[0064]**
- **BAEUMLEIN.** *Plant Journal,* 1992, vol. 2 (2), 233-9 **[0064]**
- **MANN.** *Nat. Biotechnol.,* 2003, vol. 21, 255-261 **[0075]**
- **HUBER.** *Curr. Opin. Plant Biol,* 2004, vol. 7, 318-322 **[0075]**
- Manual of Methods for General Bacteriology. American Society for Bacteriology, 1981 **[0086]**
- **GOA J.** *Scand J Clin Lab Invest,* 1953, vol. 5, 218-222 **[0099]**
- **LOWRY OH et al.** *J Biol Chem,* 1951, vol. 193, 265-275 **[0099]**
- **BRADFORD MM.** *Analyt Biochem,* 1976, vol. 72, 248-254 **[0099]**
- **MANIATIS T ; FRITSCH EF ; SAMBROOK J.** Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory, 1989 **[0103]**
- **SILHAVY et al.** Experiments with Gene Fusions. Cold Spring Harbor Laboratory, 1984 **[0103]**
- **AUSUBEL et al.** Current Protocols in Molecular Biology. Greene Publishing Assoc. and Wiley Interscience, 1987 **[0103]**
- Plant Molecular Biology Manual. Kluwer Academic Publisher, 1990 **[0103]**
- **J. COOMBS.** Dictionary of Biotechnology. Stockton Press, 1994 **[0108]**
- **ANDERSON ; YOUNG.** Quantitative Filter Hybridization. *Nucleic Acid Hybridization,* 1985 **[0108]**
- **W. R. PEARSON ; D. J. LIPMAN.** *PNAS,* 1988, vol. 85, 2444 **[0112]**
- **W. R. PEARSON.** *Methods in Enzymology,* 1990, vol. 183, 63 **[0112]**
- **W. R. PEARSON.** *Enzymology,* 1990, vol. 183, 63 **[0112]**
- **NEEDLEMAN ; WUNSCH.** *J Mol. Biol.,* 1970, vol. 48, 443-453 **[0131]**
- **K. HECKMAN ; L. R. PEASE.** *Nature Protocols,* vol. 2, 924-932 **[0138]**
- **SANGER et al.** *Proc. Natl. Acad. Sci. USA,* 1977, vol. 74, 5463-5467 **[0139]**
- **DEBLAERE et al.** *Nucl. Acids. Res.,* 1984, vol. 13, 4777-4788 **[0146]**
- **MURASHIGE ; SKOOG.** *Physiol. Plant.,* 1962, vol. 15, 473 **[0146]**
- **QUI et al.** *J. Biol. Chem.,* 2001, vol. 276, 31561-31566 **[0147]**
- **BELL et al.** *In Vitro Cell. Dev. Biol. Plant,* 1999, vol. 35 (6), 456-465 **[0148]**
- **MLYNAROVA et al.** *Plant Cell Report,* 1994, vol. 13, 282-285 **[0148]**
- **ULLMAN.** Encyclopedia of Industrial Chemistry. VCH, 1985, vol. A2, S. 89-90, S. 443-613 **[0149]**
- **FALLON, A. et al.** Applications of HPLC in Biochemistry. *Laboratory Techniques in Biochemistry and Molecular Biology,* 1987, vol. 17 **[0149]**

- Product recovery and purification. **REHM et al.** Biotechnology. VCH, 1993, vol. 3, 469-714 **[0149]**
- **BELTER, P.A et al.** Bioseparations: downstream processing for Biotechnology. John Wiley and Sons, 1988 **[0149]**
- **KENNEDY, J.F. ; CABRAL, J.M.S.** Recovery processes for biological Materials. John Wiley and Sons, 1992 **[0149]**
- Biochemical Separations. **SHAEIWITZ, J.A ; HENRY, J.D.** Ullmann's Encyclopedia of Industrial Chemistry. VCH, 1988, vol. B3, 1-27 **[0149]**
- **DECHOW, F.J.** Separation and purification techniques in biotechnology. Noyes Publications, 1989 **[0149]**
- **CAHOON et al.** *Proc. Natl. Acad. Sci. USA,* 1999, vol. 96 (22), 12935-12940 **[0150]**
- **BROWSE et al.** *Analytic Biochemistry,* 1986, vol. 152, 141-145 **[0150]**
- **CHRISTIE, WILLIAM W.** Advances in Lipid Methodology, Ayr/Scotland: Oily Press. Oily Press Lipid Library **[0150]**
- Gas Chromatography and Lipids. **CHRISTIE, WILLIAM W.** A Practical Guide-Ayr. Oily Press Lipid Library, 1989, vol. IX, 307 S **[0150]**
- Progress in Lipid Research. Pergamon Press, 1952, vol. 1, 16 **[0150]**