

Recombinant Production of Steviol Glycosides

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Application Serial No. 61/521,084, filed August 8, 2011; U.S. Application Serial No. 61/521,203, filed August 8, 2011; U.S. Application Serial No. 61/521,051, filed August 8, 2011; U.S. Application Serial No. 61/523,487, filed August 15, 2011; U.S. Application Serial No. 61/567,929, filed December 7, 2011; and U.S. Application Serial No. 61/603,639, filed February 27, 2012, all of which are incorporated by reference herein in their entirety.

TECHNICAL FIELD

This disclosure relates to the recombinant production of steviol glycosides. In particular, this disclosure relates to the production of steviol glycosides such as rebaudioside D by recombinant hosts such as recombinant microorganisms, plants, or plant cells. This disclosure also provides compositions containing steviol glycosides. The disclosure also relates to tools and methods for producing terpenoids by modulating the biosynthesis of terpenoid precursors of the squalene pathway.

BACKGROUND

Sweeteners are well known as ingredients used most commonly in the food, beverage, or confectionary industries. The sweetener can either be incorporated into a final food product during production or for stand-alone use, when appropriately diluted, as a tabletop sweetener or an at-home replacement for sugars in baking. Sweeteners include natural sweeteners such as sucrose, high fructose corn syrup, molasses, maple syrup, and honey and artificial sweeteners such as aspartame, saccharine and sucralose. Stevia extract is a natural sweetener that can be isolated and extracted from a perennial shrub, *Stevia rebaudiana*. Stevia is commonly grown in South America and Asia for commercial production of stevia extract. Stevia extract, purified to various degrees, is used commercially as a high intensity sweetener in foods and in blends or alone as a tabletop sweetener.

Extracts of the Stevia plant contain rebaudiosides and other steviol glycosides that contribute to the sweet flavor, although the amount of each glycoside often varies among different production batches. Existing commercial products are predominantly rebaudioside A with lesser amounts of other glycosides such as rebaudioside C, D, and F.

5 Stevia extracts may also contain contaminants such as plant-derived compounds that contribute to off-flavors. These off-flavors can be more or less problematic depending on the food system or application of choice. Potential contaminants include pigments, lipids, proteins, phenolics, saccharides, spathulenol and other sesquiterpenes, labdane diterpenes, monoterpenes, decanoic acid, 8,11,14-eicosatrienoic acid, 2-
10 methyl octadecane, pentacosane, octacosane, tetracosane, octadecanol, stigmasterol, β -sitosterol, α - and β -amyrin, lupeol, β -amryin acetate, pentacyclic triterpenes, centauredin, quercitin, epi- α -cadinol, carophyllenes and derivatives, beta-pinene, beta-sitosterol, and gibberellin.

SUMMARY

15 Provided herein is a recombinant host, such as a microorganism, plant, or plant cell, comprising one or more biosynthesis genes whose expression results in production of steviol glycosides such as rebaudioside A, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, or dulcoside A. In particular, EUGT11, a uridine 5'-diphospho (UDP) glycosyl transferase described herein, can be used alone or in
20 combination with one or more other UDP glycosyl transferases such as UGT74G1, UGT76G1, UGT85C2, and UGT91D2e, to allow the production and accumulation of rebaudioside D in recombinant hosts or using *in vitro* systems. As described herein, EUGT11 has a strong 1,2-19-O-glucose glycosylation activity, which is an important step for rebaudioside D production.

25 Typically, stevioside and rebaudioside A are the primary compounds in commercially-produced stevia extracts. Stevioside is reported to have a more bitter and less sweet taste than rebaudioside A. The composition of stevia extract can vary from lot to lot depending on the soil and climate in which the plants are grown. Depending upon the sourced plant, the climate conditions, and the extraction process, the amount of

rebaudioside A in commercial preparations is reported to vary from 20 to 97% of the total steviol glycoside content. Other steviol glycosides are present in varying amounts in stevia extracts. For example, Rebaudioside B is typically present at less than 1-2%, whereas Rebaudioside C can be present at levels as high as 7-15%. Rebaudioside D is typically present in levels of 2% or less, and Rebaudioside F is typically present in compositions at 3.5% or less of the total steviol glycosides. The amount of the minor steviol glycosides affects the flavor profile of a Stevia extract. In addition, Rebaudioside D and other higher glycosylated steviol glycosides are thought to be higher quality sweeteners than Rebaudioside A. As such, the recombinant hosts and methods described herein are particularly useful for producing steviol glycoside compositions having an increased amount of Rebaudioside D for use, for example, as a non-caloric sweetener with functional and sensory properties superior to those of many high-potency sweeteners.

In one aspect, this document features a recombinant host that includes a recombinant gene encoding a polypeptide having at least 80% identity to the amino acid sequence set forth in SEQ ID NO:152.

This document also features a recombinant host that includes a recombinant gene encoding a polypeptide having the ability to transfer a second sugar moiety to the C-2' of a 19-O-glucose of rubusoside. This document also features a recombinant host that includes a recombinant gene encoding a polypeptide having the ability to transfer a second sugar moiety to the C-2' of a 19-O-glucose of stevioside.

In another aspect, this document features a recombinant host that includes a recombinant gene encoding a polypeptide having the ability to transfer a second sugar moiety to the C-2' of the 19-O-glucose of rubusoside and to the C-2' of the 13-O-glucose of rubusoside.

This document also features a recombinant host that includes a recombinant gene encoding a polypeptide having the ability to transfer a second sugar moiety to the C-2' of a 19-O-glucose of rebaudioside A to produce rebaudioside D, wherein the catalysis rate of the polypeptide is at least 20 times faster (e.g., 25 or 30 times faster) than a 91D2c

polypeptide having the amino acid sequence set forth in SEQ ID NO: 5 when the reactions are performed under corresponding conditions.

In any of the recombinant hosts described herein, the polypeptide can have at least 85% sequence identity (e.g., 90%, 95%, 98%, or 99% sequence identity) to the amino acid sequence set forth in SEQ ID NO:152. The polypeptide can have the amino acid sequence set forth in SEQ ID NO: 152.

Any of the hosts described herein further can include a recombinant gene encoding a UGT85C polypeptide having at least 90% identity to the amino acid sequence set forth in SEQ ID NO:3. The UGT85C polypeptide can include one or more amino acid substitutions at residues 9, 10, 13, 15, 21, 27, 60, 65, 71, 87, 91, 220, 243, 270, 289, 298, 334, 336, 350, 368, 389, 394, 397, 418, 420, 440, 441, 444, and 471 of SEQ ID NO:3.

Any of the hosts described herein further can include a recombinant gene encoding a UGT76G polypeptide having at least 90% identity to the amino acid sequence set forth in SEQ ID NO:7. The UGT76G polypeptide can have one or more amino acid substitutions at residues 29, 74, 87, 91, 116, 123, 125, 126, 130, 145, 192, 193, 194, 196, 198, 199, 200, 203, 204, 205, 206, 207, 208, 266, 273, 274, 284, 285, 291, 330, 331, and 346 of SEQ ID NO:7.

Any of the hosts described herein further can include a gene (e.g., a recombinant gene) encoding a UGT74G1 polypeptide.

Any of the hosts described herein further can include a gene (e.g., a recombinant gene) encoding a functional UGT91D2 polypeptide. The UGT91D2 polypeptide can have at least 80% sequence identity to the amino acid sequence set forth in SEQ ID NO:5. The UGT91D2 polypeptide can have a mutation at position 206, 207, or 343 of SEQ ID NO:5. The UGT91D2 polypeptide also can have a mutation at positions 211 and 286 of SEQ ID NO:5 (e.g., L211M and V286A, referred to as UGT91D2e-b). The UGT91D2 polypeptide can have the amino acid sequence set forth in SEQ ID NOs: 5, 10, 12, 76, 78, or 95.

Any of the hosts described herein further can include one or more of
(i) a gene encoding a geranylgeranyl diphosphate synthase;

(ii) a gene encoding a bifunctional copalyl diphosphate synthase and kaurene synthase, or a gene encoding a copalyl diphosphate synthase and a gene encoding a kaurene synthase;

(iii) a gene encoding a kaurene oxidase; and

5 (iv) a gene encoding a steviol synthetase. Each of the genes of (i), (ii), (iii), and (iv) can be a recombinant gene.

Any of the hosts described herein further can include one or more of

(v) a gene encoding a truncated HMG-CoA;

(vi) a gene encoding a CPR;

10 (vii) a gene encoding a rhamnose synthetase;

(viii) a gene encoding a UDP-glucose dehydrogenase; and

(ix) a gene encoding a UDP-glucuronic acid decarboxylase. At least one of the genes of (i), (ii), (iii), (iv), (v), (vi), (vii), (viii), or (ix) can be a recombinant gene.

The geranylgeranyl diphosphate synthase can have greater than 90 % sequence
15 identity to one of the amino acid sequences set forth in SEQ ID NOs: 121-128. The copalyl diphosphate synthase can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NOs: 129-131. The kaurene synthase can have greater than 90 % sequence identity to one of the amino acid sequences set forth in SEQ ID NOs: 132-135. The kaurene oxidase can have greater than 90 % sequence identity to one of the
20 amino acid sequences set forth in SEQ ID NOs: 138-141. The steviol synthetase can have greater than 90 % sequence identity to one of the amino acid sequences set forth in SEQ ID NOs: 142-146.

Any of the recombinant hosts can produce at least one steviol glycoside when cultured under conditions in which each of the genes is expressed. The steviol glycoside
25 can be selected from the group consisting of rubusoside, rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, dulcoside A, stevioside, steviol-19-*O*-Glucoside, steviol-13-*O*-glucoside, steviol-1,2-bioside, steviol-1,3-bioside, 1,3-stevioside, as well as other rhamnosylated or xylosylated intermediates. The steviol glycoside (e.g., rebaudioside D) can accumulate to at least 1 mg/liter (e.g., at least 10
30 mg/liter, 20 mg/liter, 100 mg/liter, 200 mg/liter, 300 mg/liter, 400 mg/liter, 500 mg/liter,

600 mg/liter, or 700 mg/liter, or greater) of culture medium when cultured under said conditions.

This document also features a method of producing a steviol glycoside. The method includes growing any of the hosts described herein in a culture medium, under
5 conditions in which the genes are expressed; and recovering the steviol glycoside produced by the host. The growing step can include inducing expression of one or more of the genes. The steviol glycoside can be a 13-*O*-1,2-diglycosylated and/or a 19-*O*-1,2-diglycosylated steviol glycoside (e.g., stevioside, steviol 1,2 bioside, rebaudioside D, or rebaudioside E). For example, the steviol glycoside can be rebaudioside D or
10 rebaudioside E. Other examples of steviol glycosides can include rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside F, and dulcoside A.

This document also features a recombinant host. The host includes (i) a gene encoding a UGT74G1; (ii) a gene encoding a UGT85C2; (iii) a gene encoding a UGT76G1; (iv) a gene encoding a glycosyltransferase having the ability to transfer a
15 second sugar moiety to the C-2' of a 19-*O*-glucose of rubusoside or stevioside; and (v) optionally a gene encoding a UGT91D2e, wherein at least one of the genes is a recombinant gene. In some embodiments, each of the genes is a recombinant gene. The host can produce at least one steviol glycoside (e.g., rebaudioside D) when cultured under conditions in which each of the genes (e.g., recombinant genes) is expressed. The host
20 further can include (a) a gene encoding a bifunctional copalyl diphosphate synthase and kaurene synthase, or a gene encoding a copalyl diphosphate synthase and a gene encoding a kaurene synthase; (b) a gene encoding a kaurene oxidase; (c) a gene encoding a steviol synthetase; (d) a gene encoding a geranylgeranyl diphosphate synthase.

This document also features a steviol glycoside composition produced by any of
25 the hosts described herein. The composition has reduced levels of stevia plant-derived contaminants relative to a stevia extract.

In another aspect, this document features a steviol glycoside composition produced by any of the hosts described herein. The composition has a steviol glycoside composition enriched for rebaudioside D relative to the steviol glycoside composition of
30 a wild-type *Stevia* plant.

In yet another aspect, this document features a method of producing a steviol glycoside composition. The method includes growing a host described herein in a culture medium, under conditions in which each of the genes is expressed; and recovering the steviol glycoside composition produced by the host (e.g., a microorganism). The composition is enriched for rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F or dulcoside A relative to the steviol glycoside composition of a wild-type *Stevia* plant. The steviol glycoside composition produced by the host (e.g., microorganism) can have a reduced level of stevia plant-derived contaminants relative to a stevia extract.

This document also features a method for transferring a second sugar moiety to the C-2' of a 19-*O*-glucose or the C-2' of a 13-*O*-glucose in a steviol glycoside. The method includes contacting the steviol glycoside with a EUGT11 polypeptide described herein or UGT91D2 polypeptide described herein (e.g., UGT91D2e-b) and a UDP-sugar under suitable reaction conditions for the transfer of the second sugar moiety to the steviol glycoside. The steviol glycoside can be rubusoside, wherein the second sugar moiety is glucose, and stevioside is produced upon transfer of the second glucose moiety. The steviol glycoside can be stevioside, wherein the second sugar moiety is glucose, and Rebaudioside E is produced upon transfer of the second glucose moiety. The steviol glycoside can be Rebaudioside A, and Rebaudioside D is produced upon transfer of the second glucose moiety.

In another embodiment of an improved downstream steviol glycoside pathway as disclosed herein, materials and methods are provided for the recombinant production of sucrose synthase, and to materials and methods for increasing production of UDP-glucose in a host, specifically for increasing the availability of UDP-glucose *in vivo*, with the purpose of promoting glycosylation reactions in the cells, and methods for reducing UDP concentrations in the cells are provided.

The document also provides a recombinant host comprising one or more exogenous nucleic acids encoding a sucrose transporter and a sucrose synthase, wherein expression of the one or more exogenous nucleic acids with a glucosyltransferase results in increased levels of UDP-glucose in the host. Optionally, the one or more exogenous

nucleic acids comprise a SUS1 sequence. Optionally, the SUS1 sequence is from *Coffea arabica*, or encodes a functional homolog of the sucrose synthase encoded by the *Coffea arabica* SUS1 sequence, but equally an *Arabidopsis thaliana* or *Stevia rebaudiana* SUS may be used as described herein. In the recombinant host of the invention, the one or
5 more exogenous nucleic acids may comprise a sequence encoding a polypeptide having the sequence set forth in SEQ ID NO:180, or an amino acid sequence at least 90 percent identical thereto, and optionally the one or more exogenous nucleic acids comprise a SUC1 sequence. In one embodiment, the SUC1 sequence is from *Arabidopsis thaliana*, or the SUC1 sequence encodes a functional homolog of the sucrose transporter encoded
10 by the *Arabidopsis thaliana* SUC1 sequence. In the recombinant host, the one or more exogenous nucleic acids may comprise a sequence encoding a polypeptide having the sequence set forth in SEQ ID NO:179, or an amino acid sequence at least 90 percent identical thereto. The recombinant host has reduced ability to degrade external sucrose, as compared to a corresponding host that lacks the one or more exogenous nucleic acids.

15 The recombinant host may be a microorganism, such as a Saccharomycete, for example *Saccharomyces cerevisiae*. Alternatively, the microorganism is *Escherichia coli*. In an alternative embodiment, the recombinant host is a plant or plant cell.

The invention also provides a method for increasing the level of UDP-glucose and reducing the level of UDP in a cell, the method comprising expressing in the cell a
20 recombinant sucrose synthase sequence and a recombinant sucrose transporter sequence, in a medium comprising sucrose, wherein the cell is deficient in sucrose degradation.

The invention additionally provides a method for promoting a glycosylation reaction in a cell, comprising expressing in the cell a recombinant sucrose synthase sequence and a recombinant sucrose transporter sequence, in a medium comprising
25 sucrose, wherein the expressing results in a decreased level of UDP in the cell and an increased level of UDP-glucose in the cell, such that glycosylation in the cell is increased.

In either method for increasing the level of UDP-glucose or promoting glycosylation, the cell may produce vanillin glucoside, resulting in increased production of vanillin glucoside by the cell, or may produce steviol glucoside, resulting in increased
30 production of steviol glucoside by the cell. Optionally, the SUS1 sequence is a *A.*

thaliana, *S. rebaudiana*, or *Coffea arabica* SUS1 sequence (see e.g., FIG. 17, SEQ ID NOs. 175-177), or is a sequence that encodes a functional homolog of the sucrose synthase encoded by the *A. thaliana*, *S. rebaudiana*, or *Coffea arabica* SUS1 sequence. The recombinant sucrose synthase sequence optionally comprises a nucleic acid encoding a polypeptide having the sequence set forth in SEQ ID NO:180, or an amino acid sequence at least 90% identical thereto, wherein optionally the recombinant sucrose transporter sequence is a SUC1 sequence, or wherein optionally the SUC1 sequence is an *Arabidopsis thaliana* SUC1 sequence, or is a sequence that encodes a functional homolog of the sucrose transporter encoded by the *Arabidopsis thaliana* SUC1 sequence, or wherein optionally the recombinant sucrose transporter sequence comprises a nucleic acid encoding a polypeptide having the sequence set forth in SEQ ID NO:179, or an amino acid sequence at least 90 % identical thereto. In either method, the host is a microorganism, for example a Saccharomycete, optionally such as *Saccharomyces cerevisiae*. Or the host may be *Escherichia coli*. Or the host may be a plant cell.

Also provided herein is a recombinant host, such as a microorganism, comprising one or more biosynthesis genes whose expression results in production of diterpenoids. Such genes include a gene encoding an *ent*-copalyl diphosphate synthase (CDPS) (EC 5.5.1.13), a gene encoding an *ent*-kaurene synthase, a gene encoding an *ent*-kaurene oxidase; or a gene encoding a steviol synthetase. At least one of the genes is a recombinant gene. The host can also be a plant cell. Expression of these gene(s) in a Stevia plant can result in increased steviol glycoside levels in the plant. In some embodiments the recombinant host further comprises a plurality of copies of a recombinant gene encoding a CDPS polypeptide (EC 5.5.1.13) lacking a chloroplast transit peptide sequence. The CDPS polypeptide can have at least 90%, 95%, 99 %, or 100% identity to the truncated CDPS amino acid sequence set forth in FIG. 14. The host can further comprise a plurality of copies of a recombinant gene encoding a KAH polypeptide, e.g., a KAH polypeptide that has at least 90%, 95%, 99 %, or 100% identity to the KAH amino acid sequence set forth in FIG. 12. The host can further comprise one or more of: (i) a gene encoding a geranylgeranyl diphosphate synthase; (ii) a gene encoding a *ent*-kaurene oxidase; and (iii) a gene encoding a *ent*-kaurene synthase. The

host can further comprise one or more of (iv) a gene encoding a truncated HMG-CoA; (v) a gene encoding a CPR; (vi) a gene encoding a rhamnose synthetase; (vii) a gene encoding a UDP-glucose dehydrogenase; and (viii) a gene encoding a UDP-glucuronic acid decarboxylase. Two or more exogenous CPRs can be present, for example. The expression of one or more of such genes can be inducible. At least one of genes (i), (ii), (iii), (iv), (v), (vi), (vii), or (viii) can be a recombinant gene, and in some cases each of the genes of (i), (ii), (iii), (iv), (v), (vi), (vii), and (viii) is a recombinant gene. The geranylgeranyl diphosphate synthase can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NO:127; the kaurene oxidase can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NO:138; a CPR can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NO:168; a CPR can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NO:170, and a kaurene synthase can have greater than 90 % sequence identity to the amino acid sequence set forth in SEQ ID NO: 156.

In one aspect, this document features an isolated nucleic acid encoding a polypeptide having the amino acid sequence set forth in SEQ ID NO:5, wherein the polypeptide contains substitutions position 211 and 286 of SEQ ID NO:5. For example, the polypeptide can include a methionine at position 211 and an alanine at position 286.

In one aspect, this document features an isolated nucleic acid encoding a polypeptide having at least 80% identity (e.g., at least 85%, 90%, 95%, or 99% identity) to the amino acid sequence set forth in FIG. 12C (SEQ ID NO:164). The polypeptide can have the amino acid sequence set forth in FIG. 12C.

In another aspect, this document features a nucleic acid construct that included a regulatory region operably linked to a nucleic acid encoding a polypeptide having at least 80% identity (e.g., at least 85%, 90%, 95%, or 99% identity) to the amino acid sequence set forth in FIG. 12C (SEQ ID NO:164). The polypeptide can have the amino acid sequence set forth in FIG. 12C.

This document also features a recombinant host that includes a recombinant gene (e.g., a plurality of copies of a recombinant gene) encoding a KAH polypeptide having at least 80% identity (e.g., at least 85%, 90%, 95%, or 99% identity) to the amino acid

sequence set forth in FIG. 12C. The polypeptide can have the amino acid sequence set forth in FIG. 12C. The host can be a microorganism such as a saccharomycete (e.g., *Saccharomyces cerevisiae*) or *Escherichia coli*. The host can be a plant or plant cell (e.g., a *Stevia*, *Physcomitrella*, or tobacco plant or plant cell). The *Stevia* plant or plant cell is a *Stevia rebaudiana* plant or plant cell. The recombinant host can produce steviol when cultured under conditions in which each of the genes is expressed. The recombinant host can further comprise a gene encoding a UGT74G1 polypeptide; a gene encoding a UGT85C2 polypeptide; a gene encoding a UGT76G1 polypeptide; a gene encoding a UGT91D2 polypeptide; and/or a gene encoding a EUGT11 polypeptide.

Such a host can produce at least one steviol glycoside when cultured under conditions in which each of the genes is expressed. The steviol glycoside can be steviol-13-O-glucoside, steviol-19-O-glucoside, rubusoside, rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, and/or dulcoside A. The recombinant host can further comprise one or more of: a gene encoding a deoxyxylulose 5-phosphate synthase (DXS); a gene encoding a D-1-deoxyxylulose 5-phosphate reductoisomerase (DXR); a gene encoding a 4-diphosphocytidyl-2-C-methyl-D-erythritol synthase (CMS); a gene encoding a 4-diphosphocytidyl-2-C-methyl-D-erythritol kinase (CMK); a gene encoding a 4-diphosphocytidyl-2-C-methyl-D-erythritol 2,4-cyclodiphosphate synthase (MCS); a gene encoding a 1-hydroxy-2-methyl-2(E)-butenyl 4-diphosphate synthase (HDS); and a gene encoding a 1-hydroxy-2-methyl-2(E)-butenyl 4-diphosphate reductase (HDR). The recombinant host can further comprise one or more of: a gene encoding an acetoacetyl-CoA thiolase; a gene encoding a truncated HMG-CoA reductase; a gene encoding a mevalonate kinase; a gene encoding a phosphomevalonate kinase; and a gene encoding a mevalonate pyrophosphate decarboxylase. In another aspect, this document features a recombinant host that further comprises a gene encoding an *ent*-kaurene synthase (EC 4.2.3.19) and/or a gene encoding a gibberellin 20-oxidase (EC 1.14.11.12). Such a host produces gibberellin GA3 when cultured under conditions in which each of the genes is expressed.

This document also features an isolated nucleic acid encoding a CPR polypeptide having at least 80% sequence identity (e.g., at least 85%, 90%, 95%, or 99% sequence

identity) to the *S. rebaudiana* CPR amino acid sequence set forth in FIG. 13. In some embodiments, the polypeptide has the *S. rebaudiana* CPR amino acid sequence set forth in FIG.13 (SEQ ID NOs: 169 and 170).

In any of the hosts described herein, expression of one or more of the genes can be inducible.

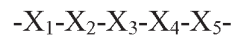
In any of the hosts described herein, one or more genes encoding endogenous phosphatases can be deleted or disrupted such that endogenous phosphatase activity is reduced. For example, the yeast gene *DPP1* and/or *LPP1* can be disrupted or deleted such that the degradation of farnesyl pyrophosphate (FPP) to farnesol is reduced and the degradation of geranylgeranylpyrophosphate (GGPP) to geranylgeraniol (GGOH) is reduced.

In another aspect, as described herein, *ERG9* can be modified as defined below, resulting in the decreased production of squalene synthase (SQS) and an accumulation of terpenoid precursors. The precursors may or may not be secreted into the culture medium and can in turn be used as substrates to enzymes capable of metabolizing the terpenoid precursors into desired terpenoids.

Thus, in a main aspect the present invention relates to a cell comprising a nucleic acid sequence, said nucleic acid comprising

- i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to
- iii) an open reading frame operably linked to
- iv) a transcription termination signal,

wherein the heterologous insert sequence has the general formula (I):



wherein X_2 comprises at least 4 consecutive nucleotides being complementary to, and forming a hairpin secondary structure element with at least 4 consecutive nucleotides of X_4 , and

wherein X₃ is optional and if present comprises unpaired nucleotides involved in forming a hairpin loop between X₂ and X₄, and

wherein X₁ and X₅ individually and optionally comprises one or more nucleotides, and

5 wherein the open reading frame upon expression encodes a polypeptide sequence having at least 70% identity to a squalene synthase (EC 2.5.1.21) or a biologically active fragment thereof, said fragment having at least 70% sequence identity to said squalene synthase in a range of overlap of at least 100 amino acids.

10 The cell of the present invention is useful in enhancing yield of industrially interesting terpenoids. Accordingly, in another aspect the present invention relates to a method for producing a terpenoid compound synthesized through the squalene pathway, in a cell culture, said method comprising the steps of

- (a) providing the cell as defined herein above,
- (b) culturing the cell of (a).
- 15 (c) recovering the terpenoid product compound.

By providing the cell comprising the genetically modified construct defined herein above, the accumulation of terpenoid precursors is enhanced (see e.g., FIG. 20).

Thus, in another aspect, the invention relates to a method for producing a terpenoid derived from a terpenoid precursor selected from the group consisting of
20 Farnesyl-pyrophosphate (FPP), Isopentenyl-pyrophosphate (IPP), Dimethylallyl-pyrophosphate (DMAPP), Geranyl-pyrophosphate (GPP) and/or Geranylgeranyl-pyrophosphate (GGPP), said method comprising:

- (a) contacting said precursor with an enzyme of the squalene synthase pathway,
- 25 (b) recovering the terpenoid product.

The present invention may operate by at least partly, sterically hindering binding of the ribosome to the RNA thus reducing the translation of squalene synthase.

Accordingly, in one aspect the present invention relates to a method for reducing the translation rate of a functional squalene synthase (EC 2.5.1.21) said method comprising:

- 30 (a) providing the cell defined herein above,

- (b) culturing the cell of (a).

Similarly, the invention in another aspect relates to a method for decreasing turnover of farnesyl-pp to squalene, said method comprising:

- (a) providing the cell defined herein above,
- (b) culturing the cell of (a).

As depicted in FIG. 20, the knocking down of the ERG9 results in build-up of precursors to squalene synthase. Thus in one aspect, the present invention relates to a method for enhancing accumulation of a compound selected from the group consisting of Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and Geranylgeranyl-pyrophosphate, said method comprising the steps of:

- (a) providing the cell defined herein above, and
- (b) culturing the cell of (a).

In one embodiment the invention relates to the production of Geranylgeranyl Pyrophosphate (GGPP) as well as other terpenoids, which can be prepared from Geranylgeranyl Pyrophosphate (GGPP).

In this embodiment of the invention the above described decrease of production of squalene synthase (SQS) may be combined with an increase in activity of Geranylgeranyl Pyrophosphate Synthase (GGPPS), which converts FPP to Geranylgeranyl Pyrophosphate (GGPP), leading to increased production of GGPP.

Thus, in one embodiment the invention relates to a microbial cell comprising a nucleic acid sequence, said nucleic acid comprising

- i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to
- iii) an open reading frame operably linked to
- iv) a transcription termination signal,

wherein the heterologous insert sequence and the open reading frame are as defined herein above,

wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell.

5 In addition, the document relates to a method for producing steviol or a steviol glycoside, wherein the method comprises use of any one of the above-mentioned microbial cells.

Any of the hosts described herein can be a microorganism (e.g., a Saccharomycete such as *Saccharomyces cerevisiae*, or *Escherichia coli*), or a plant or plant cell (e.g., a *Stevia* such as a *Stevia rebaudiana*, *Physcomitrella*, or tobacco plant or
10 plant cell).

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention belongs. Although methods and materials similar or equivalent to those described herein can be used to practice the invention, suitable methods and materials are
15 described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be limiting. Other features and advantages of the invention will be apparent from the following detailed
20 description. Applicants reserve the right to alternatively claim any disclosed invention using the transitional phrase “comprising,” “consisting essentially of,” or “consisting of,” according to standard practice in patent law.

DESCRIPTION OF DRAWINGS

FIG. 1 is the chemical structure of various steviol glycosides.

25 FIGS. 2A- D show representative pathways for the biosynthesis of steviol glycosides from steviol.

FIG. 3 is a schematic representation of 19-O-1,2-diglycosylation reactions by EUGT11 and UGT91D2e. The numbers are the average signal intensity for the substrates

or the products of the reaction, from liquid chromatography-mass spectrometry (LC-MS) chromatograms

FIG. 4 contains LC-MS chromatograms showing the production of rebaudioside D (RebD) from Rebaudioside A (RebA) using *in vitro* transcribed and translated UGT91D2e (SEQ ID NO:5) (left panel) or EUGT11 (SEQ ID NO:152) (right panel). The LC-MS was set to detect certain masses corresponding to steviol + 5 glucoses (such as RebD), steviol + 4 glucoses (such as RebA) etc. Each 'lane' is scaled according to the highest peak.

FIG. 5 contains LC-MS chromatograms showing the conversion of rubusoside to stevioside and compounds '2' and '3' (RebE) by UGT91D2e (left panel) and EUGT11 (right panel).

FIG. 6 is an alignment of the amino acid sequence of EUGT11 (SEQ ID NO:152, top line) with the amino acid sequence of UGT91D2e (SEQ ID NO:5, bottom line).

FIG. 7 contains the amino acid sequence of EUGT11 (SEQ ID NO:152), the nucleotide sequence (SEQ ID NO:153) encoding EUGT11, and the nucleotide sequence encoding EUGT11 that has been codon optimized for expression in yeast (SEQ ID NO: 154).

FIG. 8 is an alignment of the secondary structure predictions of UGT91D2e with UGT85H2 and UGT71G1. Secondary structure predictions were made by subjecting the amino acid sequences of the three UGTs to NetSurfP ver. 1.1 - Protein Surface Accessibility and Secondary Structure Predictions, at the world wide web at cbs.dtu.dk/services/NetSurfP/. This predicted the presence and location of alpha helices, beta sheets and coils in the proteins. These were subsequently labeled as shown for UGT91D2e. For example, the first N-terminal beta-sheet was labeled N β 1. The y-axis represents the certainty of the prediction, the higher the more confident and the x-axis represents amino acid position. Although the primary sequence identity between these UGTs is very low, the secondary structures show a very high degree of conservation.

FIG. 9 is an alignment of the amino acid sequences of UGT91D1 and UGT91D2e (SEQ ID NO: 5).

FIG. 10 is a bar graph of the activity of double amino acid substitution mutants of UGT91D2e. The filled bars represent stevioside production and the open bars represent 1,2-bioside production.

FIG. 11 is a schematic representation of UDP-glucose regeneration for the biosynthesis of steviol glycosides. SUS = sucrose synthase; Steviol = steviol or steviol glycoside substrate; UGT = UDP glycosyl transferase.

FIG. 12A is the nucleotide sequence encoding the *Stevia rebaudiana* KAH (SEQ ID NO:163), designated SrKAHe1 herein.

FIG. 12B is the nucleotide sequence encoding the *Stevia rebaudiana* KAHe1 that has been codon-optimized for expression in yeast (SEQ ID NO:165).

FIG. 12C is the amino acid sequence of the *Stevia rebaudiana* KAHe1 (SEQ ID NO:164).

FIG. 13A contains the amino acid sequences of CPR polypeptides from *S. cerevisiae* (encoded by NCP1 gene) (SEQ ID NO:166), *A. thaliana* (encoded by ATR1 and encoded by ATR2) ((SEQ ID NOs: 148 and 168), and *S. rebaudiana* (encoded by CPR7 and encoded by CPR8) (SEQ ID NOs: 169 and 170).

FIG. 13B contains ATR1 nucleotide sequence (Accession No. CAA23011) that has been codon optimized for expression in yeast (SEQ ID NO:171); ATR2 nucleotide sequence that has been codon optimized for expression in yeast (SEQ ID NO:172); the *Stevia rebaudiana* CPR7 nucleotide sequence (SEQ ID NO:173); and the *Stevia rebaudiana* CPR8 nucleotide sequence (SEQ ID NO:174).

FIG. 14A contains the nucleotide sequence (SEQ ID NO:157) encoding a CDPS polypeptide (SEQ ID NO:158) from *Zea mays*. The sequence that is in bold and underlined can be deleted to remove the sequence encoding the chloroplast transit sequence.

FIG. 14B contains the amino acid sequence of the CDPS polypeptide (SEQ ID NO:158) from *Zea mays*. The sequence that is in bold and underlined can be deleted to remove the chloroplast transit sequence.

FIG. 15A contains a codon-optimized nucleotide sequence (SEQ ID NO:161) encoding a bifunctional CDPS-KS polypeptide (SEQ ID NO:162) from *Gibberella*

fujikuroi. FIG. 15B contains the amino acid sequence of the bifunctional CDPS-KS polypeptide (SEQ ID NO:162) from *Gibberella fujikuroi*.

FIG. 16 is a graph of the growth of two strains of *S. cerevisiae*, enhanced EFSC1972 (designated T2) and enhanced EFSC1972 with further overexpression of the Arabidopsis thaliana kaurene synthase (KS-5) (designated T7, squares). Numbers on the y-axis are OD600 values of the cell culture, while numbers on the x-axis represent hours of growth in synthetic complete based medium at 30°C.

FIG. 17 contains the nucleic acid sequences encoding the *A. thaliana*, *S. rebaudiana* (from contig10573 selection_ORF S11E, with the mutation that changes S11 to glutamate (E) in bold, lowercase letters), and coffee (*Coffea arabica*) sucrose synthases, SEQ ID NOs:175, 176, and 177, respectively.

FIG. 18 is a bar graph of rebD production in permeabilized *S. cerevisiae*, which had been transformed with EUGT11 or an empty plasmid ("Empty"). Cells were grown to exponential growth phase, washed in PBS buffer and subsequently treated with Triton X-100 (0.3% or 0.5% in PBS) 30°C, 30 min. After permeabilization cells were washed in PBS and resuspended in reaction mix containing 100 µM RebA and 300 µM UDP-glucose. Reactions proceeded for 20h, 30°C.

FIG. 19A is the amino acid sequence of the *A. thaliana* UDP-glycosyltransferase UGT72E2 (SEQ ID NO:178).

FIG. 19B is the amino acid sequence of the sucrose transporter SUC1 from *A. thaliana* (SEQ ID NO:179).

FIG. 19C is the amino acid sequence of the sucrose synthase from coffee (SEQ ID NO:180).

FIG. 20 is a schematic of the isoprenoid pathway in yeast, showing the position of ERG9.

FIG. 21 contains the nucleotide sequence of the *Saccharomyces cerevisiae* Cyc1 promoter (SEQ ID NO:185) and *Saccharomyces cerevisiae* Kex2 promoter (SEQ ID NO:186).

FIG. 22 is a schematic of the PCR product containing two regions, HR1 and HR2, which are homologous to parts of the genome sequence within the ERG9 promoter or 5'

end of the ERG9 open reading frame (ORF), respectively. Also, on the PCR product is an antibiotic marker, NatR, which can be embedded between two Lox sites (L) for subsequent excision with Cre recombinase. The PCR product further can include a promoter, such as either the wild type ScKex2, wild type ScCyc1, and the promoter further can include a heterologous insert such as a hairpin (SEQ ID NO: 181-184) at its 3'-end (See FIG. 23).

FIG. 23 is a schematic of promoter and ORF with a hairpin stemloop immediately upstream of the translation startsite (arrow) and an alignment of a portion of the wild-type *S. cerevisiae* Cyc1 promoter sequence and initial ATG of the ERG9 OPR without a heterologous insert (SEQ ID NO:187) and with four different heterologous inserts (SEQ ID NOs. 188-191). 75% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 184 (SEQ ID NO:191); 50% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 183 (SEQ ID NO:190); 20% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 182 (SEQ ID NO:189); 5% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 181 (SEQ ID NO:188).

FIG. 24 is a bar graph showing amorphaadiene produced in yeast strains with different promoter constructs inserted in front of the ERG9 gene of the host genome. CTRL-ADS refers to control strain with no modification; ERG9-CYC1-100% refers to construct comprising the ScCyc1 promoter and no insert; ERG9-CYC1-50% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 183 (SEQ ID NO:190); ERG9-CYC1-20% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 182 (SEQ ID NO:189); ERG9-CYC1-5% refers to construct comprising the ScCyc1 promoter followed by SEQ ID NO: 181 (SEQ ID NO:188); ERG9-KEX2-100% refers to construct comprising the ScKex2 promoter.

FIG. 25 contains the amino acid sequence of squalene synthase polypeptides from *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Yarrowia lipolytica*, *Candida glabrata*, *Ashbya gossypii*, *Cyberlindnera jadinii*, *Candida albicans*, *Saccharomyces cerevisiae*, *Homo sapiens*, *Mus musculus*, and *Rattus norvegicus* (SEQ ID NOs:192-202),

and the amino acid sequence of a geranylgeranyl diphosphate synthase (GGPPS) from *Aspergillus nidulans* and *S. cerevisiae* (SEQ ID NOs. 203 and 167).

FIG. 26 is a bar graph of geranylgeraniol (GGOH) accumulation in the ERG9-CYC1-5% strain and ERG9-KEX2 strain after 72 hours.

5 FIG. 27 is a representative chromatograph showing the conversion of rubusoside to xylosylated intermediates for RebF production by UGT91D2e and EUGT11.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

This document is based on the discovery that recombinant hosts such as plant
10 cells, plants, or microorganisms can be developed that express polypeptides useful for the biosynthesis of steviol glycosides such as rebaudioside A, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, or dulcoside A. The recombinant hosts described herein are particularly useful for producing Rebaudioside D. Such hosts can express one or more Uridine 5'-diphospho (UDP) glycosyl transferases suitable for producing steviol
15 glycosides. Expression of these biosynthetic polypeptides in various microbial chassis allows steviol glycosides to be produced in a consistent, reproducible manner from energy and carbon sources such as sugars, glycerol, CO₂, H₂, and sunlight. The proportion of each steviol glycoside produced by a recombinant host can be tailored by incorporating preselected biosynthetic enzymes into the hosts and expressing them at
20 appropriate levels, to produce a sweetener composition with a consistent taste profile. Furthermore, the concentrations of steviol glycosides produced by recombinant hosts are expected to be higher than the levels of steviol glycosides produced in the *Stevia* plant, which improves the efficiency of the downstream purification. Such sweetener compositions contain little or no plant based contaminants, relative to the amount of
25 contaminants present in *Stevia* extracts.

At least one of the genes is a recombinant gene, the particular recombinant gene(s) depending on the species or strain selected for use. Additional genes or biosynthetic modules can be included in order to increase steviol glycoside yield, improve efficiency with which energy and carbon sources are converted to steviol and its

glycosides, and/or to enhance productivity from the cell culture or plant. Such additional biosynthetic modules include genes involved in the synthesis of the terpenoid precursors, isopentenyl diphosphate and dimethylallyl diphosphate. Additional biosynthetic modules include terpene synthase and terpene cyclase genes, such as genes encoding geranylgeranyl diphosphate synthase and copalyl diphosphate synthase; these genes may be endogenous genes or recombinant genes.

I. Steviol and Steviol Glycoside Biosynthesis Polypeptides

A. Steviol Biosynthesis Polypeptides

Chemical structures for several of the compounds found in Stevia extracts are shown in FIG. 1, including the diterpene steviol and various steviol glycosides. CAS numbers are shown in Table A below. See also, Steviol Glycosides Chemical and Technical Assessment 69th JECFA, prepared by Harriet Wallin, Food Agric. Org. (2007).

Table A.

COMPOUND	CAS #
Steviol	471-80-7
Rebaudioside A	58543-16-1
Steviolbioside	41093-60-1
Stevioside	57817-89-7
Rebaudioside B	58543-17-2
Rebaudioside C	63550-99-2
Rebaudioside D	63279-13-0
Rebaudioside E	63279-14-1
Rebaudioside F	438045-89-7
Rubusoside	63849-39-4
Dulcoside A	64432-06-0

It has been discovered that expression of certain genes in a host such as a microorganism confers the ability to synthesize steviol glycosides upon that host. As discussed in more detail below, one or more of such genes may be present naturally in a host. Typically, however, one or more of such genes are recombinant genes that have been transformed into a host that does not naturally possess them.

The biochemical pathway to produce steviol involves formation of geranylgeranyl diphosphate, cyclization to (-) copalyl diphosphate, followed by oxidation and hydroxylation to form steviol. Thus, conversion of geranylgeranyl diphosphate to steviol in a recombinant microorganism involves the expression of a gene encoding a kaurene synthase (KS), a gene encoding a kaurene oxidase (KO), and a gene encoding a steviol synthetase (KAH). Steviol synthetase also is known as kaurenoic acid 13-hydroxylase.

Suitable KS polypeptides are known. For example, suitable KS enzymes include those made by *Stevia rebaudiana*, *Zea mays*, *Populus trichocarpa*, and *Arabidopsis thaliana*. See, Table 1 and SEQ ID NOS: 132-135 and 156. Nucleotide sequences encoding these polypeptides are set forth in SEQ ID NOS: 40-47 and 155. The nucleotide sequences set forth in SEQ ID NOS: 40-43 were modified for expression in yeast while the nucleotide sequences set forth in SEQ ID NOS: 44-47 are from the source organisms from which the KS polypeptides were identified.

Table 1. KS Clones

Enzyme Source Organism	gi Number	Accession Number	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>	4959241	AAD34295	MM-12	2355	40	132
<i>Stevia rebaudiana</i>	4959239	AAD34294	MM-13	2355	41	133
<i>Zea mays</i>	162458963	NP_001105097	MM-14	1773	42	134
<i>Populus trichocarpa</i>	224098838	XP_002311286	MM-15	2232	43	135
<i>Arabidopsis thaliana</i>	3056724	AF034774	EV-70	2358	155	156

Suitable KO polypeptides are known. For example, suitable KO enzymes include those made by *Stevia rebaudiana*, *Arabidopsis thaliana*, *Gibberella fujikuroi* and *Trametes versicolor*. See, Table 2 and SEQ ID NOS: 138-141. Nucleotide sequences encoding these polypeptides are set forth in in SEQ ID NOS: 52-59. The nucleotide sequences set forth in SEQ ID NOS: 52-55 were modified for expression in yeast. The nucleotide sequences set forth in SEQ ID NOS: 56-59 are from the source organisms from which the KO polypeptides were identified.

Table 2. KO Clones

Enzyme Source Organism	gi Number	Accession Number	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>	76446107	ABA42921	MM-18	1542	52	138
<i>Arabidopsis thaliana</i>	3342249	AAC39505	MM-19	1530	53	139
<i>Gibberella fujikoro</i>	4127832	CAA76703	MM-20	1578	54	140
<i>Trametes versicolor</i>	14278967	BAB59027	MM-21	1500	55	141

Suitable KAH polypeptides are known. For example, suitable KAH enzymes include those made by *Stevia rebaudiana*, *Arabidopsis thaliana*, *Vitis vinifera* and *Medicago trunculata*. See, e.g., Table 3, SEQ ID NOs: 142-146; U.S. Patent Publication No. 2008-0271205; U.S. Patent Publication No. 2008-0064063 and Genbank Accession No. gi 189098312. The steviol synthetase from *Arabidopsis thaliana* is classified as a CYP714A2. Nucleotide sequences encoding these KAH enzymes are set forth in SEQ ID NOs: 60-69. The nucleotide sequences set forth in SEQ ID NOs: 60-64 were modified for expression in yeast while the nucleotide sequences from the source organisms from which the polypeptides were identified are set forth in SEQ ID NOs: 65-69.

Table 3. KAH Clones

Enzyme Source Organism	gi Number	Accession Number	Plasmid Name	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>		--*	pMUS35	MM-22	1578	60	142
<i>Stevia rebaudiana</i>	189418962	ACD93722	pMUS36	MM-23	1431	61	143
<i>Arabidopsis thaliana</i>	15238644	NP_197872	pMUS37	MM-24	1578	62	144
<i>Vitis vinifera</i>	225458454	XP_002282091	pMUS38	MM-25	1590	63	145
<i>Medicago trunculata</i>	84514135	ABC59076	pMUS39	MM-26	1440	64	146

* = Sequence is shown in U.S. Patent Publication No. 2008-0064063.

In addition, a KAH polypeptide from *Stevia rebaudiana* that was identified herein is particularly useful in a recombinant host. The nucleotide sequence (SEQ ID NO:163) encoding the *S. rebaudiana* KAH (SrKAHe1) (SEQ ID NO:164) is set forth in FIG. 12A. A nucleotide sequence encoding the *S. rebaudiana* KAH that has been codon-optimized for expression in yeast (SEQ ID NO:165) is set forth in FIG. 12B. The amino acid sequence of the *S. rebaudiana* KAH is set forth in FIG. 12C. The *S. rebaudiana* KAH shows significantly higher steviol synthase activity as compared to the *Arabidopsis thaliana* ent-kaurenoic acid hydroxylase described by Yamaguchi *et al.* (U.S. Patent Publication No. 2008/0271205 A1) when expressed in *S. cerevisiae*. The *S. rebaudiana* KAH polypeptide set forth in FIG. 12C has less than 20% identity to the KAH from U.S. Patent Publication No. 2008/0271205, and less than 35% identity to the KAH from U.S. Patent Publication No. 2008/0064063.

In some embodiments, a recombinant microorganism contains a recombinant gene encoding a KO and/or a KAH polypeptide. Such microorganisms also typically contain a recombinant gene encoding a cytochrome P450 reductase (CPR) polypeptide, since certain combinations of KO and/or KAH polypeptides require expression of an exogenous CPR polypeptide. In particular, the activity of a KO and/or a KAH polypeptide of plant origin can be significantly increased by the inclusion of a recombinant gene encoding an exogenous CPR polypeptide. Suitable CPR polypeptides are known. For example, suitable CPR enzymes include those made by *Stevia rebaudiana* and *Arabidopsis thaliana*. See, e.g., Table 4 and SEQ ID NOs: 147 and 148. Nucleotide sequences encoding these polypeptides are set forth in SEQ ID NOs: 70, 71, 73, and 74. The nucleotide sequences set forth in SEQ ID NOs: 70-72 were modified for expression in yeast. The nucleotide sequences from the source organisms from which the polypeptides were identified are set forth in SEQ ID NOs:73-75.

Table 4. CPR Clones

Enzyme Source Organism	gi Number	Accession Number	Plasmid Name	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>	93211213	ABB88839	pMUS40	MM-27	2133	70	147
<i>Arabidopsis</i>	15233853	NP_194183	pMUS41	MM-28	2079	71	148

<i>thaliana</i>							
<i>Giberella fujikuroi</i>	32562989	CAE09055	pMUS42	MM-29	2142	72	149

For example, the steviol synthase encoded by SrKAHe1 is activated by the *S. cerevisiae* CPR encoded by gene NCP1 (YHR042W). Even better activation of the steviol synthase encoded by SrKAHe1 is observed when the *Arabidopsis thaliana* CPR encoded by the gene *ATR2* or the *S. rebaudiana* CPR encoded by the gene *CPR8* are co-expressed. FIG. 13A contains the amino acid sequence of the *S. cerevisiae*, *A. thaliana* (from *ATR1* and *ATR2* genes) and *S. rebaudiana* CPR polypeptides (from *CPR7* and *CPR8* genes) (SEQ ID NOs: 166-170). FIG. 13 B contains the nucleotide sequence encoding the *A. thaliana* and *S. rebaudiana* CPR polypeptides (SEQ ID NOs: 171-174).

For example, the yeast gene *DPPI* and/or the yeast gene *LPPI* can be disrupted or deleted such that the degradation of farnesyl pyrophosphate (FPP) to farnesol is reduced and the degradation of geranylgeranylpyrophosphate (GGPP) to geranylgeraniol (GGOH) is reduced. Alternatively, the promoter or enhancer elements of an endogenous gene encoding a phosphatase can be altered such that the expression of their encoded proteins is altered. Homologous recombination can be used to disrupt an endogenous gene. For example, a "gene replacement" vector can be constructed in such a way to include a selectable marker gene. The selectable marker gene can be operably linked, at both 5' and 3' end, to portions of the gene of sufficient length to mediate homologous recombination. The selectable marker can be one of any number of genes that complement host cell auxotrophy, provide antibiotic resistance, or result in a color change. Linearized DNA fragments of the gene replacement vector then are introduced into the cells using methods well known in the art (see below). Integration of the linear fragments into the genome and the disruption of the gene can be determined based on the selection marker and can be verified by, for example, Southern blot analysis. Subsequent to its use in selection, a selectable marker can be removed from the genome of the host cell by, e.g., Cre-loxP systems (see, e.g., Gossen et al. (2002) *Ann. Rev. Genetics* 36:153-173 and U.S. Application Publication No. 20060014264). Alternatively, a gene replacement vector can be constructed in such a way as to include a portion of the gene to

be disrupted, where the portion is devoid of any endogenous gene promoter sequence and encodes none, or an inactive fragment of, the coding sequence of the gene. An "inactive fragment" is a fragment of the gene that encodes a protein having, e.g., less than about 10% (e.g., less than about 9%, less than about 8%, less than about 7%, less than about 6%, less than about 5%, less than about 4%, less than about 3%, less than about 2%, less than about 1%, or 0%) of the activity of the protein produced from the full-length coding sequence of the gene. Such a portion of the gene is inserted in a vector in such a way that no known promoter sequence is operably linked to the gene sequence, but that a stop codon and a transcription termination sequence are operably linked to the portion of the gene sequence. This vector can be subsequently linearized in the portion of the gene sequence and transformed into a cell. By way of single homologous recombination, this linearized vector is then integrated in the endogenous counterpart of the gene.

Expression in a recombinant microorganism of these genes results in the conversion of geranylgeranyl diphosphate to steviol.

B. Steviol Glycoside Biosynthesis Polypeptides

A recombinant host described herein can convert steviol to a steviol glycoside. Such a host (e.g., microorganism) contains genes encoding one or more UDP Glycosyl Transferases, also known as UGTs. UGTs transfer a monosaccharide unit from an activated nucleotide sugar to an acceptor moiety, in this case, an –OH or –COOH moiety on steviol or steviol derivative. UGTs have been classified into families and subfamilies based on sequence homology. Li et al. *J. Biol. Chem.* 276:4338-4343 (2001).

B. 1 Rubusoside Biosynthesis Polypeptides

The biosynthesis of rubusoside involves glycosylation of the 13-OH and the 19-COOH of steviol. See FIG. 2A. Conversion of steviol to rubusoside in a recombinant host such as a microorganism can be accomplished by the expression of gene(s) encoding UGTs 85C2 and 74G1, which transfer a glucose unit to the 13-OH or the 19-COOH, respectively, of steviol.

A suitable UGT85C2 functions as a uridine 5'-diphospho glucosyl:steviol 13-OH transferase, and a uridine 5'-diphospho glucosyl:steviol-19-*O*-glucoside 13-OH transferase. Functional UGT85C2 polypeptides also may catalyze glucosyl transferase reactions that utilize steviol glycoside substrates other than steviol and steviol-19-*O*-glucoside.

A suitable UGT74G1 polypeptide functions as a uridine 5'-diphospho glucosyl: steviol 19-COOH transferase and a uridine 5'-diphospho glucosyl: steviol-13-*O*-glucoside 19-COOH transferase. Functional UGT74G1 polypeptides also may catalyze glycosyl transferase reactions that utilize steviol glycoside substrates other than steviol and steviol-13-*O*-glucoside, or that transfer sugar moieties from donors other than uridine diphosphate glucose.

A recombinant microorganism expressing a functional UGT74G1 and a functional UGT85C2 can make rubusoside and both steviol monosides (i.e., steviol 13-*O*-monoglucoside and steviol 19-*O*-monoglucoside) when steviol is used as a feedstock in the medium. One or more of such genes may be present naturally in the host. Typically, however, such genes are recombinant genes that have been transformed into a host (e.g., microorganism) that does not naturally possess them.

As used herein, the term recombinant host is intended to refer to a host, the genome of which has been augmented by at least one incorporated DNA sequence. Such DNA sequences include but are not limited to genes that are not naturally present, DNA sequences that are not normally transcribed into RNA or translated into a protein ("expressed"), and other genes or DNA sequences which one desires to introduce into the non-recombinant host. It will be appreciated that typically the genome of a recombinant host described herein is augmented through the stable introduction of one or more recombinant genes. Generally, the introduced DNA is not originally resident in the host that is the recipient of the DNA, but it is within the scope of the invention to isolate a DNA segment from a given host, and to subsequently introduce one or more additional copies of that DNA into the same host, e.g., to enhance production of the product of a gene or alter the expression pattern of a gene. In some instances, the introduced DNA will modify or even replace an endogenous gene or DNA sequence by, e.g., homologous

recombination or site-directed mutagenesis. Suitable recombinant hosts include microorganisms, plant cells, and plants.

The term “recombinant gene” refers to a gene or DNA sequence that is introduced into a recipient host, regardless of whether the same or a similar gene or DNA sequence may already be present in such a host. “Introduced,” or “augmented” in this context, is known in the art to mean introduced or augmented by the hand of man. Thus, a recombinant gene may be a DNA sequence from another species, or may be a DNA sequence that originated from or is present in the same species, but has been incorporated into a host by recombinant methods to form a recombinant host. It will be appreciated that a recombinant gene that is introduced into a host can be identical to a DNA sequence that is normally present in the host being transformed, and is introduced to provide one or more additional copies of the DNA to thereby permit overexpression or modified expression of the gene product of that DNA.

Suitable UGT74G1 and UGT85C2 polypeptides include those made by *Stevia rebaudiana*. Genes encoding functional UGT74G1 and UGT85C2 polypeptides from *Stevia* are reported in Richman, et al. Plant J. 41: 56-67 (2005). Amino acid sequences of *S. rebaudiana* UGT74G1 and UGT85C2 polypeptides are set forth in SEQ ID NOs: 1 and 3, respectively. Nucleotide sequences encoding UGT74G1 and UGT85C2 that have been optimized for expression in yeast are set forth in SEQ ID NOs: 2 and 4, respectively. DNA 2.0 codon-optimized sequence for UGTs 85C2, 91D2e, 74G1 and 76G1 are set forth in SEQ ID NOs: 82, 84, 83, and 85, respectively. See also the UGT85C2 and UGT74G1 variants described below in the “Functional Homolog” section. For example, an UGT85C2 polypeptide containing substitutions at positions 65, 71, 270, 289, and 389 can be used (e.g., A65S, E71Q, T270M, Q289H, and A389V).

In some embodiments, the recombinant host is a microorganism. The recombinant microorganism can be grown on media containing steviol in order to produce rubusoside. In other embodiments, however, the recombinant microorganism expresses one or more recombinant genes involved in steviol biosynthesis, e.g., a CDPS gene, a KS gene, a KO gene and/or a KAH gene. Suitable CDPS polypeptides are known. For example, suitable CDPS enzymes include those made by *Stevia rebaudiana*,

Streptomyces clavuligerus, *Bradyrhizobium japonicum*, *Zea mays*, and *Arabidopsis*. See, e.g., Table 5 and SEQ ID NOs: 129-131, 158, and 160. Nucleotide sequences encoding these polypeptides are set forth in SEQ ID NOs: 34-39, 157, and 159. The nucleotide sequences set forth in SEQ ID NOs: 34-36 were modified for expression in yeast. The nucleotide sequences from the source organisms from which the polypeptides were identified are set forth in SEQ ID NOs:37-39.

In some embodiments, CDPS polypeptides that lack a chloroplast transit peptide at the amino terminus of the unmodified polypeptide can be used. For example, the first 150 nucleotides from the 5' end of the *Zea mays* CDPS coding sequence shown in FIG. 14 (SEQ ID NO:157) can be removed. Doing so removes the amino terminal 50 residues of the amino acid sequence shown in FIG. 14 (SEQ ID NO:158), which encode a chloroplast transit peptide. The truncated CDPS gene can be fitted with a new ATG translation start site and operably linked to a promoter, typically a constitutive or highly expressing promoter. When a plurality of copies of the truncated coding sequence are introduced into a microorganism, expression of the CDPS polypeptide from the promoter results in an increased carbon flux towards *ent*-kaurene biosynthesis.

Table 5. CDPS Clones

Enzyme Source Organism	gi Number	Accession Number	Plasmid Name	Construct Name	Length (nts)	SEQ ID: (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>	2642661	AAB87091	pMUS22	MM-9	2364	34	129
<i>Streptomyces clavuligerus</i>	197705855	EDY51667	pMUS23	MM-10	1584	35	130
<i>Bradyrhizobium japonicum</i>	529968	AAC28895.1	pMUS24	MM-11	1551	36	131
<i>Zea mays</i>	50082774	AY562490		EV65	2484	157	158
<i>Arabidopsis thaliana</i>	18412041	NM_116512		EV64	2409	159	160

CDPS-KS bifunctional proteins (SEQ ID NOs: 136 and 137) also can be used. Nucleotide sequences encoding the CDPS-KS bifunctional enzymes shown in Table 6 were modified for expression in yeast (see SEQ ID NOs: 48 and 49). The nucleotide sequences from the source organisms from which the polypeptides were originally

identified are set forth in SEQ ID NOs: 50 and 51. A bifunctional enzyme from *Gibberella fujikuroi* (SEQ ID NO:162) also can be used. A nucleotide sequence encoding the *Gibberella fujikuroi* bifunctional CDPS-KS enzyme was modified for expression in yeast (see FIG. 15A, SEQ ID NO:161).

Table 6. CDPS-KS Clones

Enzyme Source Organism	gi Number	Accession Number	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Phomopsis amygdali</i>	186704306	BAG30962	MM-16	2952	48	136
<i>Physcomitrella patens</i>	146325986	BAF61135	MM-17	2646	49	137
<i>Gibberella fujikuroi</i>	62900107	Q9UVY5.1		2859	161	162

Thus, a microorganism containing a CDPS gene, a KS gene, a KO gene and a KAH gene in addition to a UGT74G1 and a UGT85C2 gene is capable of producing both steviol monosides and rubusoside without the necessity for using steviol as a feedstock.

In some embodiments, the recombinant microorganism further expresses a recombinant gene encoding a geranylgeranyl diphosphate synthase (GGPPS). Suitable GGPPS polypeptides are known. For example, suitable GGPPS enzymes include those made by *Stevia rebaudiana*, *Gibberella fujikuroi*, *Mus musculus*, *Thalassiosira pseudonana*, *Streptomyces clavuligerus*, *Sulfolobus acidocaldarius*, *Synechococcus* sp. and *Arabidopsis thaliana*. See, Table 7 and SEQ ID NOs: 121-128. Nucleotide sequences encoding these polypeptides are set forth in SEQ ID NOs:18-33. The nucleotide sequences set forth in SEQ ID NOs: 18-25 were modified for expression in yeast while the nucleotide sequences from the source organisms from which the polypeptides were identified are set forth in SEQ ID NOs: 26-33.

Table 7. GGPPS Clones

Enzyme Source Organism	gi Number	Accession Number	Plasmid Name	Construct Name	Length (nts)	SEQ ID (DNA)	SEQ ID (protein)
<i>Stevia rebaudiana</i>	90289577	ABD92926	pMUS14	MM-1	1086	18	121

<i>Gibberella fujikuroi</i>	3549881	CAA75568	pMUS15	MM-2	1029	19	122
<i>Mus musculus</i>	47124116	AAH69913	pMUS16	MM-3	903	20	123
<i>Thalassiosira pseudonana</i>	223997332	XP_002288339	pMUS17	MM-4	1020	21	124
<i>Streptomyces clavuligerus</i>	254389342	ZP_05004570	pMUS18	MM-5	1068	22	125
<i>Sulfolobus acidocaldarius</i>	506371	BAA43200	pMUS19	MM-6	993	23	126
<i>Synechococcus</i> sp.	86553638	ABC98596	pMUS20	MM-7	894	24	127
<i>Arabidopsis thaliana</i>	15234534	NP_195399	pMUS21	MM-8	1113	25	128

In some embodiments, the recombinant microorganism further can express recombinant genes involved in diterpene biosynthesis or production of terpenoid precursors, e.g., genes in the methylerythritol 4-phosphate (MEP) pathway or genes in the mevalonate (MEV) pathway discussed below, have reduced phosphatase activity, and/or express a sucrose synthase (SUS) as discussed herein.

B. 2 Rebaudioside A, Rebaudioside D, and Rebaudioside E Biosynthesis Polypeptides

The biosynthesis of rebaudioside A involves glucosylation of the aglycone steviol. Specifically, rebaudioside A can be formed by glucosylation of the 13-OH of steviol which forms the 13-*O*-steviolmonoside, glucosylation of the C-2' of the 13-*O*-glucose of steviolmonoside which forms steviol-1,2-bioside, glucosylation of the C-19 carboxyl of steviol-1,2-bioside which forms stevioside, and glucosylation of the C-3' of the C-13-*O*-glucose of stevioside. The order in which each glucosylation reaction occurs can vary. See FIG. 2A.

The biosynthesis of rebaudioside E and/or rebaudioside D involves glucosylation of the aglycone steviol. Specifically, rebaudioside E can be formed by glucosylation of the 13-OH of steviol which forms steviol-13-*O*-glucoside, glucosylation of the C-2' of the 13-*O*-glucose of steviol-13-*O*-glucoside which forms the steviol-1,2-bioside, glucosylation of the C-19 carboxyl of the 1,2-bioside to form 1,2-stevioside, and glucosylation of the C-2' of the 19-*O*-glucose of the 1,2-stevioside to form rebaudioside

E. Rebaudioside D can be formed by glucosylation of the C-3' of the C-13-O-glucose of rebaudioside E. The order in which each glycosylation reaction occurs can vary. For example, the glucosylation of the C-2' of the 19-O-glucose may be the last step in the pathway, wherein Rebaudioside A is an intermediate in the pathway. See FIG. 2C.

5 It has been discovered that conversion of steviol to rebaudioside A, rebaudioside D, and/or rebaudioside E in a recombinant host can be accomplished by expressing the following functional UGTs: EUGT11, 74G1, 85C2, and 76G1, and optionally 91D2. Thus, a recombinant microorganism expressing combinations of these four or five UGTs can make rebaudioside A and rebaudioside D when steviol is used as a feedstock.

10 Typically, one or more of these genes are recombinant genes that have been transformed into a microorganism that does not naturally possess them. It has also been discovered that UGTs designated herein as SM12UGT can be substituted for UGT91D2.

In some embodiments, less than five (e.g., one, two, three, or four) UGTs are expressed in a host. For example, a recombinant microorganism expressing a functional
15 EUGT11 can make rebaudioside D when rebaudioside A is used as a feedstock. A recombinant microorganism expressing two functional UGTs, EUGT11 and 76G1, and optionally a functional 91D12, can make rebaudioside D when rubusoside or 1,2-stevioside is used as a feedstock. As another alternative, a recombinant microorganism expressing three functional UGTs, EUGT11, 74G1, 76G1, and optionally 91D2, can
20 make rebaudioside D when fed the monoside, steviol-13-O-glucoside, in the medium. Similarly, conversion of steviol-19-O-glucoside to rebaudioside D in a recombinant microorganism can be accomplished by the expression of genes encoding UGTs EUGT11, 85C2, 76G1, and optionally 91D2, when fed steviol-19-O-glucoside. Typically, one or more of these genes are recombinant genes that have been transformed into a host
25 that does not naturally possess them.

Suitable UGT74G1 and UGT85C2 polypeptides include those discussed above. A suitable UGT76G1 adds a glucose moiety to the C-3' of the C-13-O-glucose of the acceptor molecule, a steviol 1,2 glycoside. Thus, UGT76G1 functions, for example, as a uridine 5'-diphospho glucosyl: steviol 13-O-1,2 glucoside C-3' glucosyl transferase and a
30 uridine 5'-diphospho glucosyl: steviol-19-O-glucose, 13-O-1,2 bioside C-3' glucosyl

transferase. Functional UGT76G1 polypeptides may also catalyze glucosyl transferase reactions that utilize steviol glycoside substrates that contain sugars other than glucose, e.g., steviol rhamnosides and steviol xylosides. See, FIGS 2A, 2B, 2C and 2D. Suitable UGT76G1 polypeptides include those made by *S. rebaudiana* and reported in Richman, et al. Plant J. 41: 56-67 (2005). The amino acid sequence of a *S. rebaudiana* UGT76G1 polypeptide is set forth in SEQ ID NO:7. The nucleotide sequence encoding the UGT76G1 polypeptide of SEQ ID NO:7 has been optimized for expression in yeast and is set forth in SEQ ID NO:8. See also the UGT76G1 variants set forth in the "Functional Homolog" section.

A suitable EUGT11 or UGT91D2 polypeptide functions as a uridine 5'-diphospho glucosyl: steviol-13-*O*-glucoside transferase (also referred to as a steviol-13-monoglucoside 1,2-glucosylase), transferring a glucose moiety to the C-2' of the 13-*O*-glucose of the acceptor molecule, steviol-13-*O*-glucoside.

A suitable EUGT11 or UGT91D2 polypeptide also functions as a uridine 5'-diphospho glucosyl: rubusoside transferase transferring a glucose moiety to the C-2' of the 13-*O*-glucose of the acceptor molecule, rubusoside, to produce stevioside. EUGT11 polypeptides also can transfer a glucose moiety to the C-2' of the 19-*O*-glucose of the acceptor molecule, rubusoside, to produce a 19-*O*-1,2-diglycosylated rubusoside (compound 2 in FIG. 3).

Functional EUGT11 or UGT91D2 polypeptides also can catalyze reactions that utilize steviol glycoside substrates other than steviol-13-*O*-glucoside and rubusoside. For example, a functional EUGT11 polypeptide may utilize stevioside as a substrate, transferring a glucose moiety to the C-2' of the 19-*O*-glucose residue to produce Rebaudioside E (see compound 3 in FIG. 3). Functional EUGT11 and UGT91D2 polypeptides may also utilize Rebaudioside A as a substrate, transferring a glucose moiety to the C-2' of the 19-*O*-glucose residue of Rebaudioside A to produce Rebaudioside D. As set forth in the Examples, EUGT11 can convert Rebaudioside A to Rebaudioside D at a rate that is least 20 times faster (e.g., as least 25 times or at least 30 times faster) than the corresponding rate of UGT91D2e (SEQ ID NO: 5) when the reactions are performed under similar conditions, i.e., similar time, temperature, purity,

and substrate concentration. As such, EUGT11 produces greater amounts of RebD than UGT91D2e when incubated under similar conditions.

In addition, a functional EUGT11 exhibits significant C-2' 19-O-diglycosylation activity with rubusoside or stevioside as substrates, whereas UGT91D2e has no detectable diglycosylation activity with these substrates. Thus, a functional EUGT11 can be distinguished from UGT91D2e by the differences in steviol glycoside substrate-specificity. FIG. 3 provides a schematic overview of the 19-O-1,2 diglycosylation reactions that are performed by EUGT11 and UGT91D2e.

A functional EUGT11 or UGT91D2 polypeptide typically does not transfer a glucose moiety to steviol compounds having a 1,3-bound glucose at the C-13 position, i.e., transfer of a glucose moiety to steviol 1,3-bioside and 1,3-stevioside does not occur.

Functional EUGT11 and UGT91D2 polypeptides can transfer sugar moieties from donors other than uridine diphosphate glucose. For example, a functional EUGT11 or UGT91D2 polypeptide can act as a uridine 5'-diphospho D-xylosyl: steviol-13-O-glucoside transferase, transferring a xylose moiety to the C-2' of the 13-O-glucose of the acceptor molecule, steviol-13-O-glucoside. As another example, a functional EUGT11 or UGT91D2 polypeptide can act as a uridine 5'-diphospho L-rhamnosyl: steviol-13-O-glucoside transferase, transferring a rhamnose moiety to the C-2' of the 13-O-glucose of the acceptor molecule, steviol-13-O-glucoside

Suitable EUGT11 polypeptides are described herein and can include the EUGT11 polypeptide from *Oryza sativa* (GenBank Accession No. AC133334). For example, an EUGT11 polypeptide can have an amino acid sequence with at least 70% sequence identity (e.g., at least 75, 80, 85, 90, 95, 96, 97, 98, or 99% sequence identity) to the amino acid sequence set forth in SEQ ID NO: 152 (see FIG. 7). The nucleotide sequence encoding the amino acid sequence of SEQ ID NO: 152 is set forth in SEQ ID NO: 153. SEQ ID NO: 154 is a nucleotide sequence encoding the polypeptide of SEQ ID NO: 152 that has been codon optimized for expression in yeast.

Suitable functional UGT91D2 polypeptides include those disclosed herein, e.g., the polypeptides designated UGT91D2e and UGT91D2m. The amino acid sequence of an exemplary UGT91D2e polypeptide from *Stevia rebaudiana* is set forth in SEQ ID NO:

5. SEQ ID NO:6 is a nucleotide sequence encoding the polypeptide of SEQ ID NO:5 that has been codon optimized for expression in yeast. The *S. rebaudiana* nucleotide sequence encoding the polypeptide of SEQ ID NO:5 is set forth in SEQ ID NO:9. The amino acid sequences of exemplary UGT91D2m polypeptides from *S. rebaudiana* are set forth in SEQ ID NOs: 10 and 12, and are encoded by the nucleic acid sequences set forth in SEQ ID NOs: 11 and 13, respectively. In addition, UGT91D2 variants containing a substitution at amino acid residues 206, 207, and 343 of SEQ ID NO: 5 can be used. For example, the amino acid sequence set forth in SEQ ID NO:95 and having the following mutations with respect to wild-type UGT92D2e (SEQ ID NO:5) G206R, Y207C, and W343R can be used. In addition, a UGT91D2 variant containing substitutions at amino acid residues 211 and 286 can be used. For example, a UGT91D2 variant can include a substitution of a methionine for leucine at position 211 and a substitution of an alanine for valine at position 286 of SEQ ID NO:5 (UGT91D2e-b).

As indicated above, UGTs designated herein as SM12UGT can be substituted for UGT91D2. Suitable functional SM12UGT polypeptides include those made by *Ipomoea purpurea* (Japanese morning glory) and described in Morita et al. Plant J. 42, 353-363 (2005). The amino acid sequence encoding the *I. purpurea* IP3GGT polypeptide is set forth in SEQ ID NO:76. SEQ ID NO:77 is a nucleotide sequence encoding the polypeptide of SEQ ID NO:76 that has been codon optimized for expression in yeast. Another suitable SM12UGT polypeptide is a Bp94B1 polypeptide having an R25S mutation. See Osmani et al. Plant Phys. 148: 1295-1308 (2008) and Sawada et al. J. Biol. Chem. 280:899-906 (2005). The amino acid sequence of the *Bellis perennis* (red daisy) UGT94B1 polypeptide is set forth in SEQ ID NO:78. SEQ ID NO:79 is the nucleotide sequence encoding the polypeptide of SEQ ID NO:78 that has been codon optimized for expression in yeast.

In some embodiments, the recombinant microorganism is grown on media containing steviol-13-*O*-glucoside or steviol-19-*O*-glucoside in order to produce rebaudioside A and/or rebaudioside D. In such embodiments, the microorganism contains and expresses genes encoding a functional EUGT11, a functional UGT74G1, a functional UGT85C2, a functional UGT76G1, and an optional functional UGT91D2, and

is capable of accumulating rebaudioside A and rebaudioside D when steviol, one or both of the steviolmonosides, or rubusoside is used as feedstock.

In other embodiments, the recombinant microorganism is grown on media containing rubusoside in order to produce rebaudioside A and/or rebaudioside D. In such
5 embodiments, the microorganism contains and expresses genes encoding a functional EUGT11, a functional UGT76G1, and an optional functional UGT91D2, and is capable of producing rebaudioside A and/or rebaudioside D when rubusoside is used as feedstock.

In other embodiments the recombinant microorganism expresses one or more genes involved in steviol biosynthesis, e.g., a CDPS gene, a KS gene, a KO gene and/or a
10 KAH gene. Thus, for example, a microorganism containing a CDPS gene, a KS gene, a KO gene and a KAH gene, in addition to a EUGT11, a UGT74G1, a UGT85C2, a UGT76G1, and optionally a functional UGT91D2 (e.g., UGT91D2e), is capable of producing rebaudioside A, rebaudioside D, and/or rebaudioside E without the necessity for including steviol in the culture media.

15 In some embodiments, the recombinant host further contains and expresses a recombinant GGPPS gene in order to provide increased levels of the diterpene precursor geranylgeranyl diphosphate, for increased flux through the steviol biosynthetic pathway. In some embodiments, the recombinant host further contains a construct to silence the expression of non-steviol pathways consuming geranylgeranyl diphosphate, ent-
20 Kaurenoic acid or farnesyl pyrophosphate, thereby providing increased flux through the steviol and steviol glycosides biosynthetic pathways. For example, flux to sterol production pathways such as ergosterol may be reduced by downregulation of the *ERG9* gene. See, the *ERG9* section below and Examples 24-25. In cells that produce gibberellins, gibberellin synthesis may be downregulated to increase flux of ent-
25 kaurenoic acid to steviol. In carotenoid-producing organisms, flux to steviol may be increased by downregulation of one or more carotenoid biosynthetic genes. In some embodiments, the recombinant microorganism further can express recombinant genes involved in diterpene biosynthesis or production of terpenoid precursors, e.g., genes in the MEP or MEV) pathways discussed below, have reduced phosphatase activity, and/or
30 express a SUS as discussed herein.

One with skill in the art will recognize that by modulating relative expression levels of different UGT genes, a recombinant host can be tailored to specifically produce steviol glycoside products in a desired proportion. Transcriptional regulation of steviol biosynthesis genes and steviol glycoside biosynthesis genes can be achieved by a combination of transcriptional activation and repression using techniques known to those in the art. For *in vitro* reactions, one with skill in the art will recognize that addition of different levels of UGT enzymes in combination or under conditions which impact the relative activities of the different UGTs in combination will direct synthesis towards a desired proportion of each steviol glycoside. One with skill in the art will recognize that a higher proportion of rebaudioside D or E or more efficient conversion to rebaudioside D or E can be obtained with a diglycosylation enzyme that has a higher activity for the 19-*O*-glucoside reaction as compared to the 13-*O*-glucoside reaction (substrates rebaudioside A and stevioside).

In some embodiments, a recombinant host such as a microorganism produces rebaudioside D-enriched steviol glycoside compositions that have greater than at least 3% rebaudioside D by weight total steviol glycosides, e.g., at least 4% rebaudioside D at least 5% rebaudioside D, 10-20% rebaudioside D, 20-30% rebaudioside D, 30-40% rebaudioside D, 40-50% rebaudioside D, 50-60% rebaudioside D, 60-70% rebaudioside D, 70-80% rebaudioside D. In some embodiments, a recombinant host such as a microorganism produces steviol glycoside compositions that have at least 90% rebaudioside D, e.g., 90-99% rebaudioside D. Other steviol glycosides present may include those depicted in Figure 2 C such as steviol monosides, steviol glucobiosides, rebaudioside A, rebaudioside E, and stevioside. In some embodiments, the rebaudioside D-enriched composition produced by the host (e.g., microorganism) can be further purified and the rebaudioside D or rebaudioside E so purified can then be mixed with other steviol glycosides, flavors, or sweeteners to obtain a desired flavor system or sweetening composition. For instance, a rebaudioside D-enriched composition produced by a recombinant host can be combined with a rebaudioside A, C, or F-enriched composition produced by a different recombinant host, with rebaudioside A, F, or C purified from a Stevia extract, or with rebaudioside A, F, or C produced *in vitro*.

In some embodiments, rebaudioside A, rebaudioside D, rebaudioside B, steviol monoglucosides, steviol-1,2-bioside, rubusoside, stevioside, or rebaudioside E can be produced using *in vitro* methods while supplying the appropriate UDP-sugar and/or a cell-free system for regeneration of UDP-sugars. See, for example, Jewett MC, et al. Molecular Systems Biology, Vol. 4, article 220 (2008); Masada S et al. FEBS Letters, Vol. 581, 2562-2566 (2007). In some embodiments, sucrose and a sucrose synthase may be provided in the reaction vessel in order to regenerate UDP-glucose from the UDP generated during glycosylation reactions. See Figure 11. The sucrose synthase can be from any suitable organism. For example, a sucrose synthase coding sequence from *Arabidopsis thaliana*, *Stevia rebaudiana*, or *Coffea arabica* can be cloned into an expression plasmid under control of a suitable promoter, and expressed in a host such as a microorganism or a plant.

Conversions requiring multiple reactions may be carried out together, or stepwise. For example, rebaudioside D may be produced from rebaudioside A that is commercially available as an enriched extract or produced via biosynthesis, with the addition of stoichiometric or excess amounts of UDP-glucose and EUGT11. As an alternative, rebaudioside D may be produced from steviol glycoside extracts that are enriched for stevioside and rebaudioside A, using EUGT11 and a suitable UGT76G1 enzyme. In some embodiments, phosphatases are used to remove secondary products and improve the reaction yields. UGTs and other enzymes for *in vitro* reactions may be provided in soluble forms or in immobilized forms.

In some embodiments, rebaudioside A, rebaudioside D, or rebaudioside E can be produced using whole cells that are fed raw materials that contain precursor molecules such as steviol and/or steviol glycosides, including mixtures of steviol glycosides derived from plant extracts. The raw materials may be fed during cell growth or after cell growth. The whole cells may be in suspension or immobilized. The whole cells may be entrapped in beads, for example calcium or sodium alginate beads. The whole cells may be linked to a hollow fiber tube reactor system. The whole cells may be concentrated and entrapped within a membrane reactor system. The whole cells may be in fermentation broth or in a reaction buffer. In some embodiments, a permeabilizing agent is utilized for efficient

transfer of substrate into the cells. In some embodiments, the cells are permeabilized with a solvent such as toluene, or with a detergent such as Triton-X or Tween. In some embodiments, the cells are permeabilized with a surfactant, for example a cationic surfactant such as cetyltrimethylammonium bromide (CTAB). In some embodiments, the cells are permeabilized with periodic mechanical shock such as electroporation or a slight osmotic shock. The cells can contain one recombinant UGT or multiple recombinant UGTs. For example, the cells can contain UGT 76G1 and EUGT11 such that mixtures of stevioside and RebA are efficiently converted to RebD. In some embodiments, the whole cells are the host cells described in section III A. In some embodiments, the whole cells are a Gram-negative bacterium such as *E. coli*. In some embodiments, the whole cell is a Gram-positive bacterium such as *Bacillus*. In some embodiments, the whole cell is a fungal species such as *Aspergillus*, or a yeast such as *Saccharomyces*. In some embodiments, the term “whole cell biocatalysis” is used to refer to the process in which the whole cells are grown as described above (e.g., in a medium and optionally permeabilized) and a substrate such as rebA or stevioside is provided and converted to the end product using the enzymes from the cells. The cells may or may not be viable, and may or may not be growing during the bioconversion reactions. In contrast, in fermentation, the cells are cultured in a growth medium and fed a carbon and energy source such as glucose and the end product is produced with viable cells.

B. 3 Dulcoside A and Rebaudioside C Biosynthesis Polypeptides

The biosynthesis of rebaudioside C and/or dulcoside A involves glucosylation and rhamnosylation of the aglycone steviol. Specifically, dulcoside A can be formed by glucosylation of the 13-OH of steviol which forms steviol-13-*O*-glucoside, rhamnosylation of the C-2' of the 13-*O*-glucose of steviol-13-*O*-glucoside which forms the 1,2 rhamnobioside, and glucosylation of the C-19 carboxyl of the 1,2 rhamnobioside. Rebaudioside C can be formed by glucosylation of the C-3' of the C-13-*O*-glucose of dulcoside A. The order in which each glycosylation reaction occurs can vary. See FIG. 2B.

It has been discovered that conversion of steviol to dulcoside A in a recombinant host can be accomplished by the expression of gene(s) encoding the following functional UGTs: 85C2, EUGT11 and/or 91D2e, and 74G1. Thus, a recombinant microorganism expressing these three or four UGTs and a rhamnose synthetase can make dulcoside A when fed steviol in the medium. Alternatively, a recombinant microorganism expressing two UGTs, EUGT11 and 74G1, and rhamnose synthetase can make dulcoside A when fed the monoside, steviol-13-*O*-glucoside or steviol-19-*O*-glucoside, in the medium. Similarly, conversion of steviol to rebaudioside C in a recombinant microorganism can be accomplished by the expression of gene(s) encoding UGTs 85C2, EUGT11, 74G1, 76G1, optionally 91D2e, and rhamnose synthetase when fed steviol, by the expression of genes encoding UGTs EUGT11 and/or 91D2e, 74G1, and 76G1, and rhamnose synthetase when fed steviol-13-*O*-glucoside, by the expression of genes encoding UGTs 85C2, EUGT11 and/or 91D2e, 76G1, and rhamnose synthetase when fed steviol-19-*O*-glucoside, or by the expression of genes encoding UGTs EUGT11 and/or 91D2e, 76G1, and rhamnose synthetase when fed rubusoside. Typically, one or more of these genes are recombinant genes that have been transformed into a microorganism that does not naturally possess them.

Suitable EUGT11, UGT91D2, UGT74G1, UGT76G1 and UGT85C2 polypeptides include the functional UGT polypeptides discussed herein. Rhamnose synthetase provides increased amounts of the UDP-rhamnose donor for rhamnosylation of the steviol compound acceptor. Suitable rhamnose synthetases include those made by *Arabidopsis thaliana*, such as the product of the *A. thaliana* RHM2 gene.

In some embodiments, a UGT79B3 polypeptide is substituted for a UGT91D2 polypeptide. Suitable UGT79B3 polypeptides include those made by *Arabidopsis thaliana*, which are capable of rhamnosylation of steviol 13-*O*-monoside *in vitro*. *A. thaliana* UGT79B3 can rhamnosylate glucosylated compounds to form 1,2-rhamnosides. The amino acid sequence of an *Arabidopsis thaliana* UGT79B3 is set forth in SEQ ID NO:150. The nucleotide sequence encoding the amino acid sequence of SEQ ID NO:150 is set forth in SEQ ID NO:151.

In some embodiments rebaudioside C can be produced using *in vitro* methods while supplying the appropriate UDP-sugar and/or a cell-free system for regeneration of UDP-sugars. See, for example, "An integrated cell-free metabolic platform for protein production and synthetic biology" by Jewett MC, Calhoun KA, Voloshin A, Wu JJ and Swartz JR in Molecular Systems Biology, 4, article 220 (2008); Masada S et al. FEBS Letters, Vol. 581, 2562-2566 (2007). In some embodiments, sucrose and a sucrose synthase may be provided in the reaction vessel in order to regenerate UDP-glucose from UDP during the glycosylation reactions. See FIG. 11. The sucrose synthase can be from any suitable organism. For example, a sucrose synthase coding sequence from *Arabidopsis thaliana*, *Stevia rebaudiana*, or *Coffea arabica* can be cloned into an expression plasmid under control of a suitable promoter, and expressed in a host (e.g., a microorganism or a plant). In some embodiments a RHM2 enzyme (Rhamnose synthase) may also be provided, with NADPH, to generate UDP-rhamnose from UDP-glucose.

Reactions may be carried out together, or stepwise. For instance, rebaudioside C may be produced from rubusoside with the addition of stoichiometric amounts of UDP-rhamnose and EUGT11, followed by addition of UGT76G1 and an excess or stoichiometric supply of UDP-glucose. In some embodiments, phosphatases are used to remove secondary products and improve the reaction yields. UGTs and other enzymes for *in vitro* reactions may be provided in soluble forms or immobilized forms. In some embodiments, rebaudioside C, Dulcoside A, or other steviol rhamnosides can be produced using whole cells as discussed above. The cells can contain one recombinant UGT or multiple recombinant UGTs. For example, the cells can contain UGT 76G1 and EUGT11 such that mixtures of stevioside and RebA are efficiently converted to RebD. In some embodiments, the whole cells are the host cells described in section III A.

In other embodiments, the recombinant host expresses one or more genes involved in steviol biosynthesis, e.g., a CDPS gene, a KS gene, a KO gene and/or a KAH gene. Thus, for example, a microorganism containing a CDPS gene, a KS gene, a KO gene and a KAH gene, in addition to a UGT85C2, a UGT74G1, a EUGT11 gene, optionally a UGT91D2e gene, and a UGT76G1 gene, is capable of producing rebaudioside C without the necessity for including steviol in the culture media. In

addition, the recombinant host typically expresses an endogenous or a recombinant gene encoding a rhamnose synthetase. Such a gene is useful in order to provide increased amounts of the UDP-rhamnose donor for rhamnosylation of the steviol compound acceptor. Suitable rhamnose synthetases include those made by *Arabidopsis thaliana*,
5 such as the product of the *A. thaliana* RHM2 gene.

One with skill in the art will recognize that by modulating relative expression levels of different UGT genes as well as modulating the availability of UDP-rhamnose, a recombinant host can be tailored to specifically produce steviol and steviol glycoside products in a desired proportion. Transcriptional regulation of steviol biosynthesis genes,
10 and steviol glycoside biosynthesis genes can be achieved by a combination of transcriptional activation and repression using techniques known to those in the art. For *in vitro* reactions, one with skill in the art will recognize that addition of different levels of UGT enzymes in combination or under conditions which impact the relative activities of the different UGTs in combination will direct synthesis towards a desired proportion
15 of each steviol glycoside.

In some embodiments, the recombinant host further contains and expresses a recombinant GGPPS gene in order to provide increased levels of the diterpene precursor geranylgeranyl diphosphate, for increased flux through the rebaudioside A biosynthetic pathway. In some embodiments, the recombinant host further contains a construct to
20 silence or reduce the expression of non-steviol pathways consuming geranylgeranyl diphosphate, ent-Kaurenoic acid or farnesyl pyrophosphate, thereby providing increased flux through the steviol and steviol glycosides biosynthetic pathways. For example, flux to sterol production pathways such as ergosterol may be reduced by downregulation of the ERG9 gene. See, the ERG9 section below and Examples 24-25. In cells that produce
25 gibberellins, gibberellin synthesis may be downregulated to increase flux of ent-kaurenoic acid to steviol. In carotenoid-producing organisms, flux to steviol may be increased by downregulation of one or more carotenoid biosynthetic genes.

In some embodiments, the recombinant host further contains and expresses recombinant genes involved in diterpene biosynthesis or production of terpenoid

precursors, e.g., genes in the MEP or MEV pathway, have reduced phosphatase activity, and/or express a SUS as discussed herein.

In some embodiments, a recombinant host such as a microorganism produces steviol glycoside compositions that have greater than at least 15% rebaudioside C of the total steviol glycosides, e.g., at least 20% rebaudioside C, 30-40% rebaudioside C, 40-50% rebaudioside C, 50-60% rebaudioside C, 60-70% rebaudioside C, 70-80% rebaudioside C, 80-90% rebaudioside C. In some embodiments, a recombinant host such as a microorganism produces steviol glycoside compositions that have at least 90% rebaudioside C, e.g., 90-99% rebaudioside C. Other steviol glycosides present may include those depicted in Figures 2 A and B such as steviol monosides, steviol glucobiosides, steviol rhamnobiosides, rebaudioside A, and Dulcoside A. In some embodiments, the rebaudioside C-enriched composition produced by the host can be further purified and the rebaudioside C or Dulcoside A so purified may then be mixed with other steviol glycosides, flavors, or sweeteners to obtain a desired flavor system or sweetening composition. For instance, a rebaudioside C-enriched composition produced by a recombinant microorganism can be combined with a rebaudioside A, F, or D-enriched composition produced by a different recombinant microorganism, with rebaudioside A, F, or D purified from a Stevia extract, or with rebaudioside A, F, or D produced *in vitro*.

B. 4 Rebaudioside F Biosynthesis Polypeptides

The biosynthesis of rebaudioside F involves glucosylation and xylosylation of the aglycone steviol. Specifically, rebaudioside F can be formed by glucosylation of the 13-OH of steviol which forms steviol-13-*O*-glucoside, xylosylation of the C-2' of the 13-*O*-glucose of steviol-13-*O*-glucoside which forms steviol-1,2-xylobioside, glucosylation of the C-19 carboxyl of the 1,2-xylobioside to form 1,2-stevioxyloside, and glucosylation of the C-3' of the C-13-*O*-glucose of 1,2-stevioxyloside to form rebaudioside F. The order in which each glycosylation reaction occurs can vary. See FIG. 2D.

It has been discovered that conversion of steviol to rebaudioside F in a recombinant host can be accomplished by the expression of genes encoding the following

functional UGTs: 85C2, EUGT11 and/or 91D2e, 74G1, and 76G1, along with endogenous or recombinantly expressed UDP-glucose dehydrogenase and UDP-glucuronic acid decarboxylase. Thus, a recombinant microorganism expressing these four or five UGTs along with endogenous or recombinant UDP-glucose dehydrogenase and UDP-glucuronic acid decarboxylase can make rebaudioside F when fed steviol in the medium. Alternatively, a recombinant microorganism expressing two functional UGTs, EUGT11 or 91D2e, and 76G1, can make rebaudioside F when fed rubusoside in the medium. As another alternative, a recombinant microorganism expressing a functional UGT 76G1 can make rebaudioside F when fed 1,2 steviorhamnoside. As another alternative, a recombinant microorganism expressing 74G1, EUGT11 and/or 91D2e, 76G1, and can make rebaudioside F when fed the monoside, steviol-13-*O*-glucoside, in the medium. Similarly, conversion of steviol-19-*O*-glucoside to rebaudioside F in a recombinant microorganism can be accomplished by the expression of genes encoding UGTs 85C2, EUGT11 and/or 91D2e, and 76G1, when fed steviol-19-*O*-glucoside. Typically, one or more of these genes are recombinant genes that have been transformed into a host that does not naturally possess them.

Suitable EUGT11, UGT91D2, UGT74G1, UGT76G1 and UGT85C2 polypeptides include the functional UGT polypeptides discussed herein. In some embodiments, a UGT79B3 polypeptide is substituted for a UGT91, as discussed above. UDP-glucose dehydrogenase and UDP-glucuronic acid decarboxylase provide increased amounts of the UDP-xylose donor for xylosylation of the steviol compound acceptor. Suitable UDP-glucose dehydrogenases and UDP-glucuronic acid decarboxylases include those made by *Arabidopsis thaliana* or *Cryptococcus neoformans*. For example, suitable UDP-glucose dehydrogenase and UDP-glucuronic acid decarboxylases polypeptides can be encoded by the *A. thaliana* UGD1 gene and UXS3 gene, respectively. See, Oka and Jigami, FEBS J. 273:2645-2657 (2006).

In some embodiments rebaudioside F can be produced using *in vitro* methods while supplying the appropriate UDP-sugar and/or a cell-free system for regeneration of UDP-sugars. See, for example, Jewett MC, et al. Molecular Systems Biology, Vol. 4, article 220 (2008); Masada S et al. FEBS Letters, Vol. 581, 2562-2566 (2007). In some

embodiments, sucrose and a sucrose synthase are provided in the reaction vessel in order to regenerate UDP-glucose from UDP during the glycosylation reactions. See FIG. 11.

The sucrose synthase can be from any suitable organism. For example, a sucrose synthase coding sequence from *Arabidopsis thaliana*, *Stevia rebaudiana*, or *Coffea arabica* can be cloned into an expression plasmid under control of a suitable promoter, and expressed in a host, e.g., a microorganism or a plant. In some embodiments, UDP-xylose can be produced from UDP-glucose by supplying suitable enzymes, for example, the *Arabidopsis thaliana* UGD1 (UDP-glucose dehydrogenase) and UXS3 (UDP-glucuronic acid decarboxylase) enzymes along with NAD⁺ cofactor.

Reactions may be carried out together, or stepwise. For instance, rebaudioside F may be produced from rubusoside with the addition of stoichiometric amounts of UDP-xylose and EUGT11, followed by addition of UGT76G1 and an excess or stoichiometric supply of UDP-glucose. In some embodiments, phosphatases are used to remove secondary products and improve the reaction yields. UGTs and other enzymes for *in vitro* reactions may be provided in soluble forms or immobilized forms. In some embodiments, rebaudioside F or other steviol xylosides can be produced using whole cells as discussed above. For example, the cells may contain UGT 76G1 and EUGT11 such that mixtures of stevioside and RebA are efficiently converted to RebD. In some embodiments, the whole cells are the host cells described in section III A.

In other embodiments, the recombinant host expresses one or more genes involved in steviol biosynthesis, e.g., a CDPS gene, a KS gene, a KO gene and/or a KAH gene. Thus, for example, a microorganism containing a CDPS gene, a KS gene, a KO gene and a KAH gene, in addition to a EUGT11, UGT85C2, a UGT74G1, an optional UGT91D2 gene, and a UGT76G1 gene, is capable of producing rebaudioside F without the necessity for including steviol in the culture media. In addition, the recombinant host typically expresses an endogenous or a recombinant gene encoding a UDP-glucose dehydrogenase and a UDP-glucuronic acid decarboxylase. Such genes are useful in order to provide increased amounts of the UDP-xylose donor for xylosylation of the steviol compound acceptor. Suitable UDP-glucose dehydrogenases and UDP-glucuronic acid decarboxylases include those made by *Arabidopsis thaliana* or *Cryptococcus*

neoformans. For example, suitable UDP-glucose dehydrogenase and UDP-glucuronic acid decarboxylases polypeptides can be encoded by the *A. thaliana* UGD1 gene and UXS3 gene, respectively. See, Oka and Jigami, FEBS J. 273:2645-2657 (2006).

One with skill in the art will recognize that by modulating relative expression
5 levels of different UGT genes as well as modulating the availability of UDP-xylose, a recombinant microorganism can be tailored to specifically produce steviol and steviol glycoside products in a desired proportion. Transcriptional regulation of steviol biosynthesis genes can be achieved by a combination of transcriptional activation and repression using techniques known to those in the art. For *in vitro* reactions, one with
10 skill in the art will recognize that addition of different levels of UGT enzymes in combination or under conditions which impact the relative activities of the different UGTs in combination will direct synthesis towards a desired proportion of each steviol glycosides.

In some embodiments, the recombinant host further contains and expresses a
15 recombinant GGPPS gene in order to provide increased levels of the diterpene precursor geranylgeranyl diphosphate, for increased flux through the steviol biosynthetic pathway. In some embodiments, the recombinant host further contains a construct to silence the expression of non-steviol pathways consuming geranylgeranyl diphosphate, ent-Kaurenoic acid or farnesyl pyrophosphate, thereby providing increased flux through the
20 steviol and steviol glycosides biosynthetic pathways. For example, flux to sterol production pathways such as ergosterol may be reduced by downregulation of the ERG9 gene. See, the ERG9 section below and Examples 24-25. In cells that produce gibberellins, gibberellin synthesis may be downregulated to increase flux of ent-kaurenoic acid to steviol. In carotenoid-producing organisms, flux to steviol may be
25 increased by downregulation of one or more carotenoid biosynthetic genes. In some embodiments, the recombinant host further contains and expresses recombinant genes involved in diterpene biosynthesis, e.g., genes in the MEP pathway discussed below.

In some embodiments, a recombinant host such as a microorganism produces
rebaudioside F-enriched steviol glycoside compositions that have greater than at least
30 4% rebaudioside F by weight total steviol glycosides, e.g., at least 5% rebaudioside F, at

least 6% of rebaudioside F, 10-20% rebaudioside F, 20-30% rebaudioside F, 30-40% rebaudioside F, 40-50% rebaudioside F, 50-60% rebaudioside F, 60-70% rebaudioside F, 70-80% rebaudioside F. In some embodiments, a recombinant host such as a microorganism produces steviol glycoside compositions that have at least 90% rebaudioside F, e.g., 90-99% rebaudioside F. Other steviol glycosides present may include those depicted in FIGs 2A and D such as steviol monosides, steviol glucobiosides, steviol xylobiosides, rebaudioside A, stevioxyloside, rubusoside and stevioside. In some embodiments, the rebaudioside F-enriched composition produced by the host can be mixed with other steviol glycosides, flavors, or sweeteners to obtain a desired flavor system or sweetening composition. For instance, a rebaudioside F-enriched composition produced by a recombinant microorganism can be combined with a rebaudioside A, C, or D-enriched composition produced by a different recombinant microorganism, with rebaudioside A, C, or D purified from a Stevia extract, or with rebaudioside A, C, or D produced *in vitro*.

C. Other Polypeptides

Genes for additional polypeptides whose expression facilitates more efficient or larger scale production of steviol or a steviol glycoside can also be introduced into a recombinant host. For example, a recombinant microorganism, plant, or plant cell can also contain one or more genes encoding a geranylgeranyl diphosphate synthase (GGPPS, also referred to as GGDPS). As another example, the recombinant host can contain one or more genes encoding a rhamnose synthetase, or one or more genes encoding a UDP-glucose dehydrogenase and/or a UDP-glucuronic acid decarboxylase. As another example, a recombinant host can also contain one or more genes encoding a cytochrome P450 reductase (CPR). Expression of a recombinant CPR facilitates the cycling of NADP⁺ to regenerate NADPH, which is utilized as a cofactor for terpenoid biosynthesis. Other methods can be used to regenerate NADHP levels as well. In circumstances where NADPH becomes limiting; strains can be further modified to include exogenous transhydrogenase genes. See, e.g., Sauer et al., J. Biol. Chem. 279: 6613–6619 (2004).

Other methods are known to those with skill in the art to reduce or otherwise modify the ratio of NADH/NADPH such that the desired cofactor level is increased.

As another example, the recombinant host can contain one or more genes encoding one or more enzymes in the MEP pathway or the mevalonate pathway. Such genes are useful because they can increase the flux of carbon into the diterpene biosynthesis pathway, producing geranylgeranyl diphosphate from isopentenyl diphosphate and dimethylallyl diphosphate generated by the pathway. The geranylgeranyl diphosphate so produced can be directed towards steviol and steviol glycoside biosynthesis due to expression of steviol biosynthesis polypeptides and steviol glycoside biosynthesis polypeptides.

As another example the recombinant host can contain one or more genes encoding a sucrose synthase, and additionally can contain sucrose uptake genes if desired. The sucrose synthase reaction can be used to increase the UDP-glucose pool in a fermentation host, or in a whole cell bioconversion process. This regenerates UDP-glucose from UDP produced during glycosylation and sucrose, allowing for efficient glycosylation. In some organisms, disruption of the endogenous invertase is advantageous to prevent degradation of sucrose. For example, the *S. cerevisiae* SUC2 invertase may be disrupted. The sucrose synthase (SUS) can be from any suitable organism. For example, a sucrose synthase coding sequence from, without limitation, *Arabidopsis thaliana*, *Stevia rebaudiana*, or *Coffea arabica* can be cloned into an expression plasmid under control of a suitable promoter, and expressed in a host (e.g., a microorganism or a plant). The sucrose synthase can be expressed in such a strain in combination with a sucrose transporter (e.g., the *A. thaliana* SUC1 transporter or a functional homolog thereof) and one or more UGTs (e.g., one or more of UGT85C2, UGT74G1, UGT76G1, and UGT91D2e, EUGT11 or functional homologs thereof). Culturing the host in a medium that contains sucrose can promote production of UDP-glucose, as well as one or more glucosides (e.g., steviol glycosides).

In addition, a recombinant host can have reduced phosphatase activity as discussed herein.

C. 1 MEP Biosynthesis Polypeptides

In some embodiments, a recombinant host contains one or more genes encoding enzymes involved in the methylerythritol 4-phosphate (MEP) pathway for isoprenoid biosynthesis. Enzymes in the MEP pathway include deoxyxylulose 5-phosphate synthase (DXS), D-1-deoxyxylulose 5-phosphate reductoisomerase (DXR), 4-diphosphocytidyl-2-C-methyl-D-erythritol synthase (CMS), 4-diphosphocytidyl-2-C-methyl-D-erythritol kinase (CMK), 4-diphosphocytidyl-2-C-methyl-D-erythritol 2,4-cyclodiphosphate synthase (MCS), 1-hydroxy-2-methyl-2(E)-butenyl 4-diphosphate synthase (HDS) and 1-hydroxy-2-methyl-2(E)-butenyl 4-diphosphate reductase (HDR). One or more DXS genes, DXR genes, CMS genes, CMK genes, MCS genes, HDS genes and/or HDR genes can be incorporated into a recombinant microorganism. See, Rodríguez-Concepción and Boronat, Plant Phys. 130: 1079-1089 (2002).

Suitable genes encoding DXS, DXR, CMS, CMK, MCS, HDS and/or HDR polypeptides include those made by *E. coli*, *Arabidopsis thaliana* and *Synechococcus leopoliensis*. Nucleotide sequences encoding DXR polypeptides are described, for example, in U.S. Patent No. 7,335,815.

C. 2 Mevalonate Biosynthesis Polypeptides

In some embodiments, a recombinant host contains one or more genes encoding enzymes involved in the mevalonate pathway for isoprenoid biosynthesis. Genes suitable for transformation into a host encode enzymes in the mevalonate pathway such as a truncated 3-hydroxy-3-methyl-glutaryl (HMG)-CoA reductase (tHMG), and/or a gene encoding a mevalonate kinase (MK), and/or a gene encoding a phosphomevalonate kinase (PMK), and/or a gene encoding a mevalonate pyrophosphate decarboxylase (MPPD). Thus, one or more HMG-CoA reductase genes, MK genes, PMK genes, and/or MPPD genes can be incorporated into a recombinant host such as a microorganism.

Suitable genes encoding mevalonate pathway polypeptides are known. For example, suitable polypeptides include those made by *E. coli*, *Paracoccus denitrificans*, *Saccharomyces cerevisiae*, *Arabidopsis thaliana*, *Kitasatospora griseola*, *Homo sapiens*, *Drosophila melanogaster*, *Gallus gallus*, *Streptomyces* sp. KO-3988, *Nicotiana attenuata*,

Kitasatospora griseola, *Hevea brasiliensis*, *Enterococcus faecium* and *Haematococcus pluvialis*. See, e.g., Table 8 and U.S. Patent Nos. 7,183,089, 5,460,949, and 5,306,862.

Table 8. Sources of HMG CoA Reductases and other Mevalonate Genes

Accession#	Organism	Enzyme	Size (nt)	Gene name	SEQ ID (codon optimized)	SEQ ID (protein)
XM_001467423	<i>Leishmania infantum</i>	Acetyl-CoA C-acetyltransferase	1323	MEV-4	103	104
YML075C	<i>Saccharomyces cerevisiae</i>	Truncated HMG (tHMG1)	1584	tHMG1	105	106
EU263989	<i>Ganoderma lucidum</i>	3-HMG-CoA reductase	3681	MEV-11	107	108
BC153262	<i>Bos taurus</i>	3-HMG-CoA reductase	2667	MEV-12	109	110
AAD47596	<i>Artemisia annua</i>	3-HMG-CoA reductase	1704	MEV-13	111	112
AAB62280	<i>Trypanosoma cruzi</i>	3-HMG-CoA reductase	1308	MEV-14	113	114
CAG41604	<i>Staph aureus</i>	3-HMG-CoA reductase	1281	MEV-15	115	116
DNA2.0 sequence	<i>Archaeoglobus fulgidus</i>	3-HMG-CoA reductase	1311	HMG reductase	117	118
DNA2.0 sequence	<i>Pseudomonas mevalonii</i>	3-HMG-CoA reductase	1287	HMG reductase	119	120

C.3 Sucrose Synthase Polypeptides

Sucrose synthase (SUS) can be used as a tool for generating UDP-sugar. SUS (EC 2.4.1.13) catalyzes the formation of UDP-glucose and fructose from sucrose and UDP (FIG. 11). UDP generated by the reaction of UGTs thus can be converted into UDP-glucose in the presence of sucrose. See, e.g., Chen et al. (2001) *J. Am. Chem. Soc.* 123:8866-8867; Shao et al. (2003) *Appl. Env. Microbiol.* 69:5238-5242; Masada et al. (2007) *FEBS Lett.* 581:2562-2566; and Son et al. (2009) *J. Microbiol. Biotechnol.* 19:709-712.

Sucrose synthases can be used to generate UDP-glucose and remove UDP, facilitating efficient glycosylation of compounds in various systems. For example, yeast deficient in the ability to utilize sucrose can be made to grow on sucrose by introducing a

sucrose transporter and a SUS. For example, *Saccharomyces cerevisiae* does not have an efficient sucrose uptake system, and relies on extracellular SUC2 to utilize sucrose. The combination of disrupting the endogenous *S. cerevisiae* SUC2 invertase and expressing recombinant SUS resulted in a yeast strain that was able to metabolize intracellular but
5 not extracellular sucrose (Riesmeier et al. ((1992) *EMBO J.* 11:4705-4713). The strain was used to isolate sucrose transporters by transformation with a cDNA expression library and selection of transformants that had gained the ability to take up sucrose.

As described herein, the combined expression of recombinant sucrose synthase and a sucrose transporter *in vivo* can lead to increased UDP-glucose availability and
10 removal of unwanted UDP. For example, functional expression of a recombinant sucrose synthase, a sucrose transporter, and a glycosyltransferase, in combination with knockout of the natural sucrose degradation system (SUC2 in the case of *S. cerevisiae*) can be used to generate a cell that is capable of producing increased amounts of glycosylated compounds such as steviol glycosides. This higher glycosylation capability is due to at
15 least (a) a higher capacity for producing UDP-glucose in a more energy efficient manner, and (b) removal of UDP from growth medium, as UDP can inhibit glycosylation reactions.

The sucrose synthase can be from any suitable organism. For example, a sucrose synthase coding sequence from, without limitation, *Arabidopsis thaliana*, *Stevia*
20 *rebaudiana*, or *Coffea arabica* (see, e.g., FIGs. 19A-19C, SEQ ID NOs:178, 179, and 180) can be cloned into an expression plasmid under control of a suitable promoter, and expressed in a host (e.g., a microorganism or a plant). As described in the Examples herein, a SUS coding sequence may be expressed in a *SUC2* (sucrose hydrolyzing enzyme) deficient *S. cerevisiae* strain, so as to avoid degradation of extracellular sucrose
25 by the yeast. The sucrose synthase can be expressed in such a strain in combination with a sucrose transporter (e.g., the *A. thaliana* SUC1 transporter or a functional homolog thereof) and one or more UGTs (e.g., one or more of UGT85C2, UGT74G1, UGT76G1, EUGT11, and UGT91D2e, or functional homologs thereof). Culturing the host in a medium that contains sucrose can promote production of UDP-glucose, as well as one or
30 more glucosides (e.g., steviol glucoside). It is to be noted that in some cases, a sucrose

synthase and a sucrose transporter can be expressed along with a UGT in a host cell that also is recombinant for production of a particular compound (e.g., steviol).

C. 4 Modulation of ERG9 activity

5 It is an object of the disclosure to produce terpenoids based on the concept of increasing the accumulation of terpenoid precursors of the squalene pathway. Non-limiting examples of terpenoids include Hemiterpenoids, 1 isoprene unit (5 carbons); Monoterpenoids, 2 isoprene units (10C); Sesquiterpenoids, 3 isoprene units (15C); Diterpenoids, 4 isoprene units (20C) (e.g. ginkgolides); Triterpenoids, 6 isoprene units
10 (30C); Tetraterpenoids, 8 isoprene units (40C) (e.g. carotenoids); and polyterpenoid with a larger number of isoprene units.

 Hemiterpenoids include isoprene, prenol and isovaleric acid. Monoterpenoids include Geranyl pyrophosphate, Eucalyptol, Limonene and Pinene. Sesquiterpenoids include Farnesyl pyrophosphate, Artemisinin and Bisabolol. Diterpenoids include
15 Geranylgeranyl pyrophosphate, steviol, Retinol, Retinal, Phytol, Taxol, Forskolin and Aphidicolin. Triterpenoids include Squalene and Lanosterol. Tetraterpenoids include Lycopene and Carotene.

 Terpenes are hydrocarbons resulting from the combination of several isoprene units. Terpenoids can be thought of as terpene derivatives. The term terpene is sometimes
20 used broadly to include the terpenoids. Just like terpenes, the terpenoids can be classified according to the number of isoprene units used. The present invention is focussed on terpenoids and in particular terpenoids derived through the squalene pathway from the precursors Farnesyl-pyrophosphate (FPP), Isopentenyl-pyrophosphate (IPP), Dimethylallyl-pyrophosphate (DMAPP), Geranyl-pyrophosphate (GPP) and/or
25 Geranylgeranyl-pyrophosphate (GGPP).

 By terpenoids is understood terpenoids of the Hemiterpenoid class such as but not limited to isoprene, prenol and isovaleric acid; terpenoids of the Monoterpenoid class such as but not limited to geranyl pyrophosphate, eucalyptol, limonene and pinene; terpenoids of the Sesquiterpenoids class such as but not limited to farnesyl pyro-
30 phosphate, artemisinin and bisabolol; terpenoids of the diterpenoid class such as but not

limited to geranylgeranyl pyrophosphate, steviol, retinol, retinal, phytol, taxol, forskolin and aphidicolin; terpenoids of the Triterpenoid class such as but not limited to lanosterol; terpenoids of the Tetraterpenoid class such as but not limited to lycopene and carotene.

5 In one embodiment the invention relates to production of terpenoids, which are biosynthesized from Geranylgeranyl-pyrophosphate (GGPP). In particular such terpenoids may be steviol.

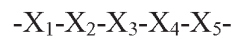
In one embodiment the invention relates to production of terpenoids, which are biosynthesized from Geranylgeranyl-pyrophosphate (GGPP). In particular such terpenoids may be steviol.

10 **The cell**

The present invention relates to a cell, such as any of the hosts described in section III, modified to comprise the construct depicted in FIG. 22. Accordingly, in a main aspect, the present invention relates to a cell comprising a nucleic acid, said nucleic acid comprising

- 15 i) a promoter sequence operably linked to
ii) a heterologous insert sequence operably linked to
iii) an open reading frame operably linked to
iv) a transcription termination signal,

20 wherein the heterologous insert sequence has the general formula (I):



wherein X_2 comprises at least 4 consecutive nucleotides being complementary to, and forms a hairpin secondary structure element with at least 4 consecutive nucleotides of X_4 , and

25 wherein X_3 is optional and if present comprises nucleotides involved in forming a hairpin loop between X_2 and X_4 , and

wherein X_1 and X_5 individually and optionally comprise one or more nucleotides, and

30 wherein the open reading frame upon expression encodes a squalene synthase (EC 2.5.1.21), e.g., a polypeptide sequence having at least 70% identity to a squalene synthase

(EC 2.5.1.21) or a biologically active fragment thereof, said fragment having at least 70% sequence identity to said squalene synthase in a range of overlap of at least 100 amino acids.

In addition to above mentioned nucleic acid comprising a heterologous insert sequence, the cell may also comprise one or more additional heterologous nucleic acid sequences (e.g., nucleic acids encoding any of the steviol and steviol glycoside biosynthesis polypeptides of section I). In one preferred embodiment the cell comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell.

Heterologous insert sequence

The heterologous insert sequence can adapt the secondary structure element of a hairpin with a hairpin loop. The hairpin part comprises sections X_2 and X_4 which are complementary and hybridize to one another. Sections X_2 and X_4 flank section X_3 , which comprises nucleotides that form a loop – the hairpin loop. The term complementary is understood by the person skilled in the art as meaning two sequences compared to each other, nucleotide by nucleotide counting from the 5' end to the 3' end, or vice versa.

The heterologous insert sequence is long enough to allow a hairpin to be completed, but short enough to allow limited translation of an ORF that is present in-frame and immediately 3' to the heterologous insert sequence. Thus, in one embodiment, the heterologous insert sequence comprises 10-50 nucleotides, preferably 10-30 nucleotides, more preferably 15-25 nucleotides, more preferably 17-22 nucleotides, more preferably 18-21 nucleotides, more preferably 18-20 nucleotides, more preferably 19 nucleotides.

X_2 and X_4 may individually consist of any suitable number of nucleotides, so long as a consecutive sequence of at least 4 nucleotides of X_2 is complementary to a consecutive sequence of at least 4 nucleotides of X_4 . In a preferred embodiment X_2 and X_4 consist of the same number of nucleotides.

X_2 may for example consist of in the range of 4 to 25, such as in the range of 4 to 20, for example of in the range of 4 to 15, such as in the range of 6 to 12, for example in

the range of 8 to 12, such as in the range of 9 to 11 nucleotides.

X₄ may for example consist of in the range of 4 to 25, such as in the range of 4 to 20, for example of in the range of 4 to 15, such as in the range of 6 to 12, for example in the range of 8 to 12, such as in the range of 9 to 11 nucleotides.

5 In one preferred embodiment, X₂ consists of a nucleotide sequence, which is complementary to the nucleotide sequence of X₄, i.e. it is preferred that all nucleotides of X₂ are complementary to the nucleotide sequence of X₄.

In one preferred embodiment X₄ consists of a nucleotide sequence, which is complementary to the nucleotide sequence of X₂, i.e. it is preferred that all nucleotides of
10 X₄ are complementary to the nucleotide sequence of X₂. Very preferably, X₂ and X₄ consists of the same number of nucleotides, wherein X₂ is complementary to X₄ over the entire length of X₂ and X₄.

X₃ may be absent, i.e., X₃ may consist of zero nucleotides. It is also possible that X₃ consists of in the range of 1 to 5, such as in the range of 1 to 3 nucleotides.

15 X₁ may be absent, i.e., X₁ may consist of zero nucleotides. It is also possible that X₁ consists of in the range of 1 to 25, such as in the range of 1 to 20, for example in the range of 1 to 15, such as in the range of 1 to 10, for example in the range of 1 to 5, such as in the range of 1 to 3 nucleotides.

X₅ may be absent, i.e., X₅ may consist of zero nucleotides. It is also possible that
20 X₅ may consist of in the range 1 to 5, such as in the range of 1 to 3 nucleotides.

The sequence may be any suitable sequence fulfilling the requirements defined herein above. Thus, the heterologous insert sequence may comprise a sequence selected from the group consisting of SEQ ID NO: 181, SEQ ID NO:182, SEQ ID NO:183, and SEQ ID NO:184. In a preferred embodiment the insert sequence is selected from the
25 group consisting of SEQ ID NO: 181, SEQ ID NO:182, SEQ ID NO:183, and SEQ ID NO:184.

Squalene synthase

Squalene synthase (SQS) is the first committed enzyme of the biosynthesis pathway that leads to the production of sterols. It catalyzes the synthesis of squalene from
30 farnesyl pyrophosphate via the intermediate presqualene pyrophosphate. This enzyme is a

critical branch point enzyme in the biosynthesis of terpenoids/isoprenoids and is thought to regulate the flux of isoprene intermediates through the sterol pathway. The enzyme is sometimes referred to as farnesyl-diphosphate farnesyltransferase (FDFT1).

5 The mechanism of SQS is to convert two units of farnesyl pyrophosphate into squalene.

SQS is considered to be an enzyme of eukaryotes or advanced organisms, although at least one prokaryote has been shown to possess a functionally similar enzyme.

10 In terms of structure and mechanics, squalene synthase most closely resembles phytoene syntase, which serves a similar role in many plants in the elaboration of phytoene, a precursor of many carotenoid compounds.

A high level of sequence identity indicates likelihood that the first sequence is derived from the second sequence. Amino acid sequence identity requires identical amino acid sequences between two aligned sequences. Thus, a candidate sequence sharing 70% amino acid identity with a reference sequence requires that, following alignment, 70% of the amino acids in the candidate sequence are identical to the corresponding amino acids in the reference sequence. Identity may be determined by aid of computer analysis, such as, without limitations, the ClustalW computer alignment program as described in section D. Using this program with its default settings, the mature (bioactive) part of a query and a reference polypeptide are aligned. The number of fully conserved residues are counted and divided by the length of the reference polypeptide. The ClustalW algorithm may similarly be used to align nucleotide sequences. Sequence identities may be calculated in a similar way as indicated for amino acid sequences.

25 In one important embodiment, the cell of the present invention comprises a nucleic acid sequence coding, as defined herein, upon expression for a squalene synthase wherein the squalene synthase is at least 75%, such as at least 76%, such as at least 77%, such as at least 78%, such as at least 79%, such as at least 80%, such as at least 81%, such as at least 82%, such as at least 83%, such as at least 84%, such as at least 85%, such as at least 86%, such as at least 87%, such as at least 88%, such as at least 89%,
30 such as at least 90%, such as at least 91%, such as at least 92%, such as at least 93%,

such as at least 94%, such as at least 95%, such as at least 96%, such as at least 97%,
such as at least 98%, such as at least 99%, such as at least 99.5%, such as at least 99.6%,
such as at least 99.7%, such as at least 99.8%, such as at least 99.9%, such as 100%
identical to a squalene synthase wherein the squalene synthase is selected from the group
5 consisting of SEQ ID NO:192, SEQ ID NO:193, SEQ ID NO:194, SEQ ID NO:195, SEQ
ID NO:196, SEQ ID NO:197, SEQ ID NO:198, SEQ ID NO:199, SEQ ID NO:200, SEQ
ID NO:201, and SEQ ID NO:202.

Promoter

A promoter is a region of DNA that facilitates the transcription of a particular
10 gene. Promoters are located near the genes they regulate, on the same strand and typically
upstream (towards the 5' region of the sense strand). In order for the transcription to take
place, the enzyme that synthesizes RNA, known as RNA polymerase, must attach to the
DNA near a gene. Promoters contain specific DNA sequences and response elements
which provide a secure initial binding site for RNA polymerase and for proteins called
15 transcription factors that recruit RNA polymerase. These transcription factors have
specific activator or repressor sequences of corresponding nucleotides that attach to
specific promoters and regulate gene expressions.

In bacteria, the promoter is recognized by RNA polymerase and an associated
sigma factor, which in turn are often brought to the promoter DNA by an activator
20 protein binding to its own DNA binding site nearby. In eukaryotes the process is more
complicated, and at least seven different factors are necessary for the binding of an RNA
polymerase II to the promoter. Promoters represent critical elements that can work in
concert with other regulatory regions (enhancers, silencers, boundary elements/insulators)
to direct the level of transcription of a given gene.

25 As promoters are normally immediately adjacent to the open reading frame (ORF)
in question, positions in the promoter are designated relative to the transcriptional start
site, where transcription of RNA begins for a particular gene (i.e., positions upstream are
negative numbers counting back from -1, for example -100 is a position 100 base pairs
upstream).

30 *Promoter elements*

- Core promoter - the minimal portion of the promoter required to properly initiate transcription

- o Transcription Start Site (TSS)
- o Approximately -35 bp upstream and/or downstream of the start site
- 5 o A binding site for RNA polymerase
 - RNA polymerase I: transcribes genes encoding ribosomal RNA
 - RNA polymerase II: transcribes genes encoding messenger RNA and certain small nuclear RNAs
 - RNA polymerase III: transcribes genes encoding tRNAs and other
- 10 o General transcription factor binding sites
 - Proximal promoter - the proximal sequence upstream of the gene that tends to contain primary regulatory elements
- o Approximately -250 bp upstream of the start site
- 15 o Specific transcription factor binding sites
 - Distal promoter - the distal sequence upstream of the gene that may contain additional regulatory elements, often with a weaker influence than the proximal promoter
- o Anything further upstream (but not an enhancer or other regulatory region whose influence is positional/orientation independent)
- 20 o Specific transcription factor binding sites

Prokaryotic promoters

In prokaryotes, the promoter consists of two short sequences at -10 and -35 positions upstream from the transcription start site. Sigma factors not only help in enhancing RNAP binding to the promoter but also help RNAP target specific genes to transcribe.

The sequence at -10 is called the Pribnow box, or the -10 element, and usually consists of the six nucleotides TATAAT. The Pribnow box is essential to start transcription in prokaryotes.

30 The other sequence at -35 (the -35 element) usually consists of the seven

nucleotides TTGACAT. Its presence allows a very high transcription rate.

Both of the above consensus sequences, while conserved on average, are not found intact in most promoters. On average only 3 of the 6 base pairs in each consensus sequence is found in any given promoter. No promoter has been identified to date that has
5 intact consensus sequences at both the -10 and -35; artificial promoters with complete conservation of the -10/-35 hexamers has been found to promote RNA chain initiation at very high efficiencies.

Some promoters contain a UP element (consensus sequence 5'-AAAWWTWTTTTNNNAAANN-3'; W = A or T; N = any base) centered at -50; the
10 presence of the -35 element appears to be unimportant for transcription from the UP element-containing promoters.

Eukaryotic promoters

Eukaryotic promoters are typically located upstream of the gene (ORF) and can have regulatory elements several kilobases (kb) away from the transcriptional start site.
15 In eukaryotes, the transcriptional complex can cause the DNA to fold back on itself, which allows for placement of regulatory sequences far from the actual site of transcription. Many eukaryotic promoters, contain a TATA box (sequence TATAAA), which in turn binds a TATA binding protein which assists in the formation of the RNA polymerase transcriptional complex. The TATA box typically lies very close to the
20 transcriptional start site (often within 50 bases).

The cell of the present invention comprises a nucleic acid sequence which comprises a promoter sequence. The promoter sequence is not limiting for the invention and can be any promoter suitable for the host cell of choice.

In one embodiment of the present invention the promoter is a constitutive or
25 inducible promoter.

In a further embodiment of the invention, the promoter is selected from the group consisting of an endogenous promoter, PGK-1, GPD1, PGK1, ADH1, ADH2, PYK1, TPI1, PDC1, TEF1, TEF2, FBA1, GAL1-10, CUP1, MET2, MET14, MET25, CYC1, GAL1-S, GAL1-L, TEF1, ADH1, CAG, CMV, human UbiC, RSV, EF-1alpha, SV40,
30 Mt1, Tet-On, Tet-Off, Mo-MLV-LTR, Mx1, progesterone, RU486 and Rapamycin-

inducible promoter.

Post-transcriptional regulation

Post-transcriptional regulation is the control of gene expression at the RNA level, therefore between the transcription and the translation of the gene.

5 The first instance of regulation is at transcription (transcriptional regulation) where due to the chromatin arrangement and due to the activity of transcription factors, genes are differentially transcribed.

After being produced, the stability and distribution of the different transcripts is regulated (post-transcriptional regulation) by means of RNA binding protein (RBP) that control the various steps and rates of the transcripts: events such as alternative splicing, nuclear degradation (exosome), processing, nuclear export (three alternative pathways), sequestration in DCP2-bodies for storage or degradation, and ultimately translation. These proteins achieve these events thanks to a RNA recognition motif (RRM) that binds a specific sequence or secondary structure of the transcripts, typically at the 5' and 3' UTR of the transcript.

15 Modulating the capping, splicing, addition of a Poly(A) tail, the sequence-specific nuclear export rates and in several contexts sequestration of the RNA transcript occurs in eukaryotes but not in prokaryotes. This modulation is a result of a protein or transcript which in turn is regulated and may have an affinity for certain sequences.

20 *Capping*

Capping changes the five prime end of the mRNA to a three prime end by 5'-5' linkage, which protects the mRNA from 5' exonuclease, which degrades foreign RNA. The cap also helps in ribosomal binding.

Splicing

25 Splicing removes the introns, noncoding regions that are transcribed into RNA, in order to make the mRNA able to create proteins. Cells do this by spliceosomes binding on either side of an intron, looping the intron into a circle and then cleaving it off. The two ends of the exons are then joined together.

Polyadenylation

30 Polyadenylation is the addition of a poly(A) tail to the 3' end, i.e. the poly(A) tail

consists of multiple adenosine monophosphates. The poly-A sequence acts as a buffer to the 3' exonuclease and thus increases half-life of mRNA. In addition, a long poly(A) tail can increase translation. Thus the poly-A tail may be used to further modulate translation of the construct of the present invention, in order to arrive at the optimal translation rate.

5 In eukaryotes, polyadenylation is part of the process that produces mature messenger RNA (mRNA) for translation.

The poly(A) tail is also important for the nuclear export, translation, and stability of mRNA.

10 In one embodiment the nucleic acid sequence of the cell of the present invention, as defined herein above, further comprises a polyadenyl/polyadenylation sequence, preferably the 5' end of said polyadenyl l/polyadenylation sequence is operably linked to the 3' end of the open reading frame, such as to the open reading frame encoding squalene synthase.

RNA editing

15 RNA editing is a process which results in sequence variation in the RNA molecule, and is catalyzed by enzymes. These enzymes include the Adenosine Deaminase Acting on RNA (ADAR) enzymes, which convert specific adenosine residues to inosine in an mRNA molecule by hydrolytic deamination. Three ADAR enzymes have been cloned, ADAR1, ADAR2 and ADAR3, although only the first two subtypes have
20 been shown to have RNA editing activity. Many mRNAs are vulnerable to the effects of RNA editing, including the glutamate receptor subunits GluR2, GluR3, GluR4, GluR5 and GluR6 (which are components of the AMPA and kainate receptors), the serotonin_{2C} receptor, the GABA- α 3 receptor subunit, the tryptophan hydroxylase enzyme TPH2, the hepatitis delta virus and more than 16% of microRNAs. In addition to ADAR
25 enzymes, CDAR enzymes exist and these convert cytosines in specific RNA molecules, to uracil. These enzymes are termed 'APOBEC' and have genetic loci at 22q13, a region close to the chromosomal deletion which occurs in velocardiofacial syndrome (22q11) and which is linked to psychosis. RNA editing is extensively studied in relation to infectious diseases, because the editing process alters viral function.

30 *Post-transcriptional regulatory elements*

Use of a post-transcriptional regulatory elements (PRE) is often necessary to obtain vectors with sufficient performance for certain applications. Schambach et al in Gene Ther. (2006) 13(7):641-5 reports that introduction of a post-transcriptional regulatory element (PRE) of woodchuck hepatitis virus (WHV) into the 3' untranslated region of retroviral and lentiviral gene transfer vectors enhances both titer and transgene expression. The enhancing activity of the PRE depends on the precise configuration of its sequence and the context of the vector and cell into which it is introduced.

Thus use of a PRE such as a woodchuck hepatitis virus post-transcriptional regulatory elements (WPRE) may be useful in the preparation of the cell of the present invention when using a gene therapeutic approach.

Accordingly, in one embodiment the nucleic acid sequence of the cell defined herein further comprises a post-transcriptional regulatory element.

In a further embodiment, the post-transcriptional regulatory element is a Woodchuck hepatitis virus post-transcriptional regulatory element (WPRE).

Terminal repeats

To insert genetic sequences into host DNA, viruses often use sequences of DNA that repeats up to thousands of times, so called repeats, or terminal repeats including long terminal repeats (LTR) and inverted terminal repeats (ITR), wherein said repeat sequences may be both 5' and 3' terminal repeats. ITRs aid in concatamer formation in the nucleus after the single-stranded vector DNA is converted by host cell DNA polymerase complexes into double-stranded DNA. ITR sequences may be derived from viral vectors, such as AAV, e.g. AAV2.

In one embodiment, the nucleic acid sequence or the vector of the cell defined herein comprises a 5' terminal repeat and a 3' terminal repeat.

In one embodiment said 5' and 3' terminal repeats are selected from Inverted Terminal Repeats [ITR] and Long Terminal Repeats [LTR].

In one embodiment of said 5' and 3' terminal repeats are AAV Inverted Terminal Repeats [ITR].

Geranylgeranyl Pyrophosphate Synthase

The microbial cells of the present invention may in preferred embodiments

contain a heterologous nucleic acid sequence encoding Geranylgeranyl Pyrophosphate Synthase (GGPPS). See, e.g., Table 7. GGPPS is an enzyme, which catalyzes the chemical reaction that turns one farnesyl pyrophosphate (FPP) molecule into one Geranylgeranyl Pyrophosphate (GGPP) molecule. Genes encoding GGPPS may for example be found in organisms that contain the mevalonate pathway.

The GGPPS to be used with the present invention may be any useful enzyme, which is capable of catalysing conversion of a farnesyl pyrophosphate (FPP) molecule into a Geranylgeranyl Pyrophosphate (GGPP) molecule. In particular, the GGPPS to be used with the present invention may be any enzyme capable of catalysing the following reaction:

(2E,6E)-farnesyl diphosphate + isopentenyl diphosphate $\rightarrow$ diphosphate + geranylgeranyl diphosphate.

It is preferred that the GGPPS used with the present invention is an enzyme categorised under EC 2.5.1.29.

The GGPPS may be GGPPS from a variety of sources, such as from bacteria, fungi or mammals. The GGPPS may be any kind of GGPPS, for example GGPPS-1, GGPPS-2, GGPPS-3 or GGPPS-4. The GGPPS may be wild type GGPPS or a functional homologue thereof.

For example, the GGPPS may be GGPPS-1 of *S. acidicaldarius* (SEQ ID NO: 126), GGPPS-2 of *A. nidulans* (SEQ ID NO: 203), GGPPS-3 of *S. cerevisiae* (SEQ ID NO: 167) or GGPPS-4 of *M. musculus* (SEQ ID NO: 123) or a functional homologue of any of the aforementioned.

The heterologous nucleic acid encoding said GGPPS may be any nucleic acid sequence encoding said GGPPS. Thus, in embodiments of the invention where GGPPS is a wild type protein, the nucleic acid sequence may for example be a wild type cDNA sequence encoding said protein. However, it is frequently the case that the heterologous nucleic acid is nucleic acid sequence encoding any particular GGPPS, where said nucleic acid has been codon optimised for the particular microbial cell. Thus, by way of example, if the microbial cell is *S. cerevisiae*, then the nucleic acid encoding GGPPS has preferably been codon optimised for optimal expression in *S. cerevisiae*.

Functional homologues of GGPPS are preferably protein having above-mentioned activity and sharing at least 70% amino acid identity with the sequence of a reference GGPPS. Methods for determining sequence identity are described herein above in the section "Squalene synthase" and in section D.

5 In one embodiment, the cell, such as the microbial of the present invention comprises a nucleic acid sequence coding a GGPPS or a functional homologue thereof, where said functional homologue is at least 75%, such as at least 76%, such as at least 77%, such as at least 78%, such as at least 79%, such as at least 80%, such as at least 81%, such as at least 82%, such as at least 83%, such as at least 84%, such as at least 10 85%, such as at least 86%, such as at least 87%, such as at least 88%, such as at least 89%, such as at least 90%, such as at least 91%, such as at least 92%, such as at least 93%, such as at least 94%, such as at least 95%, such as at least 96%, such as at least 97%, such as at least 98%, such as at least 99%, such as at least 99.5%, such as at least 99.6%, such as at least 99.7%, such as at least 99.8%, such as at least 99.9%, such as 15 100% identical to a GGPPS selected from the group consisting of SEQ ID NO:123, SEQ ID NO:126, SEQ ID NO:167 and SEQ ID NO:203.

Said heterologous nucleic acid sequence encoding a GGPPS is in general operably linked to a nucleic acid sequence directing expression of GGPPS in the microbial cell. The nucleic acid sequence directing expression of GGPPS in the microbial 20 cell may be a promoter sequence, and preferably said promoter sequence is selected according the particular microbial cell. The promoter may for example be any of the promoters described herein above in the section "Promoter"

Vectors

A vector is a DNA molecule used as a vehicle to transfer foreign genetic material 25 into another cell. The major types of vectors are plasmids, viruses, cosmids, and artificial chromosomes. Common to all engineered vectors is an origin of replication, a multicloning site, and a selectable marker.

The vector itself is generally a DNA sequence that consists of an insert (transgene) and a larger sequence that serves as the "backbone" of the vector. The 30 purpose of a vector which transfers genetic information to another cell is typically to

isolate, multiply, or express the insert in the target cell. Vectors called expression vectors (expression constructs) specifically are for the expression of the transgene in the target cell, and generally have a promoter sequence that drives expression of the transgene. Simpler vectors called transcription vectors are only capable of being transcribed but not translated: they can be replicated in a target cell but not expressed, unlike expression vectors. Transcription vectors are used to amplify their insert.

Insertion of a vector into the target cell is usually called transformation for bacterial cells, transfection for eukaryotic cells, although insertion of a viral vector is often called transduction.

Plasmids

Plasmid vectors are double-stranded generally circular DNA sequences that are capable of automatically replicating in a host cell. Plasmid vectors minimalistically consist of an origin of replication that allows for semi-independent replication of the plasmid in the host and also the transgene insert. Modern plasmids generally have many more features, notably including a "multiple cloning site" which includes nucleotide overhangs for insertion of an insert, and multiple restriction enzyme consensus sites to either side of the insert. In the case of plasmids utilized as transcription vectors, incubating bacteria with plasmids generates hundreds or thousands of copies of the vector within the bacteria in hours, and the vectors can be extracted from the bacteria, and the multiple cloning site can be cut by restriction enzymes to excise the hundredfold or thousandfold amplified insert. These plasmid transcription vectors characteristically lack crucial sequences that code for polyadenylation sequences and translation termination sequences in translated mRNAs, making protein expression from transcription vectors impossible. plasmids may be conjugative/transmissible and non-conjugative:

- conjugative: mediate DNA transfer through conjugation and therefore spread rapidly among the bacterial cells of a population; e.g., F plasmid, many R and some col plasmids.
- nonconjugative- do not mediate DNA through conjugation, e.g., many R and col plasmids.

Viral vectors

Viral vectors are generally genetically-engineered viruses carrying modified viral DNA or RNA that has been rendered noninfectious, but still contain viral promoters and also the transgene, thus allowing for translation of the transgene through a viral promoter. However, because viral vectors frequently are lacking infectious sequences, they require helper viruses or packaging lines for large-scale transfection. Viral vectors are often designed for permanent incorporation of the insert into the host genome, and thus leave distinct genetic markers in the host genome after incorporating the transgene. For example, retroviruses leave a characteristic retroviral integration pattern after insertion that is detectable and indicates that the viral vector has incorporated into the host genome.

In one embodiment the invention concerns a viral vector capable of transfecting a host cell, such as a cell that can be cultured, e.g. a yeast cell or any other suitable eukaryotic cell. The vector is then capable of transfecting said cell with a nucleic acid that includes the heterologous insert sequence as described herein.

The viral vector can be any suitable viral vector such as a viral vector selected from the group consisting of vectors derived from the Retroviridae family including lentivirus, HIV, SIV, FIV, EAIV, CIV.

The viral vector may also be selected from the group consisting of alphavirus, adenovirus, adeno associated virus, baculovirus, HSV, coronavirus, Bovine papilloma virus, Mo-MLV and adeno associated virus.

In embodiments of the invention wherein the microbial cell comprises a heterologous nucleic acid encoding GGPPS, then said heterologous nucleic acid may be positioned on the vector also containing the nucleic acid encoding squalene synthase, or the heterologous nucleic acid encoding GGPPS may be positioned on a different vector. Said heterologous nucleic acid encoding GGPPS may be contained in any of the vectors described herein above.

In embodiments of the invention wherein the microbial cell comprises a heterologous nucleic acid encoding HMCR, then said heterologous nucleic acid may be positioned on the vector also containing the nucleic acid encoding squalene synthase, or the heterologous nucleic acid encoding HMCR may be positioned on a different vector.

Said heterologous nucleic acid encoding HMCR may be contained in any of the vectors described herein above. It is also contained within the invention that the heterologous nucleic acid encoding GGPPS and the heterologous nucleic acid encoding HMCR may be positioned on the same or on individual vectors.

5 *Transcription*

Transcription is a necessary component in all vectors: the premise of a vector is to multiply the insert (although expression vectors later also drive the translation of the multiplied insert). Thus, even stable expression is determined by stable transcription, which generally depends on promoters in the vector. However, expression vectors have a variety of expression patterns: constitutive (consistent expression) or inducible (expression only under certain conditions or chemicals). This expression is based on different promoter activities, not post-transcriptional activities. Thus, these two different types of expression vectors depend on different types of promoters.

15 Viral promoters are often used for constitutive expression in plasmids and in viral vectors because they normally reliably force constant transcription in many cell lines and types.

Inducible expression depends on promoters that respond to the induction conditions: for example, the murine mammary tumor virus promoter only initiates transcription after dexamethasone application and the Drosophila heat shock promoter only initiates after high temperatures. transcription is the synthesis of mRNA. Genetic information is copied from DNA to RNA

20 *Expression*

Expression vectors require sequences that encode for e.g. polyadenylation tail (see herein above): Creates a polyadenylation tail at the end of the transcribed pre-mRNA that protects the mRNA from exonucleases and ensures transcriptional and translational termination: stabilizes mRNA production.

Minimal UTR length: UTRs contain specific characteristics that may impede transcription or translation, and thus the shortest UTRs or none at all are encoded for in optimal expression vectors.

Kozak sequence: Vectors should encode for a Kozak sequence in the mRNA, which assembles the ribosome for translation of the mRNA.

Above conditions are necessary for expression vectors in eukaryotes but not in prokaryotes.

5 Modern vectors may encompass additional features besides the transgene insert and a backbone such as a promoter (discussed above), genetic markers to e.g. allow for confirmation that the vector has integrated with the host genomic DNA, antibiotic resistance genes for antibiotic selection, and affinity tags for purification.

10 In one embodiment the cell of the present invention comprises a nucleic acid sequence integrated in a vector such as an expression vector.

In one embodiment the the vector is selected from the group consisting of plasmid vectors, cosmids, artificial chromosomes and viral vectors.

The plasmid vector should be able to be maintained and replicated in bacteria, fungi and yeast.

15 The present invention also concerns cells comprising plasmid and cosmid vectors as well as artificial chromosome vectors.

The important factor is that the vector is functional and that the vector comprises at least the nucleic acid sequence comprising the heterologous insert sequence as described herein.

20 In one embodiment the vector is functional in fungi and in mammalian cells.

In one embodiment the invention concerns a cell transformed or transduced with the vector as defined herein above.

Methods for producing terpenoids

25 As mentioned herein above, the cell of the present invention (e.g., recombinant host cells) is useful in enhancing yield of industrially relevant terpenoids.

The cell of the invention may therefore be used in various set-ups in order to increase accumulation of terpenoid precursors and thus to increase yield of terpenoid products resulting from enzymatic conversion of said (upstream) terpenoid precursors.

Accordingly, in one aspect the present invention relates to a method for producing a terpenoid compound synthesized through the squalene pathway, in a cell culture, said method comprising the steps of

- (a) providing the cell as defined herein above,
- 5 (b) culturing the cell of (a).
- (c) recovering the terpenoid product compound.

By providing the cell comprising the genetically modified construct defined herein above, the accumulation of terpenoid precursors is enhanced (FIG. 20).

Thus, in another aspect, the invention relates to a method for producing a terpenoid derived from a terpenoid precursor selected from the group consisting of Farnesyl-pyrophosphate (FPP), Isopentenyl-pyrophosphate (IPP), Dimethylallyl-pyrophosphate (DMAPP), Geranyl-pyrophosphate (GPP) and/or Geranylgeranyl-pyrophosphate (GGPP), said method comprising:

- (a) contacting said precursor with an enzyme of the squalene synthase pathway,
- 15 (b) recovering the terpenoid product.

In one embodiment the terpenoid (product) of the method of the present invention as defined herein above, is selected from the group consisting of hemiterpenoids, monoterpenes, sesquiterpenoids, diterpenoids, sesterpenes, triterpenoids, tetraterpenoids and polyterpenoids.

In a further embodiment the terpenoid is selected from the group consisting of farnesyl phosphate, farnesol, geranylgeranyl, geranylgeraniol, isoprene, prenol, isovaleric acid, geranyl pyrophosphate, eucalyptol, limonene, pinene, farnesyl pyrophosphate, artemisinin, bisabolol, geranylgeranyl pyrophosphate, retinol, retinal, phytol, taxol , forskolin, aphidicolin, lanosterol, lycopene and carotene.

The terpenoid product can be used as starting point in an additional refining process. Thus, in one embodiment said method further comprises dephosphorylating the farnesyl phosphate to produce farnesol.

The enzyme or enzymes used in the process of preparing the target product terpenoid compound is preferably an enzyme “located downstream” of the terpenoid

precursors Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and Geranylgeranyl-pyrophosphate such as an enzyme located downstream of the terpenoid precursors Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and Geranylgeranyl-pyrophosphate depicted in the squalene pathway of FIG. 20. The enzyme used in the process of preparing the target product terpenoid, based on the accumulation of precursors achieved through the present invention, may thus be selected from the group consisting of Dimethylallyltransferase (EC 2.5.1.1), Isoprene synthase (EC 4.2.3.27) and Geranyltransferase (EC 2.5.1.10).

The present invention may operate by at least partly, sterically hindering binding of the ribosome to the RNA thus reducing the translation of squalene synthase. Accordingly, in one aspect the present invention relates to a method for reducing the translation rate of a functional squalene synthase (EC 2.5.1.21) said method comprising:

- (a) providing the cell defined herein above,
- (b) culturing the cell of (a).

Similarly, the invention in another aspect relates to a method for decreasing turnover of farnesyl-pp to squalene, said method comprising:

- (a) providing the cell defined herein above,
- (b) culturing the cell of (a).

As depicted in FIG. 20, the knocking down of the ERG9 results in build-up of precursors to squalene synthase. Thus in one aspect, the present invention relates to a method for enhancing accumulation of a compound selected from the group consisting of Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and Geranylgeranyl-pyrophosphate, said method comprising the steps of:

- (a) providing the cell defined herein above, and
- (b) culturing the cell of (a).

In one embodiment the method of the invention as define herein above further comprises recovering the Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate or Geranylgeranyl-pyrophosphate

compound. The recovered compound may be used in further processes for producing the desired terpenoid product compound. The further process may take place in the same cell culture as the process performed and defined herein above, such as the accumulation of the terpenoid precursors by the cell of the present invention. Alternatively, the recovered
5 precursors may be added to another cell culture, or a cell free system, to produce the desired products.

As the precursors are intermediates, however mainly stable intermediates, a certain endogenous production of terpenoid products may occur based on the terpenoid precursor substrates. Also, the cells of the invention may have additional genetic
10 modifications such that they are capable of performing both the accumulation of the terpenoid precursors (construct of the cell of the invention) and whole or substantially the whole subsequent biosynthesis process to the desired terpenoid product.

Thus, in one embodiment the method of the invention further comprises recovering a compound synthesized through the squalene pathway, said compound being
15 derived from said Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and/or Geranylgeranyl-pyrophosphate. Occasionally it may be advantageous to include a squalene synthase inhibitor when culturing the cell of the present invention. Chemical inhibition of squalene synthase, e.g. by lapaquistat, is known in the art and is under investigation e.g. as a method of lowering
20 cholesterol levels in the prevention of cardiovascular disease. It has also been suggested that variants in this enzyme may be part of a genetic association with hypercholesterolemia. Other squalene synthase inhibitors include Zaragozic acid and RPR 107393.

Thus, in one embodiment the culturing step of the method(s) defined herein above
25 is performed in the presence of a squalene synthase inhibitor.

The cell of the invention may furthermore be genetically modified to further enhance production of certain key terpenoid precursors. In one embodiment the cell is additionally genetically modified to enhance activity of and/or overexpress one or more enzymes selected from the group consisting of Phosphomevalonate kinase (EC 2.7.4.2),
30 Diphosphomevalonate decarboxylase (EC 4.1.1.33), 4-hydroxy-3-methylbut-2-en-1-yl

diphosphate synthase (EC 1.17.7.1), 4-hydroxy-3-methylbut-2-enyl diphosphate reductase (EC 1.17.1.2), Isopentenyl-diphosphate Delta-isomerase 1 (EC 5.3.3.2), Short-chain Z-isoprenyl diphosphate synthase (EC 2.5.1.68), Dimethylallyltransferase (EC 2.5.1.1), Geranyltranstransferase (EC 2.5.1.10) and Geranylgeranyl pyrophosphate synthetase (EC 2.5.1.29).

As described herein above in one embodiment of the invention the microbial cell comprises both a nucleic acid encoding a squalene synthase as described herein above as well as a heterologous nucleic acid encoding a GGPPS. Such microbial cells are particularly useful for the preparation of GGPP as well as terpenoids, wherein GGPP is an intermediate in their biosynthesis.

Accordingly, in one aspect the invention relates to a method for preparing GGPP, wherein the method comprises the steps of

a. providing a microbial cell comprising a nucleic acid sequence, said nucleic acid comprising

- i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to
- iii) an open reading frame operably linked to
- iv) a transcription termination signal,

wherein the heterologous insert sequence and the open reading

frame are as defined herein above,

wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell;

b. Cultivating the microbial cell of a.;

c. Recovering the GGPP.

In another aspect the invention relates to a method for preparing a terpenoid of which GGPP is an intermediate in the biosynthesis pathway, wherein the method comprises the steps of

a. providing a microbial cell, wherein said microbial cell comprises a nucleic acid sequence, said nucleic acid comprising

- i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to
- iii) an open reading frame operably linked to
- iv) a transcription termination signal,

5 wherein the heterologous insert sequence and the open reading frame are as defined herein above,

 wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell;

10 b. Cultivating the microbial cell of a; and

 c. Recovering the terpenoid,

 wherein said terpenoid may be any terpenoid described herein above in the section “Terpenoids” having GGPP as intermediate in its biosyntheses; and said microbial cell may be any of the microbial cells described herein above in the section “The cell”; and
15 said promoter may be any promoter, such as any of the promoters described herein above in the section “Promoter”; and said heterologous insert sequence may be any of the heterologous insert sequences described herein above in the section “Heterologous insert sequence”; and said open reading frame encodes a squalene synthase, which may be any of the squalene synthases described herein above in the section “Squalene synthase”; and
20 said GGPPS may be any of the GGPPS described herein above in the section “Geranylgeranyl Pyrophosphate Synthase”.

 In this embodiment said microbial cell may also optionally contain one or more additional heterologous nucleic acids encoding one or more enzymes involved in the biosynthesis pathway of said terpenoid.

25 In one particular aspect the invention relates to a method for preparing steviol, wherein the method comprises the steps of

 a. providing a microbial cell, wherein said microbial cell comprises a nucleic acid sequence, said nucleic acid comprising

- 30 i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to

iii) an open reading frame operably linked to

iv) a transcription termination signal,

wherein the heterologous insert sequence and the open reading frame are as defined herein above,

5 wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell;

b. Cultivating the microbial cell of a.;

c. Recovering steviol,

10 wherein said microbial cell may be any of the microbial cells described herein above in the section "The cell"; and said promoter may be any promoter, such as any of the promoters described herein above in the section "Promoter"; and said heterologous insert sequence may be any of the heterologous insert sequences described herein above in the section "Heterologous insert sequence"; and said open reading frame encodes a squalene
15 synthase, which may be any of the squalene synthases described herein above in the section "Squalene synthase"; and said GGPPS may be any of the GGPPS described herein above in the section "Geranylgeranyl Pyrophosphate Synthase".

In this embodiment said microbial cell may also optionally contain one or more additional heterologous nucleic acids encoding one or more enzymes involved in the
20 biosynthesis pathway of steviol.

In another aspect the invention relates to a method for preparing a terpenoid of which GGPP is an intermediate in the biosynthesis pathway, wherein the method comprises the steps of

a. providing a microbial cell, wherein said microbial cell comprises a nucleic
25 acid sequence, said nucleic acid comprising

i) a promoter sequence operably linked to

ii) a heterologous insert sequence operably linked to

iii) an open reading frame operably linked to

iv) a transcription termination signal,

wherein the heterologous insert sequence and the open reading frame are as defined herein above,

wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell

and wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding HMCR operably linked to a nucleic acid sequence directing expression of HMCR in said cell;

b. Cultivating the microbial cell of a.;

c. Recovering the terpenoid,

wherein said terpenoid may be any terpenoid described herein above in the section

“Terpenoids” having GGPP as intermediate in its biosynthesises; and said microbial cell may be any of the microbial cells described herein above in the section “The cell”; and said promoter may be any promoter, such as any of the promoters described herein above in the section “Promoter”; and said heterologous insert sequence may be any of the heterologous insert sequences described herein above in the section “Heterologous insert sequence”; and said open reading frame encodes a squalene synthase, which may be any of the squalene synthases described herein above in the section “Squalene synthase”; and said GGPPS may be any of the GGPPS described herein above in the section “Geranylgeranyl Pyrophosphate Synthase”; and said HMCR may be any of the HMCR described herein above in the section “HMCR”.

In this embodiment said microbial cell may also optionally contain one or more additional heterologous nucleic acids encoding one or more enzymes involved in the biosynthesis pathway of said terpenoid.

In one particular aspect the invention relates to a method for preparing steviol, wherein the method comprises the steps of

a. providing a microbial cell, wherein said microbial cell comprises a nucleic acid sequence, said nucleic acid comprising

i) a promoter sequence operably linked to

ii) a heterologous insert sequence operably linked to

iii) an open reading frame operably linked to

iv) a transcription termination signal,

wherein the heterologous insert sequence and the open reading frame are as defined herein above,

5 wherein said microbial cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell;

b. Cultivating the microbial cell of a.;

c. Recovering steviol,

10 wherein said microbial cell may be any of the microbial cells described herein above in the section "The cell"; and said promoter may be any promoter, such as any of the promoters described herein above in the section "Promoter"; and said heterologous insert sequence may be any of the heterologous insert sequences described herein above in the section "Heterologous insert sequence"; and said open reading frame encodes a squalene
15 synthase, which may be any of the squalene synthases described herein above in the section "Squalene synthase"; and said GGPPS may be any of the GGPPS described herein above in the section "Geranylgeranyl Pyrophosphate Synthase" and said HMCR may be any of the HMCR described herein above in the section "HMCR".

In this embodiment said microbial cell may also optionally contain one or more
20 additional heterologous nucleic acids encoding one or more enzymes involved in the biosynthesis pathway of steviol.

In one embodiment the cell is additionally genetically modified to enhance activity of and/or overexpress one or more enzymes selected from the group consisting of acetoacetyl CoA thiolase, HMG-CoA reductase or the catalytic domain thereof, HMG-
25 CoA synthase, mevalonate kinase, phosphomevalonate kinase, phosphomevalonate decarboxylase, isopentenyl pyrophosphate isomerase, farnesyl pyrophosphate synthase, D-1-deoxyxylulose 5-phosphate synthase, and 1-deoxy-D-xylulose 5-phosphate reductoisomerase and farnesyl pyrophosphate synthase.

In one embodiment of the method of the present invention, the cell comprises a
30 mutation in the ERG9 open reading frame.

In another embodiment of the method of the present invention the cell comprises an ERG9[Delta]::HIS3 deletion/insertion allele.

In yet another embodiment the step of recovering the compound in the method of the present invention further comprises purification of said compound from the cell culture media.

D. Functional Homologs

Functional homologs of the polypeptides described above are also suitable for use in producing steviol or steviol glycosides in a recombinant host. A functional homolog is a polypeptide that has sequence similarity to a reference polypeptide, and that carries out one or more of the biochemical or physiological function(s) of the reference polypeptide. A functional homolog and the reference polypeptide may be natural occurring polypeptides, and the sequence similarity may be due to convergent or divergent evolutionary events. As such, functional homologs are sometimes designated in the literature as homologs, or orthologs, or paralogs. Variants of a naturally occurring functional homolog, such as polypeptides encoded by mutants of a wild type coding sequence, may themselves be functional homologs. Functional homologs can also be created via site-directed mutagenesis of the coding sequence for a polypeptide, or by combining domains from the coding sequences for different naturally-occurring polypeptides (“domain swapping”). Techniques for modifying genes encoding functional UGT polypeptides described herein are known and include, *inter alia*, directed evolution techniques, site-directed mutagenesis techniques and random mutagenesis techniques, and can be useful to increase specific activity of a polypeptide, alter substrate specificity, alter expression levels, alter subcellular location, or modify polypeptide:polypeptide interactions in a desired manner. Such modified polypeptides are considered functional homologs. The term “functional homolog” is sometimes applied to the nucleic acid that encodes a functionally homologous polypeptide.

Functional homologs can be identified by analysis of nucleotide and polypeptide sequence alignments. For example, performing a query on a database of nucleotide or polypeptide sequences can identify homologs of steviol or steviol glycoside biosynthesis

polypeptides. Sequence analysis can involve BLAST, Reciprocal BLAST, or PSI-BLAST analysis of nonredundant databases using a GGPPS, a CDPS, a KS, a KO or a KAH amino acid sequence as the reference sequence. Amino acid sequence is, in some instances, deduced from the nucleotide sequence. Those polypeptides in the database that have greater than 40% sequence identity are candidates for further evaluation for suitability as a steviol or steviol glycoside biosynthesis polypeptide. Amino acid sequence similarity allows for conservative amino acid substitutions, such as substitution of one hydrophobic residue for another or substitution of one polar residue for another. If desired, manual inspection of such candidates can be carried out in order to narrow the number of candidates to be further evaluated. Manual inspection can be performed by selecting those candidates that appear to have domains present in steviol biosynthesis polypeptides, *e.g.*, conserved functional domains.

Conserved regions can be identified by locating a region within the primary amino acid sequence of a steviol or a steviol glycoside biosynthesis polypeptide that is a repeated sequence, forms some secondary structure (*e.g.*, helices and beta sheets), establishes positively or negatively charged domains, or represents a protein motif or domain. See, *e.g.*, the Pfam web site describing consensus sequences for a variety of protein motifs and domains on the World Wide Web at sanger.ac.uk/Software/Pfam/ and pfam.janelia.org/. The information included at the Pfam database is described in Sonnhammer *et al.*, Nucl. Acids Res., 26:320-322 (1998); Sonnhammer *et al.*, Proteins, 28:405-420 (1997); and Bateman *et al.*, Nucl. Acids Res., 27:260-262 (1999). Conserved regions also can be determined by aligning sequences of the same or related polypeptides from closely related species. Closely related species preferably are from the same family. In some embodiments, alignment of sequences from two different species is adequate.

Typically, polypeptides that exhibit at least about 40% amino acid sequence identity are useful to identify conserved regions. Conserved regions of related polypeptides exhibit at least 45% amino acid sequence identity (*e.g.*, at least 50%, at least 60%, at least 70%, at least 80%, or at least 90% amino acid sequence identity). In some embodiments, a conserved region exhibits at least 92%, 94%, 96%, 98%, or 99% amino acid sequence identity.

For example, polypeptides suitable for producing steviol glycosides in a recombinant host include functional homologs of EUGT11, UGT91D2e, UGT91D2m, UGT85C, and UGT76G. Such homologs have greater than 90% (e.g., at least 95% or 99%) sequence identity to the amino acid sequence of EUGT11 (SEQ ID NO: 152),
5 UGT91D2e (SEQ ID NO:5), UGT91D2m (SEQ ID NO:10), UGT85C (SEQ ID NO:3), or UGT76G (SEQ ID NO:7). Variants of EUGT11, UGT91D2, UGT85C, and UGT76G polypeptides typically have 10 or fewer amino acid substitutions within the primary amino acid sequence, e.g., 7 or fewer amino acid substitutions, 5 or conservative amino acid substitutions, or between 1 and 5 substitutions. However, in some embodiments,
10 variants of EUGT11, UGT91D2, UGT85C, and UGT76G polypeptides can have 10 or more amino acid substitutions (e.g., 10, 15, 20, 25, 30, 35, 10-20, 10-35, 20-30, or 25-35 amino acid substitutions). The substitutions may be conservative, or in some embodiments, non-conservative. Non-limiting examples of non-conservative changes in UGT91D2e polypeptides include glycine to arginine and tryptophan to arginine. Non-
15 limiting examples of non-conservative substitutions in UGT76G polypeptides include valine to glutamic acid, glycine to glutamic acid, glutamine to alanine, and serine to proline. Non-limiting examples of changes to UGT85C polypeptides include histidine to aspartic acid, proline to serine, lysine to threonine, and threonine to arginine.

In some embodiments, a useful UGT91D2 homolog can have amino acid
20 substitutions (e.g., conservative amino acid substitutions) in regions of the polypeptide that are outside of predicted loops, e.g., residues 20-26, 39-43, 88-95, 121-124, 142-158, 185-198, and 203-214 are predicted loops in the N-terminal domain and residues 381-386 are predicted loops in the C-terminal domain of SEQ ID NO:5. For example, a useful UGT91D2 homolog can include at least one amino acid substitution at residues 1-19, 27-
25 38, 44-87, 96-120, 125-141, 159-184, 199-202, 215-380, or 387-473 of SEQ ID NO:5. In some embodiments, a UGT91D2 homolog can have an amino acid substitution at one or more residues selected from the group consisting of residues 30, 93, 99, 122, 140, 142, 148, 153, 156, 195, 196, 199, 206, 207, 211, 221, 286, 343, 427, and 438 of SEQ ID NO:5. For example, a UGT91D2 functional homolog can have an amino acid
30 substitution at one or more of residues 206, 207, and 343, such as an arginine at residue

206, a cysteine at residue 207, and an arginine at residue 343 of SEQ ID NO:5. See, SEQ ID NO:95. Other functional homologs of UGT91D2 can have one or more of the following: a tyrosine or phenylalanine at residue 30, a proline or glutamine at residue 93, a serine or valine at residue 99, a tyrosine or a phenylalanine at residue 122, a histidine or tyrosine at residue 140, a serine or cysteine at residue 142, an alanine or threonine at residue 148, a methionine at residue 152, an alanine at residue 153, an alanine or serine at residue 156, a glycine at residue 162, a leucine or methionine at residue 195, a glutamic acid at residue 196, a lysine or glutamic acid at residue 199, a leucine or methionine at residue 211, a leucine at residue 213, a serine or phenylalanine at residue 221, a valine or isoleucine at residue 253, a valine or alanine at residue 286, a lysine or asparagine at residue 427, an alanine at residue 438, and either an alanine or threonine at residue 462 of SEQ ID NO:5. In another embodiment, a UGT91D2 functional homolog contains a methionine at residue 211 and an alanine at residue 286.

In some embodiments, a useful UGT85C homolog can have one or more amino acid substitutions at residues 9, 10, 13, 15, 21, 27, 60, 65, 71, 87, 91, 220, 243, 270, 289, 298, 334, 336, 350, 368, 389, 394, 397, 418, 420, 440, 441, 444, and 471 of SEQ ID NO:3. Non-limiting examples of useful UGT85C homologs include polypeptides having substitutions (with respect to SEQ ID NO:3) at residue 65 (e.g., a serine at residue 65), at residue 65 in combination with residue 15 (a leucine at residue 15), 270 (e.g., a methionine, arginine, or alanine at residue 270), 418 (e.g., a valine at residue 418), 440 (e.g., an aspartic acid at residue at residue 440), or 441 (e.g., an asparagine at residue 441); residues 13 (e.g., a phenylalanine at residue 13), 15, 60 (e.g., an aspartic acid at residue 60), 270, 289 (e.g., a histidine at residue 289), and 418; substitutions at residues 13, 60, and 270; substitutions at residues 60 and 87 (e.g., a phenylalanine at residue 87); substitutions at residues 65, 71 (e.g., a glutamine at residue 71), 220 (e.g., a threonine at residue 220), 243 (e.g., a tryptophan at residue 243), and 270; substitutions at residues 65, 71, 220, 243, 270, and 441; substitutions at residues 65, 71, 220, 389 (e.g., a valine at residue 389), and 394 (e.g., a valine at residue 394); substitutions at residues 65, 71, 270, and 289; substitutions at residues 220, 243, 270, and 334 (e.g., a serine at residue 334); or substitutions at residues 270 and 289. The following amino acid mutations did not result

in a loss of activity in 85C2 polypeptides: V13F, F15L, H60D, A65S, E71Q, I87F, K220T, R243W, T270M, T270R, Q289H, L334S, A389V, I394V, P397S, E418V, G440D, and H441N. Additional mutations that were seen in active clones include K9E, K10R, Q21H, M27V, L91P, Y298C, K350T, H368R, G420R, L431P, R444G, and
 5 M471T. In some embodiments, an UGT85C2 contains substitutions at positions 65 (e.g., a serine), 71 (a glutamine), 270 (a methionine), 289 (a histidine), and 389 (a valine).

The amino acid sequence of *Stevia rebaudiana* UGTs 74G1, 76G1 and 91D2e with N-terminal, in-frame fusions of the first 158 amino acids of human MDM2 protein, and *Stevia rebaudiana* UGT85C2 with an N-terminal in-frame fusion of 4 repeats of the
 10 synthetic PMI peptide (4 X TSFAEYWNLLSP, SEQ ID NO:86) are set forth in SEQ ID NOs: 90, 88, 94, and 92, respectively; see SEQ ID NOs: 89, 92, 93, and 95 for the nucleotide sequences encoding the fusion proteins.

In some embodiments, a useful UGT76G homolog can have one or more amino acid substitutions at residues 29, 74, 87, 91, 116, 123, 125, 126, 130, 145, 192, 193, 194,
 15 196, 198, 199, 200, 203, 204, 205, 206, 207, 208, 266, 273, 274, 284, 285, 291, 330, 331, and 346 of SEQ ID NO:7. Non-limiting examples of useful UGT76G homologs include polypeptides having substitutions (with respect to SEQ ID NO:7) at residues 74, 87, 91, 116, 123, 125, 126, 130, 145, 192, 193, 194, 196, 198, 199, 200, 203, 204, 205, 206, 207, 208, and 291; residues 74, 87, 91, 116, 123, 125, 126, 130, 145, 192, 193, 194, 196, 198,
 20 199, 200, 203, 204, 205, 206, 207, 208, 266, 273, 274, 284, 285, and 291; or residues 74, 87, 91, 116, 123, 125, 126, 130, 145, 192, 193, 194, 196, 198, 199, 200, 203, 204, 205, 206, 207, 208, 266, 273, 274, 284, 285, 291, 330, 331, and 346. See, Table 9.

Table 9

Clone	Mutations
76G_G7	M29I, V74E, V87G, L91P, G116E, A123T, Q125A, I126L, T130A, V145M, C192S, S193A, F194Y, M196N, K198Q, K199I, Y200L, Y203I, F204L, E205G, N206K, I207M, T208I, P266Q, S273P, R274S, G284T, T285S, 287-3 bp deletion, L330V, G331A, L346I
76G_H12	M29I, V74E, V87G, L91P, G116E, A123T, Q125A, I126L, T130A, V145M, C192S, S193A, F194Y, M196N, K198Q, K199I, Y200L,

	Y203I, F204L, E205G, N206K, I207M, T208I, P266Q, S273P, R274S, G284T, T285S, 287-3 bp deletion
76G_C4	M29I, V74E, V87G, L91P, G116E, A123T, Q125A, I126L, T130A, V145M, C192S, S193A, F194Y, M196N, K198Q, K199I, Y200L, Y203I, F204L, E205G, N206K, I207M, T208I

Methods to modify the substrate specificity of, for example, EUGT11 or UGT91D2e, are known to those skilled in the art, and include without limitation site-directed/rational mutagenesis approaches, random directed evolution approaches and combinations in which random mutagenesis/saturation techniques are performed near the active site of the enzyme. For example see Sarah A. Osmani, et al. *Phytochemistry* 70 (2009) 325–347.

A candidate sequence typically has a length that is from 80 percent to 200 percent of the length of the reference sequence, *e.g.*, 82, 85, 87, 89, 90, 93, 95, 97, 99, 100, 105, 110, 115, 120, 130, 140, 150, 160, 170, 180, 190, or 200 percent of the length of the reference sequence. A functional homolog polypeptide typically has a length that is from 95 percent to 105 percent of the length of the reference sequence, *e.g.*, 90, 93, 95, 97, 99, 100, 105, 110, 115, or 120 percent of the length of the reference sequence, or any range between. A percent identity for any candidate nucleic acid or polypeptide relative to a reference nucleic acid or polypeptide can be determined as follows. A reference sequence (*e.g.*, a nucleic acid sequence or an amino acid sequence) is aligned to one or more candidate sequences using the computer program ClustalW (version 1.83, default parameters), which allows alignments of nucleic acid or polypeptide sequences to be carried out across their entire length (global alignment). Chenna *et al.*, *Nucleic Acids Res.*, 31(13):3497-500 (2003).

ClustalW calculates the best match between a reference and one or more candidate sequences, and aligns them so that identities, similarities and differences can be determined. Gaps of one or more residues can be inserted into a reference sequence, a candidate sequence, or both, to maximize sequence alignments. For fast pairwise alignment of nucleic acid sequences, the following default parameters are used: word

size: 2; window size: 4; scoring method: percentage; number of top diagonals: 4; and gap penalty: 5. For multiple alignment of nucleic acid sequences, the following parameters are used: gap opening penalty: 10.0; gap extension penalty: 5.0; and weight transitions: yes. For fast pairwise alignment of protein sequences, the following parameters are used:

5 word size: 1; window size: 5; scoring method: percentage; number of top diagonals: 5; gap penalty: 3. For multiple alignment of protein sequences, the following parameters are used: weight matrix: blosum; gap opening penalty: 10.0; gap extension penalty: 0.05; hydrophilic gaps: on; hydrophilic residues: Gly, Pro, Ser, Asn, Asp, Gln, Glu, Arg, and Lys; residue-specific gap penalties: on. The ClustalW output is a sequence alignment

10 that reflects the relationship between sequences. ClustalW can be run, for example, at the Baylor College of Medicine Search Launcher site on the World Wide Web (searchlauncher.bcm.tmc.edu/multi-align/multi-align.html) and at the European Bioinformatics Institute site on the World Wide Web (ebi.ac.uk/clustalw).

To determine percent identity of a candidate nucleic acid or amino acid sequence

15 to a reference sequence, the sequences are aligned using ClustalW, the number of identical matches in the alignment is divided by the length of the reference sequence, and the result is multiplied by 100. It is noted that the percent identity value can be rounded to the nearest tenth. For example, 78.11, 78.12, 78.13, and 78.14 are rounded down to 78.1, while 78.15, 78.16, 78.17, 78.18, and 78.19 are rounded up to 78.2.

20 It will be appreciated that functional UGTs can include additional amino acids that are not involved in glucosylation or other enzymatic activities carried out by the enzyme, and thus such a polypeptide can be longer than would otherwise be the case. For example, a EUGT11 polypeptide can include a purification tag (e.g., HIS tag or GST tag), a chloroplast transit peptide, a mitochondrial transit peptide, an amyloplast peptide,

25 signal peptide, or a secretion tag added to the amino or carboxy terminus. In some embodiments, a EUGT11 polypeptide includes an amino acid sequence that functions as a reporter, e.g., a green fluorescent protein or yellow fluorescent protein.

II. Steviol and Steviol Glycoside Biosynthesis Nucleic Acids

30 A recombinant gene encoding a polypeptide described herein comprises the

coding sequence for that polypeptide, operably linked in sense orientation to one or more regulatory regions suitable for expressing the polypeptide. Because many microorganisms are capable of expressing multiple gene products from a polycistronic mRNA, multiple polypeptides can be expressed under the control of a single regulatory region for those microorganisms, if desired. A coding sequence and a regulatory region are considered to be operably linked when the regulatory region and coding sequence are positioned so that the regulatory region is effective for regulating transcription or translation of the sequence. Typically, the translation initiation site of the translational reading frame of the coding sequence is positioned between one and about fifty nucleotides downstream of the regulatory region for a monocistronic gene.

In many cases, the coding sequence for a polypeptide described herein is identified in a species other than the recombinant host, *i.e.*, is a heterologous nucleic acid. Thus, if the recombinant host is a microorganism, the coding sequence can be from other prokaryotic or eukaryotic microorganisms, from plants or from animals. In some case, however, the coding sequence is a sequence that is native to the host and is being reintroduced into that organism. A native sequence can often be distinguished from the naturally occurring sequence by the presence of non-natural sequences linked to the exogenous nucleic acid, *e.g.*, non-native regulatory sequences flanking a native sequence in a recombinant nucleic acid construct. In addition, stably transformed exogenous nucleic acids typically are integrated at positions other than the position where the native sequence is found.

“Regulatory region” refers to a nucleic acid having nucleotide sequences that influence transcription or translation initiation and rate, and stability and/or mobility of a transcription or translation product. Regulatory regions include, without limitation, promoter sequences, enhancer sequences, response elements, protein recognition sites, inducible elements, protein binding sequences, 5′ and 3′ untranslated regions (UTRs), transcriptional start sites, termination sequences, polyadenylation sequences, introns, and combinations thereof. A regulatory region typically comprises at least a core (basal) promoter. A regulatory region also may include at least one control element, such as an enhancer sequence, an upstream element or an upstream activation region (UAR). A

regulatory region is operably linked to a coding sequence by positioning the regulatory region and the coding sequence so that the regulatory region is effective for regulating transcription or translation of the sequence. For example, to operably link a coding sequence and a promoter sequence, the translation initiation site of the translational
5 reading frame of the coding sequence is typically positioned between one and about fifty nucleotides downstream of the promoter. A regulatory region can, however, be positioned as much as about 5,000 nucleotides upstream of the translation initiation site, or about 2,000 nucleotides upstream of the transcription start site.

The choice of regulatory regions to be included depends upon several factors,
10 including, but not limited to, efficiency, selectability, inducibility, desired expression level, and preferential expression during certain culture stages. It is a routine matter for one of skill in the art to modulate the expression of a coding sequence by appropriately selecting and positioning regulatory regions relative to the coding sequence. It will be understood that more than one regulatory region may be present, *e.g.*, introns, enhancers,
15 upstream activation regions, transcription terminators, and inducible elements.

One or more genes can be combined in a recombinant nucleic acid construct in “modules” useful for a discrete aspect of steviol and/or steviol glycoside production. Combining a plurality of genes in a module, particularly a polycistronic module, facilitates the use of the module in a variety of species. For example, a steviol
20 biosynthesis gene cluster, or a UGT gene cluster, can be combined in a polycistronic module such that, after insertion of a suitable regulatory region, the module can be introduced into a wide variety of species. As another example, a UGT gene cluster can be combined such that each UGT coding sequence is operably linked to a separate regulatory region, to form a UGT module. Such a module can be used in those species
25 for which monocistronic expression is necessary or desirable. In addition to genes useful for steviol or steviol glycoside production, a recombinant construct typically also contains an origin of replication, and one or more selectable markers for maintenance of the construct in appropriate species.

It will be appreciated that because of the degeneracy of the genetic code, a
30 number of nucleic acids can encode a particular polypeptide; *i.e.*, for many amino acids,

there is more than one nucleotide triplet that serves as the codon for the amino acid. Thus, codons in the coding sequence for a given polypeptide can be modified such that optimal expression in a particular host is obtained, using appropriate codon bias tables for that host (e.g., microorganism). SEQ ID NOs:18-25, 34-36, 40-43, 48-49, 52-55, 60-64, 70-72, and 154 set forth nucleotide sequences encoding certain enzymes for steviol and steviol glycoside biosynthesis, modified for increased expression in yeast. As isolated nucleic acids, these modified sequences can exist as purified molecules and can be incorporated into a vector or a virus for use in constructing modules for recombinant nucleic acid constructs.

In some cases, it is desirable to inhibit one or more functions of an endogenous polypeptide in order to divert metabolic intermediates towards steviol or steviol glycoside biosynthesis. For example, it may be desirable to downregulate synthesis of sterols in a yeast strain in order to further increase steviol or steviol glycoside production, e.g., by downregulating squalene epoxidase. As another example, it may be desirable to inhibit degradative functions of certain endogenous gene products, e.g., glycohydrolases that remove glucose moieties from secondary metabolites or phosphatases as discussed herein. As another example, expression of membrane transporters involved in transport of steviol glycosides can be inhibited, such that secretion of glycosylated steviosides is inhibited. Such regulation can be beneficial in that secretion of steviol glycosides can be inhibited for a desired period of time during culture of the microorganism, thereby increasing the yield of glycoside product(s) at harvest. In such cases, a nucleic acid that inhibits expression of the polypeptide or gene product may be included in a recombinant construct that is transformed into the strain. Alternatively, mutagenesis can be used to generate mutants in genes for which it is desired to inhibit function.

III. Hosts

A. Microorganisms

A number of prokaryotes and eukaryotes are suitable for use in constructing the recombinant microorganisms described herein, e.g., gram-negative bacteria, yeast and fungi. A species and strain selected for use as a steviol or steviol glycoside production

strain is first analyzed to determine which production genes are endogenous to the strain and which genes are not present. Genes for which an endogenous counterpart is not present in the strain are assembled in one or more recombinant constructs, which are then transformed into the strain in order to supply the missing function(s).

5 Exemplary prokaryotic and eukaryotic species are described in more detail below. However, it will be appreciated that other species may be suitable. For example, suitable species may be in a genus selected from the group consisting of *Agaricus*, *Aspergillus*, *Bacillus*, *Candida*, *Corynebacterium*, *Escherichia*, *Fusarium*/*Gibberella*, *Kluyveromyces*, *Laetiporus*, *Lentinus*, *Phaffia*, *Phanerochaete*, *Pichia*, *Physcomitrella*, *Rhodoturula*,
10 *Saccharomyces*, *Schizosaccharomyces*, *Sphaceloma*, *Xanthophyllomyces* and *Yarrowia*. Exemplary species from such genera include *Lentinus tigrinus*, *Laetiporus sulphureus*, *Phanerochaete chrysosporium*, *Pichia pastoris*, *Physcomitrella patens*, *Rhodoturula glutinis* 32, *Rhodoturula mucilaginosa*, *Phaffia rhodozyma* UBV-AX, *Xanthophyllomyces dendrorhous*, *Fusarium fujikuroi*/*Gibberella fujikuroi*, *Candida utilis*,
15 and *Yarrowia lipolytica*. In some embodiments, a microorganism can be an Ascomycete such as *Gibberella fujikuroi*, *Kluyveromyces lactis*, *Schizosaccharomyces pombe*, *Aspergillus niger*, or *Saccharomyces cerevisiae*. In some embodiments, a microorganism can be a prokaryote such as *Escherichia coli*, *Rhodobacter sphaeroides*, or *Rhodobacter capsulatus*. It will be appreciated that certain microorganisms can be used to screen and
20 test genes of interest in a high throughput manner, while other microorganisms with desired productivity or growth characteristics can be used for large-scale production of steviol glycosides.

Saccharomyces cerevisiae

Saccharomyces cerevisiae is a widely used chassis organism in synthetic biology,
25 and can be used as the recombinant microorganism platform. There are libraries of mutants, plasmids, detailed computer models of metabolism and other information available for *S. cerevisiae*, allowing for rational design of various modules to enhance product yield. Methods are known for making recombinant microorganisms.

A steviol biosynthesis gene cluster can be expressed in yeast using any of a
30 number of known promoters. Strains that overproduce terpenes are known and can be

used to increase the amount of geranylgeranyl diphosphate available for steviol and steviol glycoside production.

Aspergillus spp.

Aspergillus species such as *A. oryzae*, *A. niger* and *A. sojae* are widely used
5 microorganisms in food production, and can also be used as the recombinant
microorganism platform. Nucleotide sequences are available for genomes of *A. nidulans*,
A. fumigatus, *A. oryzae*, *A. clavatus*, *A. flavus*, *A. niger*, and *A. terreus*, allowing rational
design and modification of endogenous pathways to enhance flux and increase product
yield. Metabolic models have been developed for *Aspergillus*, as well as transcriptomic
10 studies and proteomics studies. *A. niger* is cultured for the industrial production of a
number of food ingredients such as citric acid and gluconic acid, and thus species such as
A. niger are generally suitable for the production of food ingredients such as steviol and
steviol glycosides.

Escherichia coli

15 *Escherichia coli*, another widely used platform organism in synthetic biology, can
also be used as the recombinant microorganism platform. Similar to *Saccharomyces*,
there are libraries of mutants, plasmids, detailed computer models of metabolism and
other information available for *E. coli*, allowing for rational design of various modules to
enhance product yield. Methods similar to those described above for *Saccharomyces* can
20 be used to make recombinant *E. coli* microorganisms.

Agaricus, *Gibberella*, and *Phanerochaete* spp.

Agaricus, *Gibberella*, and *Phanerochaete* spp. can be useful because they are
known to produce large amounts of gibberellin in culture. Thus, the terpene precursors
for producing large amounts of steviol and steviol glycosides are already produced by
25 endogenous genes. Thus, modules containing recombinant genes for steviol or steviol
glycoside biosynthesis polypeptides can be introduced into species from such genera
without the necessity of introducing mevalonate or MEP pathway genes.

Arxula adeninivorans (*Blastobotrys adeninivorans*)

Arxula adeninivorans is a dimorphic yeast (it grows as a budding yeast like the
30 baker's yeast up to a temperature of 42 °C, above this threshold it grows in a filamentous

form) with unusual biochemical characteristics. It can grow on a wide range of substrates and can assimilate nitrate. It has successfully been applied to the generation of strains that can produce natural plastics or the development of a biosensor for estrogens in environmental samples.

5 *Yarrowia lipolytica*

Yarrowia lipolytica is a dimorphic yeast (see *Arxula adeninivorans*) that can grow on a wide range of substrates. It has a high potential for industrial applications but there are no recombinant products commercially available yet.

Rhodobacter spp.

10 *Rhodobacter* can be use as the recombinant microorganism platform. Similar to *E. coli*, there are libraries of mutants available as well as suitable plasmid vectors, allowing for rational design of various modules to enhance product yield. Isoprenoid pathways have been engineered in membraneous bacterial species of *Rhodobacter* for increased production of carotenoid and CoQ10. See, U.S. Patent Publication Nos.
15 20050003474 and 20040078846. Methods similar to those described above for *E. coli* can be used to make recombinant *Rhodobacter* microorganisms.

Candida boidinii

Candida boidinii is a methylotrophic yeast (it can grow on methanol). Like other methylotrophic species such as *Hansenula polymorpha* and *Pichia pastoris*, it provides
20 an excellent platform for the production of heterologous proteins. Yields in a multigram range of a secreted foreign protein have been reported. A computational method, IPRO, recently predicted mutations that experimentally switched the cofactor specificity of *Candida boidinii* xylose reductase from NADPH to NADH.

Hansenula polymorpha (*Pichia angusta*)

25 *Hansenula polymorpha* is another methylotrophic yeast (see *Candida boidinii*). It can furthermore grow on a wide range of other substrates; it is thermo-tolerant and can assimilate nitrate (see also *Kluyveromyces lactis*). It has been applied to the production of hepatitis B vaccines, insulin and interferon alpha-2a for the treatment of hepatitis C, furthermore to a range of technical enzymes.

30 *Kluyveromyces lactis*

Kluyveromyces lactis is a yeast regularly applied to the production of kefir. It can grow on several sugars, most importantly on lactose which is present in milk and whey. It has successfully been applied among others to the production of chymosin (an enzyme that is usually present in the stomach of calves) for the production of cheese. Production
5 takes place in fermenters on a 40,000 L scale.

Pichia pastoris

Pichia pastoris is a methylotrophic yeast (see *Candida boidinii* and *Hansenula polymorpha*). It provides an efficient platform for the production of foreign proteins. Platform elements are available as a kit and it is worldwide used in academia for the
10 production of proteins. Strains have been engineered that can produce complex human N-glycan (yeast glycans are similar but not identical to those found in humans).

Physcomitrella spp.

Physcomitrella mosses, when grown in suspension culture, have characteristics similar to yeast or other fungal cultures. This genera is becoming an important type of
15 cell for production of plant secondary metabolites, which can be difficult to produce in other types of cells.

B. Plant Cells or Plants

In some embodiments, the nucleic acids and polypeptides described herein are
20 introduced into plants or plant cells to increase overall steviol glycoside production or enrich for the production of specific steviol glycosides in proportion to others. Thus, a host can be a plant or a plant cell that includes at least one recombinant gene described herein. A plant or plant cell can be transformed by having a recombinant gene integrated into its genome, *i.e.*, can be stably transformed. Stably transformed cells typically retain
25 the introduced nucleic acid with each cell division. A plant or plant cell can also be transiently transformed such that the recombinant gene is not integrated into its genome. Transiently transformed cells typically lose all or some portion of the introduced nucleic acid with each cell division such that the introduced nucleic acid cannot be detected in daughter cells after a sufficient number of cell divisions. Both transiently transformed

and stably transformed transgenic plants and plant cells can be useful in the methods described herein.

Transgenic plant cells used in methods described herein can constitute part or all of a whole plant. Such plants can be grown in a manner suitable for the species under
5 consideration, either in a growth chamber, a greenhouse, or in a field. Transgenic plants can be bred as desired for a particular purpose, *e.g.*, to introduce a recombinant nucleic acid into other lines, to transfer a recombinant nucleic acid to other species, or for further selection of other desirable traits. Alternatively, transgenic plants can be propagated vegetatively for those species amenable to such techniques. As used herein, a transgenic
10 plant also refers to progeny of an initial transgenic plant provided the progeny inherits the transgene. Seeds produced by a transgenic plant can be grown and then selfed (or outcrossed and selfed) to obtain seeds homozygous for the nucleic acid construct.

Transgenic plants can be grown in suspension culture, or tissue or organ culture. For the purposes of this invention, solid and/or liquid tissue culture techniques can be
15 used. When using solid medium, transgenic plant cells can be placed directly onto the medium or can be placed onto a filter that is then placed in contact with the medium. When using liquid medium, transgenic plant cells can be placed onto a flotation device, *e.g.*, a porous membrane that contacts the liquid medium.

When transiently transformed plant cells are used, a reporter sequence encoding a
20 reporter polypeptide having a reporter activity can be included in the transformation procedure and an assay for reporter activity or expression can be performed at a suitable time after transformation. A suitable time for conducting the assay typically is about 1-21 days after transformation, *e.g.*, about 1-14 days, about 1-7 days, or about 1-3 days. The use of transient assays is particularly convenient for rapid analysis in different
25 species, or to confirm expression of a heterologous polypeptide whose expression has not previously been confirmed in particular recipient cells.

Techniques for introducing nucleic acids into monocotyledonous and dicotyledonous plants are known in the art, and include, without limitation, *Agrobacterium*-mediated transformation, viral vector-mediated transformation,
30 electroporation and particle gun transformation, U.S. Patent Nos 5,538,880; 5,204,253;

6,329,571; and 6,013,863. If a cell or cultured tissue is used as the recipient tissue for transformation, plants can be regenerated from transformed cultures if desired, by techniques known to those skilled in the art.

5 A population of transgenic plants can be screened and/or selected for those members of the population that have a trait or phenotype conferred by expression of the transgene. For example, a population of progeny of a single transformation event can be screened for those plants having a desired level of expression of a steviol or steviol glycoside biosynthesis polypeptide or nucleic acid. Physical and biochemical methods can be used to identify expression levels. These include Southern analysis or PCR
10 amplification for detection of a polynucleotide; Northern blots, S1 RNase protection, primer-extension, or RT-PCR amplification for detecting RNA transcripts; enzymatic assays for detecting enzyme or ribozyme activity of polypeptides and polynucleotides; and protein gel electrophoresis, Western blots, immunoprecipitation, and enzyme-linked immunoassays to detect polypeptides. Other techniques such as *in situ* hybridization,
15 enzyme staining, and immunostaining also can be used to detect the presence or expression of polypeptides and/or nucleic acids. Methods for performing all of the referenced techniques are known. As an alternative, a population of plants comprising independent transformation events can be screened for those plants having a desired trait, such as production of a steviol glycoside or modulated biosynthesis of a steviol
20 glycoside. Selection and/or screening can be carried out over one or more generations, and/or in more than one geographic location. In some cases, transgenic plants can be grown and selected under conditions which induce a desired phenotype or are otherwise necessary to produce a desired phenotype in a transgenic plant. In addition, selection and/or screening can be applied during a particular developmental stage in which the
25 phenotype is expected to be exhibited by the plant. Selection and/or screening can be carried out to choose those transgenic plants having a statistically significant difference in a steviol glycoside level relative to a control plant that lacks the transgene.

The nucleic acids, recombinant genes, and constructs described herein can be used to transform a number of monocotyledonous and dicotyledonous plants and plant
30 cell systems. Non-limiting examples of suitable monocots include, for example, cereal

crops such as rice, rye, sorghum, millet, wheat, maize, and barley. The plant may be a non-cereal monocot such as asparagus, banana, or onion. The plant also may be a dicot such as stevia (*Stevia rebaudiana*), soybean, cotton, sunflower, pea, geranium, spinach, or tobacco. In some cases, the plant may contain the precursor pathways for phenyl phosphate production such as the mevalonate pathway, typically found in the cytoplasm and mitochondria. The non-mevalonate pathway is more often found in plant plastids [Dubey, et al., 2003 *J. Biosci.* **28** 637–646]. One with skill in the art may target expression of steviol glycoside biosynthesis polypeptides to the appropriate organelle through the use of leader sequences, such that steviol glycoside biosynthesis occurs in the desired location of the plant cell. One with skill in the art will use appropriate promoters to direct synthesis, e.g., to the leaf of a plant, if so desired. Expression may also occur in tissue cultures such as callus culture or hairy root culture, if so desired.

In one embodiment, one or more nucleic acid or polypeptides described herein are introduced into Stevia (e.g., *Stevia rebaudiana*) such that overall steviol glycoside biosynthesis is increased or that the overall steviol glycoside composition is selectively enriched for one or more specific steviol glycosides (e.g., rebaudioside D). For example, one or more recombinant genes can be introduced into Stevia such that a EUGT11 enzyme (e.g., SEQ ID NO: 152 or a functional homolog thereof) is expressed alone or in combination with one or more of: a UGT91D enzyme such as UGT91D2e (e.g., SEQ ID NO:5 or a functional homolog thereof), UGT91D2m (e.g., SEQ ID NO:10); a UGT85C enzyme such as a variant described in the “Functional Homolog” section, a UGT76G1 enzyme such as a variant described in the “Functional Homolog” section, or a UGT74G1 enzyme. Nucleic acid constructs typically include a suitable promoter (e.g., 35S, e35S, or ssRUBISCO promoters) operably linked to a nucleic acid encoding the UGT polypeptide. Nucleic acids can be introduced into Stevia by *Agrobacterium*-mediated transformation; electroporation-mediated gene transfer to protoplasts; or by particle bombardment. See, e.g., Singh, et al., *Compendium of Transgenic Crop Plants: Transgenic Sugar, Tuber and Fiber*, Edited by Chittaranjan Kole and Timothy C. Hall, Blackwell Publishing Ltd. (2008), pp. 97-115. For particle bombardment of stevia leaf

derived callus, the parameters can be as follows: 6 cm distance, 1100 psi He pressure, gold particles, and one bombardment.

Stevia plants can be regenerated by somatic embryogenesis as described by Singh et al., 2008, *supra*. In particular, leaf segments (approximately 1-2cm long) can be removed from 5 to 6-week-old *in vitro* raised plants and incubated (adaxial side down) on MS medium supplemented with B5 vitamins, 30 g sucrose and 3 g Gelrite. 2,4-dichlorophenoxyacetic acid (2,4-D) can be used in combination with 6-benzyl adenine (BA), kinetin (KN), or zeatin. Proembryogenic masses appear after 8 weeks of subculture. Within 2-3 weeks of subcultures, somatic embryos will appear on the surface of cultures. Embryos can be matured in medium containing BA in combination with 2,4-D, α -naphthaleneacetic acid (NAA), or indolbutyric acid (IBA). Mature somatic embryos that germinate and form plantlets can be excised from calli. After plantlets reach 3-4 weeks, the plantlets can be transferred to pots with vermiculite and grown for 6-8 weeks in growth chambers for acclimatization and transferred to greenhouses.

In one embodiment, steviol glycosides are produced in rice. Rice and maize are readily transformable using techniques such as *Agrobacterium*-mediated transformation. Binary vector systems are commonly utilized for *Agrobacterium* exogenous gene introduction to monocots. See, for example, U.S. Patent Nos. 6,215,051 and 6,329,571. In a binary vector system, one vector contains the T-DNA region, which includes a gene of interest (e.g., a UGT described herein) and the other vector is a disarmed Ti plasmid containing the *vir* region. Co-integrated vectors and mobilizable vectors also can be used. The types and pretreatment of tissues to be transformed, the strain of *Agrobacterium* used, the duration of the inoculation, the prevention of overgrowth and necrosis by the *Agrobacterium*, can be readily adjusted by one of skill in the art. Immature embryo cells of rice can be prepared for transformation with *Agrobacterium* using binary vectors. The culture medium used is supplemented with phenolic compounds. Alternatively, the transformation can be done *in planta* using vacuum infiltration. See, for example, WO 2000037663, WO 2000063400, and WO 2001012828.

IV. Methods of Producing Steviol Glycosides

Recombinant hosts described herein can be used in methods to produce steviol or steviol glycosides. For example, if the recombinant host is a microorganism, the method can include growing the recombinant microorganism in a culture medium under
5 conditions in which steviol and/or steviol glycoside biosynthesis genes are expressed. The recombinant microorganism may be grown in a fed batch or continuous process. Typically, the recombinant microorganism is grown in a fermentor at a defined temperature(s) for a desired period of time. Depending on the particular microorganism used in the method, other recombinant genes such as isopentenyl biosynthesis genes and
10 terpene synthase and cyclase genes may also be present and expressed. Levels of substrates and intermediates, e.g., isopentenyl diphosphate, dimethylallyl diphosphate, geranylgeranyl diphosphate, kaurene and kaurenoic acid, can be determined by extracting samples from culture media for analysis according to published methods.

After the recombinant microorganism has been grown in culture for the desired
15 period of time, steviol and/or one or more steviol glycosides can then be recovered from the culture using various techniques known in the art. In some embodiments, a permeabilizing agent can be added to aid the feedstock entering into the host and product getting out. If the recombinant host is a plant or plant cells, steviol or steviol glycosides can be extracted from the plant tissue using various techniques known in the art. For
20 example, a crude lysate of the cultured microorganism or plant tissue can be centrifuged to obtain a supernatant. The resulting supernatant can then be applied to a chromatography column, e.g., a C-18 column, and washed with water to remove hydrophilic compounds, followed by elution of the compound(s) of interest with a solvent such as methanol. The compound(s) can then be further purified by preparative
25 HPLC. See also WO 2009/140394.

The amount of steviol glycoside (e.g., rebaudioside D) produced can be from about 1 mg/L to about 1500 mg/L, e.g., about 1 to about 10 mg/L, about 3 to about 10 mg/L, about 5 to about 20 mg/L, about 10 to about 50 mg/L, about 10 to about 100 mg/L, about 25 to about 500 mg/L, about 100 to about 1,500 mg/L, or about 200 to about 1,000
30 mg/L. In general, longer culture times will lead to greater amounts of product. Thus, the

recombinant microorganism can be cultured for from 1 day to 7 days, from 1 day to 5 days, from 3 days to 5 days, about 3 days, about 4 days, or about 5 days.

It will be appreciated that the various genes and modules discussed herein can be present in two or more recombinant microorganisms rather than a single microorganism.

5 When a plurality of recombinant microorganisms is used, they can be grown in a mixed culture to produce steviol and/or steviol glycosides. For example, a first microorganism can comprise one or more biosynthesis genes for producing steviol while a second microorganism comprises steviol glycoside biosynthesis genes. Alternatively, the two or more microorganisms each can be grown in a separate culture medium and the product of
10 the first culture medium, e.g., steviol, can be introduced into second culture medium to be converted into a subsequent intermediate, or into an end product such as rebaudioside A. The product produced by the second, or final microorganism is then recovered. It will also be appreciated that in some embodiments, a recombinant microorganism is grown using nutrient sources other than a culture medium and utilizing a system other than a
15 fermentor.

Steviol glycosides do not necessarily have equivalent performance in different food systems. It is therefore desirable to have the ability to direct the synthesis to steviol glycoside compositions of choice. Recombinant hosts described herein can produce compositions that are selectively enriched for specific steviol glycosides (e.g.,
20 rebaudioside D) and have a consistent taste profile. Thus, the recombinant microorganisms, plants, and plant cells described herein can facilitate the production of compositions that are tailored to meet the sweetening profile desired for a given food product and that have a proportion of each steviol glycoside that is consistent from batch to batch. Microorganisms described herein do not produce the undesired plant
25 byproducts found in Stevia extracts. Thus, steviol glycoside compositions produced by the recombinant microorganisms described herein are distinguishable from compositions derived from Stevia plants.

V. Food Products

The steviol glycosides obtained by the methods disclosed herein can be used to make food products, dietary supplements and sweetener compositions. For example, substantially pure steviol or steviol glycoside such as rebaudioside A or rebaudioside D can be included in food products such as ice cream, carbonated beverages, fruit juices, yogurts, baked goods, chewing gums, hard and soft candies, and sauces. Substantially pure steviol or steviol glycoside can also be included in non-food products such as pharmaceutical products, medicinal products, dietary supplements and nutritional supplements. Substantially pure steviol or steviol glycosides may also be included in animal feed products for both the agriculture industry and the companion animal industry. Alternatively, a mixture of steviol and/or steviol glycosides can be made by culturing recombinant microorganisms separately or growing different plants/plant cells, each producing a specific steviol or steviol glycoside, recovering the steviol or steviol glycoside in substantially pure form from each microorganism or plant/plant cells and then combining the compounds to obtain a mixture containing each compound in the desired proportion. The recombinant microorganisms, plants, and plant cells described herein permit more precise and consistent mixtures to be obtained compared to current Stevia products. In another alternative, a substantially pure steviol or steviol glycoside can be incorporated into a food product along with other sweeteners, e.g. saccharin, dextrose, sucrose, fructose, erythritol, aspartame, sucralose, monatin, or acesulfame potassium. The weight ratio of steviol or steviol glycoside relative to other sweeteners can be varied as desired to achieve a satisfactory taste in the final food product. See, e.g., U.S. Patent Publication No. 2007/0128311. In some embodiments, the steviol or steviol glycoside may be provided with a flavor (e.g., citrus) as a flavor modulator. For example, Rebaudioside C can be used as a sweetness enhancer or sweetness modulator, in particular for carbohydrate based sweeteners, such that the amount of sugar can be reduced in the food product.

Compositions produced by a recombinant microorganism, plant, or plant cell described herein can be incorporated into food products. For example, a steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can

be incorporated into a food product in an amount ranging from about 20 mg steviol glycoside/kg food product to about 1800 mg steviol glycoside/kg food product on a dry weight basis, depending on the type of steviol glycoside and food product. For example, a steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a dessert, cold confectionary (e.g., ice cream), dairy product (e.g., yogurt), or beverage (e.g., a carbonated beverage) such that the food product has a maximum of 500 mg steviol glycoside/kg food on a dry weight basis. A steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a baked good (e.g., a biscuit) such that the food product has a maximum of 300 mg steviol glycoside/kg food on a dry weight basis. A steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a sauce (e.g., chocolate syrup) or vegetable product (e.g., pickles) such that the food product has a maximum of 1000 mg steviol glycoside/kg food on a dry weight basis. A steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a bread such that the food product has a maximum of 160 mg steviol glycoside/kg food on a dry weight basis. A steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a hard or soft candy such that the food product has a maximum of 1600 mg steviol glycoside/kg food on a dry weight basis. A steviol glycoside composition produced by a recombinant microorganism, plant, or plant cell can be incorporated into a processed fruit product (e.g., fruit juices, fruit filling, jams, and jellies) such that the food product has a maximum of 1000 mg steviol glycoside/kg food on a dry weight basis.

For example, such a steviol glycoside composition can have from 90-99% rebaudioside A and an undetectable amount of stevia plant-derived contaminants, and be incorporated into a food product at from 25-1600 mg/kg, e.g., 100-500 mg/kg, 25-100 mg/kg, 250-1000 mg/kg, 50-500 mg/kg or 500-1000 mg/kg on a dry weight basis.

Such a steviol glycoside composition can be a rebaudioside B-enriched composition having greater than 3% rebaudioside B and be incorporated into the food product such that the amount of rebaudioside B in the product is from 25-1600 mg/kg,

e.g., 100-500 mg/kg, 25-100 mg/kg, 250-1000 mg/kg, 50-500 mg/kg or 500-1000 mg/kg on a dry weight basis. Typically, the rebaudioside B-enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a rebaudioside C-enriched composition having greater than 15% rebaudioside C and be incorporated into the food product such that the amount of rebaudioside C in the product is from 20-600 mg/kg, e.g., 100-600 mg/kg, 20-100 mg/kg, 20-95 mg/kg, 20-250 mg/kg, 50-75 mg/kg or 50-95 mg/kg on a dry weight basis. Typically, the rebaudioside C-enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a rebaudioside D-enriched composition having greater than 3% rebaudioside D and be incorporated into the food product such that the amount of rebaudioside D in the product is from 25-1600 mg/kg, e.g., 100-500 mg/kg, 25-100 mg/kg, 250-1000 mg/kg, 50-500 mg/kg or 500-1000 mg/kg on a dry weight basis. Typically, the rebaudioside D-enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a rebaudioside E-enriched composition having greater than 3% rebaudioside E and be incorporated into the food product such that the amount of rebaudioside E in the product is from 25-1600 mg/kg, e.g., 100-500 mg/kg, 25-100 mg/kg, 250-1000 mg/kg, 50-500 mg/kg or 500-1000 mg/kg on a dry weight basis. Typically, the rebaudioside E-enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a rebaudioside F-enriched composition having greater than 4% rebaudioside F and be incorporated into the food product such that the amount of rebaudioside F in the product is from 25-1000 mg/kg, e.g., 100-600 mg/kg, 25-100 mg/kg, 25-95 mg/kg, 50-75 mg/kg or 50-95 mg/kg on a dry weight basis. Typically, the rebaudioside F-enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a dulcoside A-enriched composition having greater than 4% dulcoside A and be incorporated into the food product such that the amount of dulcoside A in the product is from 25-1000 mg/kg, e.g., 100-600 mg/kg,

25-100 mg/kg, 25-95 mg/kg, 50-75 mg/kg or 50-95 mg/kg on a dry weight basis.

Typically, the dulcoside A-enriched composition has an undetectable amount of stevia plant-derived contaminants.

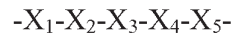
Such a steviol glycoside composition can be a composition enriched for
5 rubusoside xylosylated on either of the two positions--the 13-O-glucose or the 19-O-glucose. Such a composition can have greater than 4% of the xylosylated rubusoside compound, and can be incorporated into the food product such that the amount of xylosylated rubusoside compound in the product is from 25-1000 mg/kg, e.g., 100-600 mg/kg, 25-100 mg/kg, 25-95 mg/kg, 50-75 mg/kg or 50-95 mg/kg on a dry weight basis.
10 Typically, the xylosylated rubusoside enriched composition has an undetectable amount of stevia plant-derived contaminants.

Such a steviol glycoside composition can be a composition enriched for compounds rhamnosylated on either of the two positions--the 13-O-glucose or the 19-O-glucose, or compounds containing one rhamnose and multiple glucoses (e.g., steviol 13-O-1,3-diglycoside-1,2-rhamnoside). Such a composition can have greater than 4% of the rhamnosylated compound, and can be incorporated into the food product such that the
15 amount of rhamnosylated compound in the product is from 25-1000 mg/kg, e.g., 100-600 mg/kg, 25-100 mg/kg, 25-95 mg/kg, 50-75 mg/kg or 50-95 mg/kg on a dry weight basis. Typically, the composition enriched for rhamnosylated compounds has as an
20 undetectable amount of stevia plant-derived contaminants.

In some embodiments, a substantially pure steviol or steviol glycoside is incorporated into a tabletop sweetener or "cup-for-cup" product. Such products typically are diluted to the appropriate sweetness level with one or more bulking agents, e.g., maltodextrins, known to those skilled in the art. Steviol glycoside compositions enriched
25 for rebaudioside A, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, dulcoside A, or rhamnosylated or xylosylated compounds, can be package in a sachet, for example, at from 10,000 to 30,000 mg steviol glycoside/kg product on a dry weight basis, for tabletop use.

In some embodiments, this disclosure relates to the following items:

1. A recombinant host cell comprising a nucleic acid sequence, said nucleic acid comprising a heterologous insert sequence operably linked to an open reading frame, wherein the heterologous insert sequence has the general formula (I):



5 wherein X_2 comprises at least 4 consecutive nucleotides complementary to at least 4 consecutive nucleotides of X_4 ,

 wherein X_3 comprises zero nucleotides, or one or more nucleotides forming a hairpin loop,

 wherein X_1 and X_5 each individually consists of zero nucleotides, or one or more
10 nucleotides,

 wherein the open reading frame encodes a squalene synthase (EC 2.5.1.21).

2. The recombinant cell according to item 1, said nucleic acid comprises in 5' to 3' order, a promoter sequence operably linked to a heterologous insert sequence operably linked to an open reading frame, wherein the heterologous insert sequence and
15 the open reading frame are as defined in item 1.

3. A cell comprising a nucleic acid sequence, said nucleic acid comprising

- i) a promoter sequence operably linked to
- ii) a heterologous insert sequence operably linked to
- iii) an open reading frame operably linked to
- 20 iv) a transcription termination signal,

 wherein the heterologous insert sequence has the general formula (I):



 wherein X_2 comprises at least 4 consecutive nucleic acids being complementary to, and forms a hairpin secondary structure element with at least 4 consecutive nucleic
25 acids of X_4 , and

 wherein X_3 comprises unpaired nucleic acids thus forming a hairpin loop between X_2 and X_4 , and

 wherein X_1 and X_5 individually and optionally comprises one or more nucleic
30 acids, and

wherein the open reading frame upon expression encodes a polypeptide sequence having at least 70% identity to a squalene synthase (EC 2.5.1.21) or a biologically active fragment thereof, said fragment having at least 70% sequence identity to said squalene synthase in a range of overlap of at least 100 amino acids.

5 4. The cell according to any one of items 1 to 3, wherein the heterologous insert sequence comprises 10-50 nucleotides, preferably 10-30 nucleotides, more preferably 15-25 nucleotides, more preferably 17-22 nucleotides, more preferably 18-21 nucleotides, more preferably 18-20 nucleotides, more preferably 19 nucleotides.

 5. The cell according to any one of items 1 to 4, wherein X_2 and X_4 consists of the
10 same number of nucleotides.

 6. The cell according to any one of items 1 to 5, wherein all X_2 consists of in the range of 4 to 25, such as in the range of 4 to 20, for example of in the range of 4 to 15, such as in the range of 6 to 12, for example in the range of 8 to 12, such as in the range of 9 to 11 nucleotides.

15 7. The cell according to any one of items 1 to 6, wherein all X_4 consists of in the range of 4 to 25, such as in the range of 4 to 20, for example of in the range of 4 to 15, such as in the range of 6 to 12, for example in the range of 8 to 12, such as in the range of 9 to 11 nucleotides.

 8. The cell according to any one of items 1 to 7, wherein X_2 consists of a
20 nucleotide sequence, which is complementary to the nucleotide sequence of X_4 .

 9. The cell according to any one of items 1 to 8, wherein X_4 consists of a nucleotide sequence, which is complementary to the nucleotide sequence of X_2 .

 10. The cell according to any one of items 1 to 9, wherein X_3 is absent, i.e. X_3 consists of zero nucleotides.

25 11. The cell according to any one of items 1 to 9, wherein X_3 consists of in the range of 1 to 5, such as in the range of 1 to 3 nucleotides.

 12. The cell according to any one of items 1 to 11, wherein X_1 is absent, i.e. X_1 consists of zero nucleotides.

 13. The cell according to any one of items 1 to 11, wherein X_1 consists of in the
30 range of 1 to 25, such as in the range of 1 to 20, for example in the range of 1 to 15, such

as in the range of 1 to 10, for example in the range of 1 to 5, such as in the range of 1 to 3 nucleotides.

14. The cell according to any one items 1 to 13, wherein X_5 is absent, i.e. X_5 consists of zero nucleotides.

5 15. The cell according to any one of items 1 to 11, wherein X_5 consists of in the range 1 to 5, such as in the range of 1 to 3 nucleotides.

16. The cell according to any one of items 1 to 15, wherein the heterologous insert sequence comprises a sequence selected from the group consisting of SEQ ID NO: 181, SEQ ID NO: 182, SEQ ID NO: 183 and SEQ ID NO: 184.

10 17. The cell according to any one of items 1 to 16, wherein the heterologous insert sequence is selected from the group consisting of SEQ ID NO: 181, SEQ ID NO: 182, SEQ ID NO: 183 and SEQ ID NO: 184.

18. The cell according to any one of items 1 to 17, wherein the squalene synthase is at least 75%, such as at least 80%, such as at least 85%, such as at least 87%, such as at least 90%, such as at least 91%, such as at least 92%, such as at least 93%, such as at least 94%, such as at least 95%, such as at least 96%, such as at least 97%, such as at least 98%, such as at least 99%, such as 100% identical to a squalene synthase selected from the group consisting of SEQ ID NO: 192, SEQ ID NO:193, SEQ ID NO:194, SEQ ID NO:194, SEQ ID NO:195, SEQ ID NO:196, SEQ ID NO:197, SEQ ID NO:198, SEQ ID NO:199, SEQ ID NO:200, SEQ ID NO:201, and SEQ ID NO:202.

20 19. The cell according to any one of items 1 to 18, wherein said promoter is a constitutive or inducible promoter.

20. The cell according to any one of items 1 to 19, wherein said promoter is selected from the group consisting of an endogenous promoter, GPD1, PGK1, ADH1, ADH2, PYK1, TPI1, PDC1, TEF1, TEF2, FBA1, GAL1-10, CUP1, MET2, MET14, MET25, CYC1, GAL1-S, GAL1-L, TEF1, ADH1, CAG, CMV, human UbiC, RSV, EF-1alpha, SV40, Mt1, Tet-On, Tet-Off, Mo-MLV-LTR, Mx1, progesterone, RU486 and Rapamycin-inducible promoter.

21. The cell according to any one of items 1 to 20, wherein the nucleic acid sequence further comprises a polyadenyl sequence.

30

22. The cell according to item 21, wherein the 5' end of said polyadenyl sequence is operably linked to the 3' end of the nucleic acid of item 1.

23. The cell according to any one of items 1 to 22, wherein the nucleic acid sequence further comprises a post-transcriptional regulatory element.

5 24. The cell of item 23, wherein said post-transcriptional regulatory element is a Woodchuck hepatitis virus post-transcriptional regulatory element (WPRE).

25. The cell of any of items 1 to 24, wherein the nucleic acid comprises a 5' terminal repeat and a 3' terminal repeat.

26. The cell of item 25, wherein the 5' and 3' terminal repeats are selected from
10 Inverted Terminal Repeats [ITR] and Long Terminal Repeats [LTR].

27. The cell according to any one of items 1 to 26, wherein the nucleic acid sequence is integrated in a vector.

28. The cell of item 27, wherein the vector is an expression vector.

29. The cell of item 27, wherein the vector is selected from the group consisting
15 of plasmid vectors, cosmids, artificial chromosomes and viral vectors.

30. The cell of item 29 wherein the plasmid vector can be maintained and replicated in bacteria, fungi and yeast.

31. The cell of item 29, wherein the viral vector is selected from the group consisting of vectors derived from the Retroviridae family including lentivirus, HIV, SIV,
20 FIV, EAV, CIV.

32. The cell of item 31, wherein the viral vector is selected from the group consisting of alphavirus, adenovirus, adeno associated virus, baculovirus, HSV, coronavirus, Bovine papilloma virus, Mo-MLV and adeno associated virus.

33. The cell of any of items 27 to 32, wherein said vector is functional in
25 mammalian cells.

34. The cell of any of the preceding items wherein the cell is transformed or transduced with the vector of any of the items 27 to 33.

35. The cell of any of items 1 to 34, wherein said cell is a eukaryotic cell.

36. The cell of any of items 1 to 34, wherein said cell is a prokaryotic cell.

37. The cell of item 35, wherein said cell is selected from the group consisting of fungi cells such as yeast and aspergillus; microalgae such as Chlorella and Prototheca; plant cells; and mammalian cells, such as human, feline, porcine, simian, canine, murine, rat, mouse and rabbit cells.

5 38. The cell of item 37, wherein the yeast is selected from the group consisting of *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Yarrowia lipolytica*, *Candida glabrata*, *Ashbya gossypii*, *Cyberlindnera jadinii*, and *Candida albicans*.

39. The cell of item 37, wherein the cell is selected from the group consisting of CHO, CHO-K1, HEI193T, HEK293, COS, PC12, HiB5, RN33b, BHK cells.

10 40. The cell of item 36, wherein said cell is *E. coli*, *Corynebacterium*, *Bacillus*, *Pseudomonas* or *Streptomyces*.

41. The cell of any of items 35 to 40, wherein said prokaryotic cell, or said fungi cell, has been genetically modified to express at least a portion of the enzymes of the mevalonate independent pathway.

15 42. The cell according to any one of items 1 to 41, wherein the cell furthermore comprises a heterologous nucleic acid encoding GGPPS operably linked to a nucleic acid sequence directing expression of GGPPS in said cell.

43. The cell according to item 42, wherein said GGPPS is selected from the groups consisting of SEQ ID NO: 126, SEQ ID NO:123, SEQ ID NO:203, SEQ ID NO:167, and functional homologues thereof sharing at least 75% sequence identity with any of the aforementioned.

43. A method for producing a terpenoid compound synthesized through the squalene pathway, in a cell culture, said method comprising the steps of

- 25 (a) providing the cell of any one of items 1 to 42,
 (b) culturing the cell of (a).
 (c) recovering the terpenoid product compound.

44. A method for producing a terpenoid derived from a terpenoid precursor selected from the group consisting of Farnesyl-pyrophosphate (FPP), Isopentenyl-pyrophosphate (IPP), Dimethylallyl-pyrophosphate (DMAPP), Geranyl-pyrophosphate

(GPP) and/or Geranylgeranyl-pyrophosphate (GGPP),
said method comprising:

(a) contacting said precursor with an enzyme of the squalene synthase
pathway,

5 (b) recovering the terpenoid product.

45. The method of any of items 44 and 45, wherein the terpenoid product is selected from the group consisting of hemiterpenoids, monoterpenes, sesquiterpenoids, diterpenoids, sesterpenes, triterpenoids, tetraterpenoids and polyterpenoids.

46. The method of item 44, wherein the terpenoid is selected from the group
10 consisting of farnesyl phosphate, farnesol, geranylgeranyl, geranylgeraniol, isoprene, prenol, isovaleric acid, geranyl pyrophosphate, eucalyptol, limonene, pinene, farnesyl pyrophosphate, artemisinin, bisabolol, geranylgeranyl pyrophosphate, retinol, retinal, phytol, taxol, forskolin, aphidicolin, lanosterol, lycopene and carotene.

47. The method of item 46, wherein said method further comprises
15 dephosphorylating the farnesyl phosphate to produce farnesol.

48. The method of item 44, wherein the enzyme of the squalene synthase pathway is selected from the group consisting of Dimethylallyltransferase (EC 2.5.1.1), Isoprene synthase (EC 4.2.3.27) and Geranyltransferase (EC 2.5.1.10).

49. A method for reducing the translation rate of a functional squalene synthase
20 (EC 2.5.1.21) said method comprising:

- (a) providing the cell of any one of items 1 to 42,
- (b) culturing the cell of (a).

50. A method for decreasing turnover of farnesyl-pp to squalene, said method
comprising:

- 25
- (d) providing the cell of any one of items 1 to 42,
 - (e) culturing the cell of (a).

51. A method for enhancing accumulation of a compound selected from the group consisting of Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and Geranylgeranyl-pyrophosphate, said method
30 comprising the steps of:

- (a) providing the cell of any one of items 1 to 42, and
- (b) culturing the cell of (a).

52. The method of item 51, further comprising recovering the Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate or Geranylgeranyl-pyrophosphate compound.

53. The method of any one of items 51 and 52, further comprising recovering a compound synthesized through the squalene pathway, said compound being derived from said Farnesyl-pyrophosphate, Isopentenyl-pyrophosphate, Dimethylallyl-pyrophosphate, Geranyl-pyrophosphate and/or Geranylgeranyl-pyrophosphate.

54. The method of any of items 43 to 53, wherein the step of culturing the cell is performed in the presence of a squalene synthase inhibitor.

55. The method of any of items 43 to 54, wherein the cell additionally is genetically modified to enhance activity of and/or overexpress one or more enzymes selected from the group consisting of Phosphomevalonate kinase (EC 2.7.4.2), Diphosphomevalonate decarboxylase (EC 4.1.1.33), 4-hydroxy-3-methylbut-2-en-1-yl diphosphate synthase (EC 1.17.7.1), 4-hydroxy-3-methylbut-2-enyl diphosphate reductase (EC 1.17.1.2), Isopentenyl-diphosphate Delta-isomerase 1 (EC 5.3.3.2), Short-chain Z-isoprenyl diphosphate synthase (EC 2.5.1.68), Dimethylallyltransferase (EC 2.5.1.1), Geranyltranstransferase (EC 2.5.1.10) and Geranylgeranyl pyrophosphate synthetase (EC 2.5.1.29).

56. The method of any of items 43 to 55, wherein the cell additionally is genetically modified to enhance activity of and/or overexpress one or more enzymes selected from the group consisting of acetoacetyl CoA thiolase, HMG-CoA reductase or the catalytic domain thereof, HMG-CoA synthase, mevalonate kinase, phosphomevalonate kinase, phosphomevalonate decarboxylase, isopentenyl pyrophosphate isomerase, farnesyl pyrophosphate synthase, D-1-deoxyxylulose 5-phosphate synthase, and 1-deoxy-D-xylulose 5-phosphate reductoisomerase and farnesyl pyrophosphate synthase.

57. The method of any of items 43 to 56, wherein the cell comprises a mutation in the ERG9 open reading frame.

58. The method of any of items 43 to 57, wherein the cell comprises an ERG9[Delta]::HIS3 deletion/insertion allele.

59. The method of any of items 43 to 58, wherein the step of recovering the compound comprises purification of said compound from the cell culture media.

5

VI. Examples

The invention will be further described in the following examples, which do not limit the scope of the invention described in the claims. In the examples described herein, the following LC-MS methodology was used to analyze steviol glycosides and steviol pathway intermediates unless otherwise indicated.

10

1) Analyses of steviol glycosides

LC-MS analyses were performed using an Agilent 1200 Series HPLC system (Agilent Technologies, Wilmington, DE, USA) fitted with a Phenomenex® kinetex C18 column (150 x 2.1 mm, 2.6 µm particles, 100 Å pore size) connected to a TSQ Quantum Access (ThermoFisher Scientific) triple quadrupole mass spectrometer with a heated electrospray ion (HESI) source. Elution was carried out using a mobile phase of eluent B (MeCN with 0.1% Formic acid) and eluent A (water with 0.1% Formic acid) by increasing the gradient from 10->40 % B from min 0.0 to 1.0, increasing 40 -> 50% B in min 1.0 to 6.5, 50->100% B from min 6.5 to 7.0 and finally washing and re-equilibration.

The flow rate was 0.4ml/min and the column temperature 30°C. The steviol glycosides were detected using SIM (Single Ion Monitoring) in positive mode with the following m/z-traces.

20

Description	Exact Mass	m/z trace	compound (typical t_R in min)
Steviol + 1 Glucose	$[M+H]^+$ 481.2796	481.2± 0.5	19-SMG (6.1), 13-SMG (6.4)
	$[M+Na]^+$ 503.2615	503.1± 0.5	
Steviol + 2 Glucose	$[M+Na]^+$ 665.3149	665± 0.5	Rubusoside (4.7) Steviol-1,2-bioside (5.2) Steviol-1,3-bioside (5.8)
Steviol + 3 Glucose	$[M+Na]^+$ 827.3677	827.4 ± 0.5	1,2-Stevioside (4.0) 1,3-Stevioside (4.4) Rebaudioside B (5.0)
Steviol + 4 Glucose	$[M+Na]^+$ 989.4200	989.4 ± 0.5	Rebaudioside A (3.9)

Steviol + 5 Glucose	$[M+Na]^+$ 1151.4728	1151.4 ± 0.5	Rebaudioside D (3.3)
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The level of steviol glycosides were quantified by comparing with calibration curves obtained with authentic standards from LGC Standards. For example, standard solutions of 0.5 to 100 μ M Rebaudioside A were typically utilized to construct a calibration curve.

2) Analyses of Steviol and *ent*-kaurenoic acid

LC-MS analyses of steviol and *ent*-kaurenoic acid were performed on the system described above. For the separation, a Thermo Science Hypersil Gold (C-18, 3 μ m, 100x2.1mm) column was used and a 20mM ammonium acetate aqueous solution was used as eluent A and acetonitrile as eluent B. The gradient conditions were: 20->55% B in min 0.0 to 1.0, 55->100 in min 1.0-7.0 and finally washing and re-equilibration. The flow rate was 0.5 mL/min and the column temperature 30°C. Steviol and *ent*-kaurenoic acid were detected using SIM (Single Ion Monitoring) in negative mode with the following m/z-traces.

Description	Exact Mass	m/z trace	typical t_R in min
Steviol	$[M-H]^-$ 317.2122	317.4 ± 0.5	3.3
Ent-kaurenoic acid	$[M-H]^-$ 301.2173	301.4 ± 0.5	5.5

3) HPLC quantification of UDP-Glucose

For the quantification of UDP-glucose, an Agilent 1200 Series HPLC system was used, with a Waters XBridge BEH amide (2.5 μ m, 3.0x50mm) column. Eluent A was a 10 mM ammonium acetate aqueous solution (pH 9.0) and Eluent B acetonitrile. The gradient conditions were: 95% B holding from min 0.0-0.5, decreasing from 95-50% B in min 0.5-4.5, holding 50% B from min 4.5-6.8 and finally re-equilibrating to 95% B. The flow rate was 0.9 mL/min and the column temperature 20°C. UDP-glucose was detected by UV_{262nm} absorbance.

The amount of UDP-glucose was quantified by comparing with a calibration curve obtained with a commercially available standard (e.g., from Sigma Aldrich).

Example 1 –Identification of EUGT11

Fifteen genes were tested for RebA 1,2-glycosylation activity. See Table 10.

Table 10

Name	Source	GenBank Accession No.
EUGT2	Oryza sativa UGT91 homolog	AP003270
EUGT3	Oryza sativa UGT91 homolog	AP005171
EUGT4	Oryza sativa UGT91 homolog	AP005643
EUGT6	Oryza sativa UGT91 homolog	AP005259
EUGT7	Oryza sativa UGT91 homolog	AP005171
EUGT8	Oryza sativa UGT91 homolog	XM 470006
EUGT9	Oryza sativa UGT91 homolog	AP005643
EUGT10	Oryza sativa UGT91 homolog	AC133334
EUGT11	Oryza sativa UGT91 homolog	AC133334
EUGT12	Oryza sativa UGT91 homolog	AC133334
EUGT15	Petunia x hybrid UGT79 homolog	Z25802
EUGT16	Arabidopsis thaliana UGT79 homolog	AC004786
EUGT17	Dianthus caryophyllus UGT79 homolog	AB294391
EUGT18	Ipomoea nil UGT79 homolog	AB192314
EUGT19	Oryza sativa UGT79 homolog	NM_001074394

5

In vitro transcription and translation of these genes was performed, and the resulting UGTs incubated with RebA and UDP-glucose. Following incubation, the reactions were analyzed by LC-MS. The reaction mixture containing EUGT11 (Rice, AC133334, SEQ ID NO:152) was shown to convert significant quantities of RebA to RebD. See LC-MS chromatograms in FIG. 4. As shown in the left panel of FIG. 4, UGT91D2e produced a trace amount of RebD when RebA was used as the feedstock. As shown in the right panel of FIG. 4, EUGT11 produced a significant amount of RebD when RebA was used as the feedstock. Preliminary quantification of the amount of RebD that was produced indicated that EUGT11 was approximately 30 times more efficient than UGT91D2e at converting RebA to RebD.

15

To further characterize EUGT11 and for quantitative comparison to UGT91D2e, the nucleotide sequence encoding EUGT11 (SEQ ID NO: 153, non-codon optimized, FIG. 7) was cloned into two *E. coli* expression vectors, one containing an *N*-terminal

HIS-tag and one containing an *N*-terminal GST-tag. EUGT11 was expressed using both systems and purified. When the purified enzymes were incubated with UDP-glucose and RebA, RebD was produced.

Example 2 –Identification of EUGT11 Reactions

5 EUGT11 was produced by *in vitro* transcription and translation, and incubated with various substrates in the RebD pathway. Similar experiments were carried out using *in vitro* transcribed and translated UGT91D2e. FIG. 3 shows a schematic overview of 19-O-1,2-diglycosylation reactions performed by EUGT11 and UGT91D2e. Compounds 1-10 3 were identified solely by mass and expected retention time. The numbers shown in FIG. 3 are the average peak height of the indicated steviol glycoside obtained from a LC-MS chromatogram, and, although not quantitative, can be used to compare the activity of the two enzymes. EUGT11 and UGT91D2e were not able to use steviol as a substrate. Both enzymes were able to convert steviol 19-*O*-monoglucoside (SMG) to compound 1, with15 EUGT11 being about ten times more efficient than UGT91D2e at converting 19-SMG to compound 1.

Both enzymes were able to convert rubusoside to stevioside with comparable activity but only EUGT11 was able to convert rubusoside to compound 2 and compound 3 (RebE). See FIG. 5. The left panel of FIG. 5 contains LC-MS chromatograms of the20 conversion of rubusoside to stevioside. The right panel of FIG. 5 contains chromatograms of the conversion of rubusoside to stevioside, to compound 2, and to compound 3 (RebE). Conversion of rubusoside to compound 3 requires two consecutive 1, 2-*O*-glycosylations at the 19- and 13-positions of steviol. UGT91D2e was able to produce a trace amount of compound 3 (RebE) in one experiment whereas EUGT1125 produced a significant amount of compound 3.

Both enzymes were able to convert RebA to RebD. However, EUGT11 was approximately 30 times better at converting RebA to RebD. Overall, it appears that EUGT11 produces more product than UGT91D2e in all reactions (with similar time, concentrations, temperature, and purity of enzyme) except the conversion of rubusoside30 to stevioside.

Example 3 –Expression of EUGT11 in Yeast

The nucleotide sequence encoding EUGT11 was codon-optimized (SEQ ID NO:154) and transformed into yeast along with nucleic acids encoding all four UGTs (UGT91D2e, UGT74G1, UGT76G1, and UGT85C2). The resulting yeast strain was grown in medium containing steviol and steviol glycosides that accumulated were analyzed by LC-MS. EUGT11 was required for the production of RebD. In other experiments, RebD production has been observed with UGT91D2e, UGT74G1, UGT76G1, and UGT85C2.

Example 4 –UGT Activity on 19-O-1,2-diglycosylated steviol glycosides

The 19-O-1,2-diglycosylated steviol glycosides produced by EUGT11 need further glycosylation to be converted to RebD. The following experiments were performed to determine if other UGTs could use these intermediates as substrates.

In one experiment, compound 1 was produced *in vitro* from 19-SMG by either EUGT11 or UGT91D2e in the presence of UDP-glucose. After boiling the sample, UGT85C2 and UDP-glucose were added. The sample was analyzed by LC-MS and compound 2 was detected. This experiment indicated that UGT85C2 can use compound 1 as a substrate.

In another experiment, compound 2 was incubated with UGT91D2e and UDP-glucose. The reaction was analyzed by LC-MS. UGT91D2e was not able to convert compound 2 to compound 3 (RebE). Incubation of compound 2 with EUGT11 and UDP-glucose results in the production of compound 3. UGT76G1 was able to use RebE as a substrate to produce RebD.

This shows that the 19-O-1,2-diglycosylation of the steviol glycosides is able to take place at any time during production of RebD as the downstream enzymes are able to metabolize the 19-O-1,2-diglycosylated intermediates.

Example 5 – Comparison of EUGT11 and UGT91D2e Sequence

The amino acid sequence of EUGT11 (SEQ ID NO:152, FIG. 7) and the amino acid sequence of UGT91D2e (SEQ ID NO:5) were aligned using the FASTA algorithm (Pearson and Lipman, Proc. Natl. Acad. Sci., 85:2444-2448 (1998)). See FIG. 6.

5 EUGT11 and UGT91D2e are 42.7% identical over 457 amino acids.

Example 6 –Modification of 19-1,2-diglycosylating activity of UGT91D2e

Crystal structures are available for a number of UGTs. Generally, the N-terminal half of a UGT is primarily involved with substrate binding whereas the C-terminal half is
10 involved in binding the UDP-sugar donor.

Modeling the secondary structure of UGT91D2e onto the secondary structure of the UGTs that have been crystalized revealed a conserved pattern of secondary structure, despite a highly diverged primary sequence as shown in FIG. 8. The crystal structures of UGT71G1 and UGT85H2 (see, for example H. Shao *et al*, The Plant Cell November
15 2005 vol. 17 no 11 3141-3154 and L. Li *et al.*, J Mol Biol. 2007 370(5):951-63) have been reported. Known loops, alpha-helices and beta-sheets are indicated on UGT91D2e in FIG. 8. Although the homology at the primary structure level of these UGTs is fairly low, the secondary structure appears to be conserved, allowing predictions regarding the locations of amino acids involved in substrate binding on UGT91D2e based on the
20 location of such amino acids in UGT85H2 and UGT71G1.

Regions commonly involved in substrate binding were superimposed on UGT91D2e and largely shown to coincide with the 22 amino acid differences from UGT91D1 (GenBank Accession No. Protein Accession number AAR06918, GI:37993665). UGT91D1 is highly expressed in *Stevia* and thought to be a functional
25 UGT. However, its substrate is not a steviol glycoside. This suggests that UGT91D1 has a different substrate, which may be defined by the 22 amino acids with which it differs from UGT91D2e. FIG. 9 is an alignment of the amino acid sequences of UGT91D1 and UGT91D2e. The boxes represent areas that are reported to be involved in substrate binding. The amino acids highlighted in dark grey show the 22 amino acid differences
30 between UGT91D1 and UGT91D2e. Stars denote amino acids that have been shown to

be involved in substrate binding in UGTs that have had their crystal structure resolved (more stars under one particular amino acids means substrate binding has been shown with more than one structure-resolved UGTs). There is a strong correlation between the 22 amino acid differences between the two UGT91s, the regions known to be involved in substrate binding, and the actual amino acids involved in substrate binding in the crystal structure-resolved UGTs. This suggests that the 22 amino acid differences between the two UGT91s are involved in substrate binding.

All 22 altered 91D2es were expressed in a XJb Autolysis *E. coli* strain from a pGEX-4T1 vector. In order to assess the activity of the enzymes, two substrate feeding experiments were performed - *in vivo* and *in vitro*. Most mutants had lower activity than wild type, however, 5 mutants showed increased activity. This was reproduced by *in vitro* transcription and translation (IVT) and showed that C583A, C631A and T857C have approximately 3-fold higher stevioside-forming activity than the wild-type UGT91D2e, whereas C662t and A1313C had approximately twice the stevioside-forming activity (nucleotide numbering). These changes result in amino acid mutations corresponding to L195M, L211M, V286A; and S221F and E438A, respectively. The increased activity differed depending on substrate, with C583A and C631A showing almost a 10-fold increase using 13-SMG as substrate and about a 3-fold increase using rubusoside as substrate, whereas T857C showed a 3-fold increase when using either 13-SMG or rubusoside as substrate.

To investigate if these mutations were additive, a range of double mutants were made and analyzed for activity (FIG. 10). In this particular experiment, a higher wild type level of activity was observed than the previous four experiments; however, the relative activities of the mutations remain the same. As rubusoside accumulates in many of the *S. cerevisiae* strains expressing the 4 UGTs (UGT74G1, UGT85C2, UGT76G1, and UGT91D2e), the stevioside-forming activity may be more important for increasing steviol glycoside production. As such, the double mutant C631A/T857C (nucleotide numbering) may be useful. This mutant has been named UGT91D2e-b, which contains the amino acid modifications L211M and V286A. The experiments have been reproduced *in vitro* using *S. cerevisiae*-expressed UGT91D2e-mutants.

To improve 19-1,2-diglycosylating activity of UGT91D2e, a directed saturated mutagenic screen of UGT91D2e of the 22 amino acid differences between UGT91D2e and UGT91D1 was performed. GeneArt's® (Life Technologies, Carlsbad, CA) site-saturation mutagenesis was used to obtain a library containing each of the mutations.

5 The library was cloned into the BamHI and NotI sites of pGEX4T1 bacterial expression plasmid expressing the mutated versions of 91D2e as GST fusion proteins, resulting in a new library (Lib#116). Lib#116 was transformed into XJbAutolysis *E. coli* strain (ZymoResearch, Orange, CA) to produce approximately 1600 clones containing the 418 expected mutations (i.e., 22 positions with 19 different amino acids at each position).

10 Other plasmids expressing GST-tagged versions of 91D2e (EPCS1314), 91D2e-b (EPSC1888) or EUGT11 (EPSC1744) as well as the empty pGEX4T1 (PSB12) were transformed as well.

Screening by LC-MS

To analyze the approximately 1600 mutant clones of UGT91D2e, the *E. coli* transformants were grown overnight at 30°C in 1 ml of NZCYM containing ampicillin
15 (100 mg/l) and chloramphenicol (33 mg/l), in 96-well format. The next day, 150 µl of each culture was inoculated into 3 ml NZCYM containing ampicillin (100 mg/l), chloramphenicol (33 mg/l), arabinose 3 mM, IPTG 0.1 mM and ethanol 2% v/v, in 24-well format, and incubated at 20°C and 200 rpm for ~20h. The following day, cells were
20 spun down and pellets were resuspended in 100 µl of lysis buffer containing 10mM Tris-HCl pH 8, 5 mM MgCl₂, 1 mM CaCl₂ and complete mini protease inhibitor EDTA-free (3 tablets/100 ml) (Hoffmann-La Roche, Basel, Switzerland) and frozen -80°C for at least 15 minutes to promote cell lysis. Pellets were thawed at room temperature and 50 µl of DNase mix (1 µl of 1.4 mg/ml DNase in H₂O (~80000u/ml), 1.2 µl of MgCl₂ 500 mM
25 and 47.8 µl of 4x PBS buffer solution) was added to each well. Plates were shaken at 500 rpm for 5 min at room temperature to allow degradation of genomic DNA. Plates were spun down at 4000 rpm for 30 min at 4°C and six µl of the lysates were used in UGT *in vitro* reactions as described for GST-91D2e-b, using rubusoside or rebaudioside A as substrates. In each case, the resulting compounds, stevioside or rebaudioside D (rebD),
30 were measured by LC-MS. Results were analyzed in comparison with the stevioside or

rebD produced by the lysates expressing the corresponding controls (91D2e, 91D2e-b, EUGT11 and the empty plasmid). Clones showing activity similar to or higher than the ones expressing 91D2e-b were selected as primary hits.

Half of the 1600 clones and the corresponding controls were assayed for their capacity to glycosylate rubusoside and rebaudiosideA. Stevioside and RebD were quantified by LC-MS. Under the conditions used, lysates from clones expressing the native UGT91D2e show activity just around background with both substrates (approximately 0.5 μ M stevioside and 1 μ M RebD), while clones expressing UGT91D2e-b show consistently improved product formation (>10 μ M Stevioside; >1.5 μ M RebD). Clones expressing EUGT11 consistently display a higher level of activity, especially using RebA as substrate. Cutoff for considering clones as *primary hits* in the screening was generally set at 1.5 μ M for both products, but in some cases was adjusted for each independent assay.

Example 7 –EUGT11 Homologs

A Blastp search of the NCBI nr database using the EUGT11 protein sequence revealed approximately 79 potential UGT homologs from 14 plant species (one of which is the Stevia UGT91D1, approximately 67% identical to EUGT11 in conserved UGT regions but less than 45% overall). Homologs with greater than 90% identity in conserved regions were identified from corn, soybean, *Arabidopsis*, grape, and *Sorghum*. The overall homology of the full-length EUGT11 homologs, at the amino acid level, was only 28-68%.

RNA was extracted from plant material by the method described by Iandolino *et al.* (Iandolino et al., *Plant Mol Biol Reporter* 22, 269-278, 2004), the RNeasy Plant mini Kit (Qiagen) according to the manufacturer's instructions, or using the Fast RNA Pro Green Kit (MP Biomedicals) according to the manufacturer's instructions. cDNA was produced by AffinityScript QPCR cDNA Synthesis Kit (Agilent) according to the manufacturer's instructions. Genomic DNA was extracted using the FastDNA kit (MP biomedicals) according to the manufacturer's instructions. PCR was performed on cDNA

using either the Dream Taq polymerase (Fermentas) or the Phusion polymerase (New England Biolabs) and a series of primers designed to amplify the homologs.

5 PCR-reactions were analyzed by electrophoresis in SyberSafe-containing agarose-TAE gels. DNA was visualized by UV-irradiation in a trans illuminator. Bands of the correct size were cut out, purified through spin columns according to the manufacturer's specifications, and cloned into TOPO-Zero blunt (for Phusion polymerase-generated products) or TOPO-TA (for Dream Taq-generated products). The TOPO-vectors containing the PCR-products were transformed into *E. coli* DH5Ba and plated on LB-agar plates containing the appropriate selective antibiotics. DNA was extracted from surviving colonies and sequenced. The genes with the correct sequence were cut out by restriction digest with SbfI and AscI, cloned into similarly digested IVT8 vector and transformed into *E. coli*. PCRs were performed on all cloned genes to amplify the gene and flanking regions required for *in vitro* transcription and translation. Proteins were produced from the PCR products by *in vitro* transcription and translation using the Promega L5540, TNT T7 Quick for PCR DNA Kit according to the manufacturer's instructions. Production of protein was evaluated by incorporation of ³⁵S-methionine followed by separation by SDS-PAGE and visualization on a Typhoon phosphor-imager.

Activity assays were set up totaling 20% (by volume) of each *in vitro* reaction, 0.1 mM rubusoside or RebA, 5% DMSO, 100 mM Tris-HCl pH 7.0, 0.01 units Fast alkaline phosphatase (Fermentas), and 0.3 mM UDP-glucose (final concentrations). Following incubation at 30°C for one hour, the samples were analyzed by LC-MS for production of stevioside and RebD as described above. The UGT91D2e and UGT91D2e-b (double mutant described in Example 6) were used as positive controls, along with EUGT11. Under the initial assay conditions, clone P 64B (see Table 11) produced a trace amount of product using rubusoside and RebA. Table 11 lists the percent identity at the amino acid level compared to EUGT11 for the whole length of the UGTs, which ranges from 28-58%. High amounts of homology (96-100%) were observed over shorter stretches of sequences, which may indicate highly conserved domains of plant UGTs.

Table 11.

30 **List of cloned EUGT11 homologs and their amino acid percent identity to EUGT11.**

UGT	Accession	% identity to EUGT11
P44G	XP_002297733.1	32.16
P54A	XP_002532392.1	34.20
P51H	XP_002325254.1	32.53
P55D	XP_002533517.1	31.90
P5F	AAM12787.1	31.73
P48G	XP_002318358.1	33.20
P52F	XP_002334090.1	32.80
P48F	XP_002318358.1	33.00
T4B-b	NP_565540.4	31.19
P56C	XP_002533518.1	32.60
T67H	XP_002270294.1	34.06
T65E	CAN80742.1	34.98
T74G	XP_002270331.1	35.48
T65D	CAN80742.1	34.98
T69F1	XP_003635103.1	34.69
P6B	Q66PF2.1	33.20
P6D variant	Q66PF2.1	33.60
P64B	ACE87855.1	34.64
T3F	AT5G65550	34.94
P53H	XP_002527371.1	33.40
P53F	XP_002527371.1	33.40
P46H	XP_002303861.1	32.40
2-b	NP_199780.1	35.79
T70F	XP_002275802.1	36.67
T72A	XP_002275850.1	36.42
T71G	XP_002275824.1	37.25
P49G	XP_002320817.1	35.15
P57H	XP_002511902.1	36.23
45 Pop	XP_002302598.1	34.21
P50G	XP_002323718.1	32.86
P50H	XP_002323718.1	32.66
T73G	XP_002281094.1	32.05
63	XP_002458816.1	37.25
P78B	NP_001147674.1	35.33
62	XP_002458815.1	34.06
P9F	BAJ84800.1	37.92
T7H	NP_001240857.1	31.30
16-1	BAJ93155.1	58.03
T16H	BAJ93155.1	58.03
31TA	BAD35324.1	51.81

P41G	NP_001174664.1	35.40
P37G	NP_001051010.1	56.71
P60aH	XP_002466606.1	57.35
12	BAJ89368.1	44.35
P12A	BAJ89368.1	44.35
P12H	BAJ89368.1	44.35
P10B	BAJ86656.1	45.16
P58aF	XP_002463702.1	43.71
P59aG	XP_002463705.1	43.51
P76H	NP_001140711.1	28.81

Example 8 - Cell-free Biocatalytic Production of Reb-D

The cell-free approach is an *in vitro* system where RebA, stevioside or a steviol glycoside mixture is enzymatically converted to RebD. The system requires stoichiometric amounts of UDP-glucose and therefore UDP-glucose regeneration from UDP and sucrose using sucrose synthase can be used. Additionally, sucrose synthase removes UDP produced during the reaction, which improves conversion to glycosylated products by alleviated product inhibition observed for glycosylation reactions. See, WO 2011/153378.

Enzyme expression and purification

UGT91D2e-b (described in Example 6) and EUGT11 are key enzymes that catalyze the glycosylation of RebA yielding RebD. These UGTs were expressed in bacteria (*E. coli*) but one of ordinary skill in the art will appreciate that such proteins also can be prepared using different methods and hosts (e.g., other bacteria such as *Bacillus sp.*, yeast such as *Pichia sp.* or *Saccharomyces sp.*, other fungi (e.g., *Aspergillus*), or other organisms). For example, the proteins can be produced by *in vitro* transcription and translation or by protein synthesis.

The UGT91D2e-b and EUGT11 genes were cloned in pET30a or pGEX4T1 plasmids. Resulting vectors were transformed into an XJb (DE3) Autolysis *E. coli* strain (ZymoResearch, Orange, CA). Initially, *E. coli* transformants were grown overnight at 30°C in NZCYM medium, followed by induction with 3 mM arabinose and 0.1 mM IPTG, and further incubation overnight at 30°C. The corresponding fusion proteins were purified by affinity chromatography using included 6HIS- or GST- tags and standard

methods. One skilled in the art will appreciate that other protein purification methods such as gel filtration or other chromatography techniques also can be used, along with precipitation/crystallization or fractionation with e.g., ammonium sulfate. While EUGT11 was expressed well using the initial conditions, UGT91D2e-b required several
5 modifications to the base protocol to increase protein solubility, including lowering the temperature of the overnight expression from 30°C to 20°C and adding 2% ethanol to the expression medium. Generally 2-4 mg/L of soluble GST-EUGT11 and 400-800 µg/l of GST-UGT91D2e-b were purified with this method.

Stability of EUGT11

10 Reactions were conducted to explore the stability of EUGT11 under various RebA to RebD reaction conditions. Omitting the substrate from the reaction mixture, EUGT11 was pre-incubated for various periods of time before substrate was added. Following a pre-incubation of the enzyme in 100 mM Tris-HCl buffer, substrate (100 µM RebA) and other reaction components (300 µM UDP-glucose, and 10 U/mL Alkaline
15 Phosphatase (Fermentas/Thermo Fisher, Waltham, MA)) were added (0, 1, 4 or 24 hours after the incubation was started). The reaction was then allowed to proceed for 20h, after which the reactions were stopped and RebD product-formation measured. Experiments were repeated at different temperatures: 30°C, 32.7°C, 35.8°C and 37°C.

The activity of EUGT11 was reduced rapidly when the enzyme was pre-incubated
20 at 37°C, reaching approximately half activity after 1 hour, and having almost no activity after 4 hours. At 30°C, the activity was not significantly reduced after 4 hours and after 24 hours, approximately one-third of the activity remained. This suggests that EUGT11 is heat-labile.

To assess the thermal stability of EUGT11 and to compare it with the other UGTs
25 in the steviol glycosylation pathway, denaturation temperatures of the proteins were determined using differential scanning calorimetry (DSC). Use of DSC thermograms to estimate denaturation temperatures, T_D , is described, for example, by E. Freire in *Methods in Molecular Biology* 1995, Vol. 40 191-218. DSC was performed (using 6HIS-purified EUGT11, yielding an apparent T_D of 39°C; while when GST-purified 91D2e-b was used,
30 the measured T_D was 79°C. For reference, the measured T_D when using 6HIS-purified

UGT74G1, UGT76G1 and UGT85C2 was 86°C in all cases. One of skill in the art will recognize that enzyme immobilization or addition of thermal protectants can be added to the reactions to improve stability of the protein. Non-limiting examples of thermal protectants include trehalose, glycerol, ammonium sulphate, betaine, trimethylamine oxide, and proteins.

Enzyme kinetics

A series of experiments were performed to determine kinetic parameters of EUGT11 and 91D2e-b. For both enzymes, 100 μ M RebA, 300 μ M UDP-glucose, and 10 U/mL Alkaline Phosphatase (Fermentas/Thermo Fisher, Waltham, MA) were used in the reactions. For EUGT11, the reactions were performed at 37°C using 100 mM Tris-HCl, pH 7, and 2% enzyme. For 91D2e-b, the reactions were performed at 30°C using 20 mM Hepes-NaOH, pH 7.6, 20% (by volume) enzyme. The initial velocities (V_0) were calculated in the linear range of a product versus time plot.

To first investigate the linearity intervals, initial time-courses were done for each enzyme. EUGT11 was assayed at 37°C for 48h at initial concentrations of 100 μ M RebA and 300 μ M UDP-glucose. UGT91D2e-b was assayed at 37°C for 24h at initial concentrations of 200 μ M RebA and 600 μ M UDP-glucose. Based on these range-finding studies, it was determined that the initial 10 minutes in the case of EUGT11, and the initial 20 minutes in UGT91D2e-b would be in the linear range with respect to product formation, and therefore initial velocities of each reaction were calculated in those intervals. In the case of EUGT11, RebA concentrations assayed were 30 μ M, 50 μ M, 100 μ M, 200 μ M, 300 μ M and 500 μ M. Concentration of UDP-glucose was always three times the concentration of RebA and incubation was performed at 37°C. By plotting the calculated V_0 as a function of the substrate concentrations, Michaelis-Menten curves were generated. By plotting the reciprocal of V_0 and the reciprocal of [S], a Lineweaver-Burk graphic was obtained, with $y = 339.85x + 1.8644$; $R^2 = 0.9759$.

$V_{\max}$ and K_M parameters were determined from the curve-fit Lineweaver-Burk data, calculated from the x- and y intercepts ($x=0$, $y=1/V_{\max}$) and ($y=0$, $x=-1/K_M$). Additionally, the same parameters also were calculated by a non-linear least squares regression, using the SOLVER function in Excel. The results obtained with both methods

for EUGT11 and RebA are presented in Table 12, along with all the kinetic parameters of this example. Results from both Nonlinear Least Square Fit method and Lineweaver-Burk plot are presented in Table 12. K_{cat} is calculated based on V_{max} divided by the approximate amount of protein in the assay.

Table 12
Comparison of kinetic parameters for EUGT11 and UGT 91D2e-b, with RebA or UDP-glucose as substrate.

	Nonlinear Least Square Fit				Lineweaver-Burk plot			
	Reb A		UDP-glucose		Reb A		UDP-glucose	
	EUGT11	91D2e-b	EUGT11	91D2e-b	EUGT11	91D2e-b	EUGT11	91D2e-b
$V_{\max}$ ($\mu\text{M}\cdot\text{min}^{-1}$)	0.52	0.34	0.79	0.19	0.54	0.44	0.78	0.18
K_{cat} (min^{-1})	8.11	0.32	12.32	0.2	8.42	0.41	12.1	0.19
K_M (μM)	162.5	1150	130	45.1	182.3	1580	118	41.9
K_{cat}/K_M ($\text{min}^{-1}\cdot\mu\text{M}^{-1}$)	0.05	0.000275	0.095	0.00454	0.046	0.000258	0.102	0.00463

In order to investigate the influence of UDP-glucose concentration in the glycosylation reaction, as well as the affinity of EUGT11 for UDP-glucose, similar kinetics analysis were performed. EUGT11 was incubated with increasing amounts of UDP-glucose (20 μ M, 50 μ M, 100 μ M, and 200 μ M), maintaining an excess of RebA (500 μ M). The kinetic parameters were calculated as described above, and shown in Table 12.

In the case of UGT91D2e-b, RebA concentrations assayed were 50 μ M, 100 μ M, 200 μ M, 300 μ M, 400 μ M and 500 μ M. Concentration of UDP-glucose was always three times the concentration of RebA and incubation was performed at 30°C, in the reaction conditions described above for UGT91D2e-b. The kinetic parameters were calculated as previously described; and the resulting kinetic parameters are shown in Table 12. Additionally, kinetic parameters of UGT91D2e-b towards UDP-glucose were determined. UGT91D2e-b was incubated with increasing amounts of UDP-glucose (30 μ M, 50 μ M, 100 μ M, and 200 μ M), maintaining an excess of RebA (1500 μ M). incubation was performed at 30°C, in optimal conditions for UGT91D2e-b. The kinetic parameters were calculated as previously described and results are presented in Table 12.

By comparison of the kinetics parameters for EUGT11 and 91D2e-b, it was concluded that 91D2e-b has a lower K_{cat} and has lower affinity for RebA (higher K_M) although the K_M for UDP-glucose of 91D2e-b is lower than EUGT11. UGT91D2e-b has a lower K_{cat}/K_M which is a measure of catalytic efficiency, combining information on rate of catalysis with a particular substrate (K_{cat}) and the strength of enzyme-substrate binding (K_M).

Determining the limiting factor in reactions

Under the conditions described above for EUGT11, approximately 25% of the RebA administered was converted to RebD. The limiting factor in these conditions could be either the enzyme, UDP-glucose or RebA. Experiments were set up to distinguish between these possibilities. A standard assay was allowed to run its course during 4 hours. This was followed by addition of either extra RebA substrate, extra enzyme, extra UDP-glucose or extra enzyme and UDP-glucose. Addition of extra enzyme resulted in a relative increase of the conversion of around 50%, adding extra RebA or UDP-glucose

alone did not increase the conversion significantly, but the simultaneous addition of enzyme and UDP-glucose increased the conversion approximately 2-fold.

Experiments were conducted to examine the limit to this benefit of adding bolus amounts of UDP-glucose and fresh enzyme in the conversion of RebA to RebD reaction. Additional enzyme or enzyme and UDP-glucose were added after 1, 6, 24 and 28 hours. In the case of the addition of both extra EUGT11 and UDP-glucose, a conversion of more than 70% was achieved. No other components had a significant effect on the conversion. This indicates that EUGT11 is a primary limiting factor for the reaction but UDP-glucose also is limiting. As UDP-glucose is present at 3-fold higher concentration than RebA, this indicates that UDP-glucose may be somewhat unstable in the reaction mixture, at least in the presence of EUGT11. Alternatively, as explained below, EUGT11 may be metabolizing the UDP-glucose.

Inhibition studies

Experiments were conducted to determine if factors such as sucrose, fructose, UDP, product (RebD) and impurities in the less pure Stevia extracts raw materials inhibited the extent of the conversion of steviol glycoside substrates to RebD. In a standard reaction mixture, excess of the potential inhibitors (sucrose, fructose, UDP, RebD, or a commercial blend of steviol glycosides (*Steviva*, Steviva Brands, Inc., Portland, OR)) were added. Following incubation, RebD-production was quantified. Addition of 500 µg/ml of the commercial *Steviva* mix (approximately 60% 1,2-stevioside, 30% RebA, 5% Rubusoside, 2% 1,2-bioside, less than 1% of RebD, RebC and others, as evaluated by LC-MS) was not found to be inhibitory, but rather increased the overall RebD production (to around 60 µM from around 30 µM without any addition) well beyond the RebD originally added with the blend (around 5 µM). From the molecules tested, only UDP was shown to have an inhibitory effect on RebD-production at the concentration used (500 µM), as measured by LC-MS. The RebD that was produced was less than 7 µM. This inhibition can be alleviated in the *in vivo* or *in vitro* reactions for RebD production, by including an UDP recycling system to UDP-glucose, either by yeast or by an added SUS (sucrose synthase enzyme) in conjunction with sucrose. Moreover, when working with lower amounts of UDP-glucose (300 µM), the

addition of alkaline phosphatase to remove UDP-G does not increase the amount of RebD produced in the *in vitro* glycosylations substantially, suggesting that the UDP produced may not be inhibitory at these concentrations.

RebA vs crude steviol glycoside mix

5 In some experiments, a crude steviol glycoside mix was used as a source of RebA instead of purified RebA. As such a crude steviol glycoside mix contains a high percentage of stevioside along with RebA, UGT76G1 was included in the reactions. *In vitro* reactions were performed as described above using 0.5 g/l of the *Steviva*[®] mix as substrate and enzyme (UGT76G1 and/or EUGT11) and incubated at 30°C. The presence
10 of steviol glycosides was analyzed by LC-MS.

 When only UGT76G1 was added to the reactions, stevioside was converted to RebA quite efficiently. An unknown penta-glycoside (with a retention time peak at 4.02 min) also was detected. When only EUGT11 was added to the reaction, large amounts of RebE, RebA, RebD and an unknown steviol-pentaglycoside (with a retention time peak at
15 3.15 min) were found. When both EUGT11 and UGT76G1 were added to the reactions, the stevioside peak was reduced, and almost entirely converted to RebA and RebD. There were trace amounts of the unknown steviol-pentaglycoside (peak at 4.02 min). No RebE was detected nor was the second unknown steviol-pentaglycoside (peak at 3.15 min). This result indicated that the use of stevia extracts as a substrate to produce RebD *in vitro*
20 is possible when EUGT11 and UGT76G1 are used in combination.

Non-specific UDP-glucose metabolism

 To determine if EUGT11 can metabolize UDP-glucose independently of the conversion of RebA to RebD, GST-purified EUGT11 was incubated in the presence or absence of RebA substrate, and UDP-glucose usage was measured as UDP-release, using
25 the TR-FRET Transcreener[®] kit (BellBrook Labs). The Transcreener[®] kit is based on a tracer molecule bound to an antibody. The tracer molecule is displaced by UDP or ADP in a highly sensitive and quantitative manner. The FP kit includes an Alexa633 tracer bound to an antibody. The tracer is displaced by UDP/ADP. The displaced tracer freely rotates leading to a decrease in fluorescence polarization. Therefore, UDP production is
30 proportional to a decrease in polarization. The FI kit includes a quenched Alexa594

Tracer bound to an antibody, which is conjugated to an IRDye® QC-1 quencher. The tracer is displaced by UDP/ADP, whereby the displaced tracer is un-quenched, leading to a positive increase in fluorescence intensity. Therefore, UDP production is proportional to an increase in fluorescence. A TR-FRET kit includes a HiLyte647 Tracer bound to an
5 Antibody-Tb conjugate. Excitation of the terbium complex in the UV range (ca. 330 nm) results in energy transfer to the tracer and emission at a higher wavelength (665nm) after a time delay. The tracer is displaced by UDP/ADP causing a decrease in TR-FRET.

It was observed that UDP-glucose measured was the same independent of the presence of RebA substrate. UDP release was not detectable in the absence of enzyme.
10 This indicates a non-specific degradation of UDP-glucose by EUGT11. Nevertheless, RebD was still produced when RebA was added, suggesting that EUGT11 would preferentially catalyze RebA glycosylation over the non-specific UDP-glucose degradation.

Experiments were set up to find out the destiny of the glucose molecule in the
15 absence of RebA or other obvious glycosylation substrates. One common factor in all previous reactions was the presence of Tris buffer and/or trace amounts of glutathione, which both contain potential glycosylation sites. The effect of these molecules on the non-specific UDP-glucose consumption was assayed using GST-purified EUGT11 (with glutathione) and HIS-purified enzyme (without glutathione) in *in vitro* reactions, in the
20 presence or absence of RebA. UDP-glucose usage was measured as UDP-release, using the TR-FRET Transcreener® kit. UDP release occurred in all cases and was independent of the presence of RebA. UDP release was slower when the HIS-purified enzyme was used, but the overall catalytic activity of the enzyme in conversion of RebA to RebD was also lower, suggesting a lower amount of active soluble enzyme present in the assay.
25 Therefore, it appears that the UDP-glucose metabolism by EUGT11 is independent of the presence of substrate and independent of the presence of glutathione in the reaction, under the conditions tested.

To test the effect of Tris on the metabolism of UDP-glucose by EUGT11, GST-EUGT11 was purified using a Tris- or a PBS-based buffer for the elution, obtaining
30 similar amounts of protein in both cases. Tris- and PBS-purified enzymes were used in *in*

vitro reactions using Tris and HEPES as buffers respectively, in the presence or absence of RebA in a similar manner as above. In both conditions, the UDP release was the same in the reactions whether RebA was added or not, indicating that the metabolism of UDP-glucose by EUGT11 is independent of both the presence of RebA and Tris in the
5 reaction. This suggests that the UDP-release detected may somehow be an artifact caused by a property of EUGT11 or, alternatively, EUGT11 may be hydrolyzing UDP-glucose. EUGT11 is still efficient at converting RebA to RebD preferentially and the loss of UDP-G can be compensated by addition of the sucrose synthase recycling system described below.

10 **RebA solubility**

The solubility of RebA determines the concentration that can be used both for the whole-cell approach and for the cell-free approach. Several different solutions of RebA in water were made and left at room temperature for several days. After 24 hours of storage, RebA precipitated at concentrations of 50 mM or higher. Twenty-five mM RebA started
15 to precipitate after 4-5 days, while 10 mM or lower concentrations remained in solution, even when stored at 4°C.

RebD solubility

The solubility of RebD was assessed by making several different solutions of RebD in water were made and incubated at 30°C for 72 hours. RebD was found to be
20 soluble in water initially in concentrations of 1 mM or lower while concentrations of 0.5 mM or less were found to be stable for longer periods of time. One with skill in the art will recognize that the solubility can be influenced by any number of conditions such as pH, temperature, or different matrices.

Sucrose synthase

Sucrose synthase (SUS) has been used to regenerate UDP-glucose from UDP and sucrose (FIG. 11) for other small molecule glycosylations (Masada Sayaka *et al. FEBS Letters* 581 (2007) 2562–2566.). Three SUS1 genes from *A. thaliana*, *S. rebaudiana* and coffee (*Coffea arabica*) were cloned into pGEX4T1 *E. coli* expression vectors (see FIG.
25 17 for the sequences). Using methods similar to those described for EUGT11, around 0.8 mg/l of GST-AtSUS1 (*A. thaliana* SUS1) was purified. Initial expression of CaSUS1
30

(*Coffea arabica* SUS1) and SrSUS1 (*S. rebaudiana* SUS1) followed by GST-purification did not produce significant amounts of protein although, when analyzed by western blot, the presence of GST-SrSUS1 was verified. When GST-SrSUS1 was expressed at 20°C in the presence of 2% ethanol, approximately 50 µg/l of enzyme was produced.

5 Experiments were performed to evaluate the UDP-glucose regenerating activity of the purified GST-AtSUS1 and GST-SrSUS1. *In vitro* assays were conducted in 100 mM Tris-HCl pH=7.5 and 1 mM UDP (final concentration). Either ~2.4 µg of purified GST-AtSUS1, ~0.15 µg of GST-SrSUS1, or ~1.5 µg commercial BSA (New England Biolabs, Ipswich, MA) were also added. Reactions were done in presence or absence of ~200 mM
10 sucrose and incubated at 37°C for 24h. Product UDP-glucose was measured by HPLC as described in the analytical section. AtSUS1 produced ~0.8 mM UDP-glucose when sucrose was present. No UDP-glucose was observed when SrSUS1 or the negative control (BSA) was used. The lack of activity observed for SrSUS1 could be explained by the poor quality and concentration of the purified enzyme. UDP-glucose production by
15 AtSUS1 was sucrose dependent and, therefore, it was concluded that AtSUS1 can be used in a coupled reaction to regenerate the UDP-glucose used by EUGT1 or other UGTs for small molecule glycosylation (FIG. 11, above).

 SUS catalyzes the formation of UDP-glucose and fructose from sucrose and from UDP as depicted in FIG. 11. This UDP-glucose then can be used by EUGT11 for
20 glycosylation of RebA to produce RebD. *In vitro* assays as described above were performed, adding ~200 mM sucrose, 1 mM UDP, 100 µM RebA, ~1.6 µg purified GST-AtSUS1 and ~0.8 µg GST-EUGT11. Formation of product, RebD, was evaluated by LC-MS. When AtSUS, EUGT11, sucrose and UDP were mixed with RebA, 81±5 µM of RebD was formed. The reaction was dependent on the presence of AtSUS, EUGT11 and
25 sucrose. The conversion rate was similar to what has been observed previously using UDP-glucose provided extraneously. This shows that AtSUS can be used to regenerate UDP-glucose for RebD-formation by EUGT11.

Example 9: Whole-cell Biocatalytic Production of RebD

In this example, several parameters were studied that are factors for using whole cell biocatalytic systems in the production of RebD from RebA or other steviol glycosides. The ability of raw materials to cross the cell membrane and availability of UDP-glucose are two such factors. Permeabilizing agents were studied as well as
5 different cell types to ascertain which systems may be the most beneficial for RebD production.

Permeabilizing agents

Several different permeabilization agents have previously been shown to allow intracellular enzymatic conversion of various compounds that are normally not able to
10 cross a cell membrane (Chow and Palecek, *Biotechnol Prog.* 2004 Mar-Apr;20(2):449-56). In several cases, the approaches resemble a partial lysis of the cells and, in yeast, often rely on the removal of the cell membrane by a detergent and the encapsulation of the enzymes inside of the remaining cell wall, which is permeable to smaller molecules. Common to these methods is the exposure to the permeabilizing agent followed by a
15 centrifugation step to pellet cells before the addition of the substrate. See, for example, Flores *et al.*, *Enzyme Microb. Technol.*, 16, pp. 340-346 (1994); Presecki & Vasic-Racki, *Biotechnology Letters*, 27, pp. 1835-1839 (2005); . Yu *et al.*, *J Ind Microbiol Biotechnol*, 34, 151-156 (2007); Chow and Palecek, *Cells. Biotechnol. Prog.*, 20, pp. 449-456 (2004); Fernandez *et al.*, *Journal of Bacteriology*, 152, pp. 1255-1264 (1982); Kondo *et al.*,
20 *Enzyme and microbial technology*, 27, pp. 806-811 (2000); Abraham and Bhat, *J Ind Microbiol Biotechnol*, 35, pp. 799-804 (2008); Liu *et al.*, *Journal of bioscience and bioengineering*, 89, pp. 554-558 (2000); and Gietz and Schiestl, *Nature Protocols*, 2, pp. 31-34 (2007) regarding permeabilization of yeast. See, Naglak and Wang, *Biotechnology and Bioengineering*, 39, pp. 732-740 (1991); Alakomi *et al.*, *Applied and environmental*
25 *Microbiology*, 66, pp. 2001-2005 (2000); and Fowler and Zabin, *Journal of bacteriology*, 92, pp. 353-357 (1966) regarding permeabilization of bacteria. As described in this example, it was determined if cells could remain viable and therefore could retain *de novo* UDP-glucose biosynthesis.

Experiments were done to establish conditions for permeabilization in *E. coli* and
30 in yeast. Growing cells (*S. cerevisiae* or *E. coli*) were treated with different

concentrations/combinations of permeabilization agents: toluene, chloroform and ethanol for permeabilization of *S. cerevisiae*, and guanidine, lactic acid, DMSO and/or Triton X-100 for permeabilization of *E. coli*. Tolerance of both model organisms to high concentrations of RebA and other potential substrates also was evaluated. The permeabilization was measured by the amount of RebD produced from a EUGT11-expressing organism after incubation in a RebA containing medium (feeding experiment). Enzyme activity was monitored before and after exposure to the permeabilizing agents by lysing the cells and analyzing the activity of the released UGTs in an *in vitro* assay.

In yeast, none of the permeabilization conditions tested resulted in an increase on RebD above the detected background (i.e., contaminating RebD levels present in the RebA stock used for feeding). This indicates that, under the tested conditions, yeast cells remain impermeable to RebA and/or the reduced cell viability caused by the solvents results in a decrease of EUGT11 activity as well.

In *E. coli*, none of the conditions tested resulted in permeabilization of the cells and subsequent production of RebD above background levels. Detectable levels of RebD were measured when lysates from strains expressing EUGT11 were used in the *in vitro* reactions (data not shown), indicating that EUGT11 enzyme is present and active even after all permeabilization treatments (though the level of activity varies). The permeabilization treatments had little or no effect on cell viability, except treating cultures with 0.2 M guanidine and 0.5% TritonX-100, which severely decreased viability.

S. cerevisiae also was subjected to permeabilization assays not allowing further growth of the cells using Triton X-100, N-lauryl sarcosine (LS), or Lithium acetate + polyethylene glycol (LiAc+PEG). That is, under these conditions, permeabilization renders the cells unviable by removing the cell membrane altogether while retaining the cell-wall as a barrier to keep enzymes and gDNA inside. In such methods, UDP-glucose can be supplemental or recycled as described above. The advantage of permeabilization versus the purely *in vitro* approach is that individual enzymes do not need to be separately produced and isolated.

N-Lauryl sarcosine treatment resulted in inactivation of EUGT11 and only a minor increase in RebD was detected when LiAc/PEG was applied (data not shown). Treatment with Triton X-100 0.3% or 0.5%, however, increased the amount of RebD above background levels (see Figure 18) while sustaining the activity of EUGT11. For Triton X-100 assays, overnight cultures were washed three times in PBS buffer. Cells corresponding to 6 OD₆₀₀ units were resuspended in PBS containing 0.3% or 0.5% Triton X-100 respectively. Treated cells were vortexed and incubated 30 minutes at 30°C. After treatment, cells were washed in PBS buffer. Cells corresponding to 5 OD₆₀₀ units were used in an *in vitro* assay, as described for GST-EUGT11 and 0.6 OD₆₀₀ units were resuspended in reaction buffer and incubated overnight at 30°C as described for the LS treated samples. Untreated samples were used as controls.

Lysates from transformants expressing EUGT11 were able to convert some RebA into RebD (8 to 50 µM were measured in the reactions) when cells were untreated or after treatment with LiAc/PEG or Triton X100. However, no RebD was measured in lysates of cell pellets treated with LS. Permeabilized but non-lysed cells were able to produce some RebD (1.4 to 1.5 µM measured) when treated with 0.3% or 0.5% Triton X100 (Figure 18) while no RebD was found on the samples treated with LS or LiAc/PEG. These results show that RebD can be produced from RebA biocatalytically using whole cells and using Triton X100 as the permeabilizing agent.

Example 10 – Assessment of codon optimized UGT sequences

Optimal coding sequences for UGT 91d2e, 74G1, 76G1, and 85C2 were designed and synthesized for yeast expression using two methodologies, supplied by GeneArt (Regensburg, Germany) (SEQ ID NOs: 6, 2, 8, and 4, respectively) or DNA 2.0 (Menlo Park, CA) (SEQ ID NOs: 84, 83, 85, and 82, respectively). The amino acid sequences of UGT 91d2e, 74G1, 76G1, and 85C2 (SEQ ID NOs: 5, 1, 7, and 3, respectively) were not changed.

The wild-type, DNA 2.0, and GeneArt sequences were assayed for *in vitro* activity to compare reactivity on substrates in the steviol glycosides pathway. UGTs were inserted in high copy (2µ) vectors and expressed from a strong constitutive

promoter (GPD1) (vectors P423-GPD, P424-GPD, P425-GPD, and P426-GPD). The plasmids were transformed individually into the universal Watchmaker strain, EFSC301 (described in Example 3 of WO2011/153378) and assays were carried out using cell lysates prepared from equal amount of cells (8 OD units). For the enzymatic reactions, 6
5 μ L of each cell lysate were incubated in a 30 μ L reaction with 0.25 mM steviol (final concentration) to test UGT74G1 and UGT85C2 clones, and with 0.25 mM 13-SMG (13SMG) (final concentration) to test 76G1 and 91D2e UGTs. Assays were carried out for 24 hours at 30°C. Prior to LC-MS analysis, one volume of 100% DMSO was added to each reaction, samples were centrifuged at 16000g, and the supernatants analysed.

10 The lysates expressing the GeneArt-optimized genes provided higher levels of UGT activity under the conditions tested. Expressed as a percentage of the wild-type enzyme, the GeneArt lysates showed equivalent activity to the wild-type for UGT74G1, 170% activity for UGT76G1, 340% activity for UGT85C2 and 130% activity for UGT91D2e. Using UGT85C2 may improve the overall flux and productivity of cells for
15 production of Reb-A and Reb-D when expressed in *S. cerevisiae*.

Further experiments were conducted to determine if the codon-optimized UGT85C2 could reduce 19-SMG accumulation and increase rubusoside and higher glycosylated steviol glycosides production. The production of 19-SMG and rubusoside were analysed in a steviol-feeding experiment of *S. cerevisiae* strain BY4741 expressing
20 the wild type UGT74G1 as well as the codon-optimized UGT85C2 from high copy (2 μ) vectors under strong constitutive promoter (GPD1) (vectors P426-GPD and P423-GPD, respectively). Whole culture samples (without cell removal) were taken and boiled in an equal volume of DMSO for total glycosides levels. Intracellular concentrations reported were obtained by pelleting cells, and resuspending in 50% DMSO to the volume of the
25 original culture sample taken, followed by boiling. The “total” glycosides level and the normalized intracellular level then were measured using LC-MS. Using wild type UGT74G1 and wild type UGT85C2, approximately 13.5 μ M rubusoside was produced in total with a maximum normalized intracellular concentration of about 7 μ M. In contrast, when wild type UGT74G1 and codon-optimized UGT85C2 were used, a maximum of 26
30 μ M rubusoside was produced, or approximately double of what was produced using the

wild type UGT85C2. Additionally, the maximum normalized intracellular concentration of rubusoside was 13 μ M, again an approximate doubling of what was produced using wild type UGT85C2. Intracellular concentration of 19-SMG was significantly reduced from a maximum of 35 μ M using the wild type UGT85C2 to 19 μ M using the codon-
5 optimized UGT85C2. Consequently, about 10 μ M less total 19-SMG was measured for the codon-optimized UGT85C2. This shows that more 19-SMG is converted into rubusoside and confirms that the wild type UGT85C2 is a bottleneck.

During diversity screening, another homolog of UGT85C2 was discovered during *Stevia rebaudiana* cDNA cloning. The homolog has the following combination of
10 conserved amino acid polymorphisms (with respect to the amino acid numbering of the wild-type *S. rebaudiana* UGT85C coding sequence set forth in Accession No. AY345978.1): A65S, E71Q, T270M, Q289H, and A389V. This clone, termed UGT85C2 D37, was expressed through coupled *in vitro* transcription-translation of PCR products (TNT[®]-T7 Quick for PCR DNA kit, Promega). The expression product was
15 assayed for glycosylation activity using steviol (0.5 mM) as the sugar acceptor, as described in WO/2011/153378 with the exception that assays were allowed to incubate for 24 hours. As compared to the wildtype UGT85C2 control assay, the D37 enzyme appears to have approximately 30% higher glycosylation activity.

20 **Example 11 - Identification of a novel *S. rebaudiana* KAH**

A partial sequence (GenBank Accession No. BG521726) was identified in the *Stevia rebaudiana* EST data base that had some homology to a *Stevia* KAH. The partial sequence was blasted against raw *Stevia rebaudiana* pyrosequencing reads using CLC main workbench software. Reads that partially overlapped with the ends of the partial
25 sequence were identified and used to increase the length of the partial sequence. This was done several times until the sequence encompassed both the start- and the stop codons. The complete sequence was analyzed for frameshift mutations and nucleotide substitutions that may have been introduced by blasting the complete sequence against the raw pyrosequencing reads. The resulting sequence was designated SrKAHe1. See
30 FIG. 12.

Activity of the KAH encoded by SrKAHe1 was assessed *in vivo* in *S. cerevisiae* background strain CEN.PK 111-61A, which expresses genes encoding enzymes constituting the entire biosynthetic pathway from the yeast secondary metabolites isopentenyl pyrophosphate (IPP) and farnesyl pyrophosphate (FPP) to steviol-19-O-monoside, except the steviol synthase enzyme that converts *ent*-kaurenoic acid to steviol.

Briefly, the *S. cerevisiae* strain CEN.PK 111-61A was modified to express an *Aspergillus nidulans* GGPPS, a 150 nt truncated *Zea mays* CDPS (with a new start codon, see below), a *S. rebaudiana* KS, a *S. rebaudiana* KO and the *S. rebaudiana* UGT74G1 from chromosomally integrated gene copies, with TPI1 and GPD1 yeast promoters driving transcription. The CEN.PK 111-61A yeast strain that expresses all of these genes was designated EFSC2386. Thus, strain EFSC2386 contained the following integrated genes: *Aspergillus nidulans* Geranyl geranyl pyrophosphate synthase (GGPPS); *Zea mays* ent-Copalyl diphosphate synthase (CDPS); *Stevia rebaudiana* ent-Kaurene synthase (KS); *Stevia rebaudiana* ent-kaurene oxidase (KO); and *Stevia rebaudiana* UGT74G1; in combination with the pathway from IPP and FPP to steviol-19-O-monoside, without a steviol synthase (KAH).

Expression of different steviol synthases (from episomal expression plasmids) was tested in strain EFSC2386 in combination with the expression of various CPRs (from episomal expression plasmids), and production of steviol-19-O-monoside was detected by LC-MS analysis of culture sample extracts. The nucleic acids encoding the CPRs were inserted in the multi cloning site of the p426 GPD basic plasmid while the nucleic acids encoding the steviol synthases were inserted in the multi cloning site the p415 TEF basic plasmid (p4XX basic plasmid series by Mumberg *et al.*, *Gene* 156 (1995), 119-122). Production of steviol-19-O-monoside occurs when a functional steviol synthase enzyme is present.

The KAHs that were expressed from episomal expression plasmids in strain EFSC2386 were “indKAH” (Kumar *et al.*, Accession no. DQ398871; Reeja *et al.*, Accession No. EU722415); “KAH1” (*S. rebaudiana* steviol synthase from Brandle *et al.*, U.S. Patent Publication No. 2008/0064063 A1); “KAH3” (*A. thaliana* steviol synthase from Yamaguchi *et al.*, U.S. Patent Publication No. 2008/0271205 A1); “SrKAHe1” (*S.*

rebaudiana steviol synthase cloned from *S. rebaudiana* cDNA as described above); and “DNA2.0.SrKAHe1” (codon optimized sequence (DNA2.0) encoding *S. rebaudiana* steviol synthase, see FIG. 12B).

The CPRs that were expressed from episomal expression plasmids in strain EFSC2386 were “CPR1” (*S. rebaudiana* NADPH dependent cytochrome P450 reductase (Kumar *et al.*, Accession no. DQ269454); “ATR1” (*A. thaliana* CPR, Accession No. CAA23011, see also FIG. 13); “ATR2” (*A. thaliana* CPR, Accession No. CAA46815, see also FIG. 13); “CPR7” (*S. rebaudiana* CPR, see FIG. 13, CPR7 is similar to “CPR1”); “CPR8” (*S. rebaudiana* CPR, similar to *Artemisia annua* CPR, see FIG. 13); and “CPR4” (*S. cerevisiae* NCP1 (Accession No. YHR042W, see also FIG. 13).

Table 13 provides the levels of steviol-19-O-monoside (μM) in strain EFSC2386 with the various combination of steviol synthases and CPRs.

Table 13
19-SMG Production

Strain	19-SMG production (μM)
"indKAH" CPR1	0.000
"indKAH" ATR1	0.000
"indKAH" ATR2	0.000
"indKAH" CPR7	0.000
"indKAH" CPR8	0.000
"indKAH" CPR4	0.000
"KAH1" CPR1	0.000
"KAH1" ATR1	0.000
"KAH1" ATR2	0.000
"KAH1" CPR7	0.000
"KAH1" CPR8	0.000
"KAH1" CPR4	0.000
"KAH3" CPR1	5.300
"KAH3" ATR1	5.921
"KAH3" ATR2	0.000
"KAH3" CPR7	5.693
"KAH3" CPR8	0.000

"KAH3" CPR4	0.000
"SrKAHe1" CPR1	20.129
"SrKAHe1" ATR1	15.613
"SrKAHe1" ATR2	40.407
"SrKAHe1" CPR7	33.724
"SrKAHe1" CPR8	41.695
"SrKAHe1" CPR4	28.949
"DNA2.0.SrKAHe1" CPR1	26.065
"DNA2.0.SrKAHe1" ATR1	26.974
"DNA2.0.SrKAHe1" ATR2	54.354
"DNA2.0.SrKAHe1" CPR7	30.797
"DNA2.0.SrKAHe1" CPR8	50.956
"DNA2.0.SrKAHe1" CPR4	30.368

Only KAH3 and the steviol synthase encoded by SrKAHe1 had activity when expressed in *S. cerevisiae*. The DNA 2.0. codon optimized SrKAHe1 sequence encoding steviol synthase resulted in a level of steviol-19-O-monoside accumulation that was approximately one order of magnitude higher as compared with a codon optimized KAH3 when each were co-expressed with optimal CPRs. In the experiments presented in this example, the combination of KAH1 and ATR2 CPR did not result in the production of steviol-19-O-monoside.

Example 12 - Pairings of CPRs and KO

The CEN.PK *S. Cerevisiae* EFSC2386 strain and the CPRs referred to in this Example are described in the Example 11 ("Identification of *S. rebaudiana* KAH"). EFSC2386 contained the following integrated genes: *Aspergillus nidulans* Geranyl geranyl pyrophosphate synthase (GGPPS); *Zea mays* ent-copalyl diphosphate synthase (CDPS); *Stevia rebaudiana* ent-kaurene synthase (KS); and *Stevia rebaudiana* ent-kaurene oxidase (KO). This strain produces *ent*-kaurenoic acid that was detected by LC-MS analysis.

A collection of cytochrome P450 reductases (CPRs) were expressed and tested in strain EFSC2386; "CPR1" (*S. rebaudiana* NADPH dependent cytochrome P450 reductase, Kumar *et al.*, Accession no. DQ269454); "ATR1" (*A. thaliana* CPR, Accession

No. CAA23011); “ATR2” (*A. thaliana* CPR, Accession No. CAA46815); “CPR7” (*S. rebaudiana* CPR, CPR7 is similar to “CPR1”); “CPR8” (*S. rebaudiana* CPR, similar to *Artemisia annua* CPR; and “CPR4” (*S. cerevisiae* NCP1, Accession No. YHR042W).

Overexpression of the *S. cerevisiae* endogenous native CPR (referred to as CPR4 in Table 14), and especially overexpression of one of the *A. thaliana* CPRs namely ATR2, gives good activation of the *Stevia rebaudiana* kaurene oxidase (the latter called KO1 in Table 14) and results in increased accumulation of *ent*-kaurenoic acid. See Table 14, which presents the area under curve (AUC) of the *ent*-kaurenoic acid peak in the LC-MS chromatograms. KO1 is an *ent*-kaurenoic acid producing yeast control strain without additional overexpression of CPRs.

Table 14 - Effect of Different Cytochrome P450 Reductase Enzymes with KO-1

Cytochrome P450 Reductase	Ent-Kaurenoic Acid (AUC)
CPR-1	14113
ATR-1	13558
ATR-2	29412
CPR-7	18918
CPR-8	12590
CPR-4	25103
Control	16593

Example 13 - Evaluating KS-5 and KS-1 in steviol pathways

The yeast strain EFSC1972 is a CEN.PK 111-61A *S. cerevisiae* strain that has the biosynthetic pathway from IPP/FPP to rubusoside expressed by integrated gene copies encoding the *Aspergillus nidulans* GGPPS (internal name GGPPS-10), the *Stevia rebaudiana* KS (KS1, SEQ ID NO:133), the *Arabidopsis thaliana* KAH (KAH-3, SEQ ID NO:144), the *Stevia rebaudiana* KO (KO1, SEQ ID NO:138), the *Stevia rebaudiana* CPR (CPR-1, SEQ ID NO:147), the full length *Zea mays* CDPS (CDPS-5, SEQ ID NO:158), the *Stevia rebaudiana* UGT74G1 (SEQ ID NO:1) and *Stevia rebaudiana* UGT85C2 (SEQ ID NO:3). Furthermore EFSC1972 has down regulation of the ERG9 gene expression by displacement of the endogenous promoter with the copper inducible promoter CUP1.

When EFSC1972 is transformed with a CEN/ARS-based plasmid that expresses the *Stevia rebaudiana* SrKAHe1 from a TEF1 promoter, and simultaneously transformed with 2 μ -based plasmids that express the *Synechococcus sp* GGPPS (GGPPS-7) and a truncated version of the *Zea mays* CDPS (truncated CDPS-5) from a GPD promoter, the result is growth-impaired *S. cerevisiae* producer of rubusoside (and 19-SMG). This strain is referred to as the “enhanced EFSC1972” in the following text. To determine whether the slow growth rate is caused by accumulation of the toxic pathway intermediate ent-copalyl diphosphate, a collection of kaurene synthase (KS) genes was expressed in the “enhanced EFSC1972” strain then growth and steviol glycoside production was assessed.

Expression of the *A. thaliana* KS (KS5) results in improved growth and steviol glycoside production of the “enhanced EFSC1972” strain. See FIG. 16. The same positive effect on growth cannot be achieved by further overexpression of the *Stevia rebaudiana* kaurene synthase (KS-1) in the enhanced EFSC1972 (data not shown).

Example 14 -- Yeast Strain EFSC1859

Saccharomyces cerevisiae strain EFSC1859 contains GGPPS-10, CDPS-5, KS-1, KO-1, KAH-3, CPR-1 and UGT74G1 coding sequences integrated into the genome and expressed from the strong constitutive GPD1 and TPI promoters. See Table 15. In addition, the endogenous promoter for the yeast ERG9 gene was replaced with the copper inducible promoter CUP1 for downregulation of the ERG9 squalene synthase. In standard yeast growth medium, the *ERG9* gene is transcribed at very low levels, since the concentration of copper in such medium is low. The decrease in ergosterol production in this strain results in increased amounts of isoprene units available for isoprenoid biosynthesis. In addition, strain EFSC1859 also expresses UGT85C2 from a 2 micron multicopy vector using a GPD1 promoter. EFSC1859 produces rubusoside and steviol 19-O-glycoside.

Zea mays CDPS DNA, with and without the chloroplast signal peptide, was expressed from a 2 micron multicopy plasmid using the GPD promoter. The nucleotide sequence and amino acid sequence of the *Zea mays* CDPS are forth in FIG. 14. The

chloroplast signal peptide is encoded by nucleotides 1-150 and corresponds to residues 1 to 50 of the amino acid sequence.

Table 15

Gene Source	Enzyme	Designation	gi Number	Accession No.
<i>Aspergillus nidulans</i>	GGPP synthase	GGPPS-10 (C301)	29468175	AF479566
<i>Zea mays</i>	CDP synthase	CDPS-5 (EV65)	50082774	AY562490
<i>Stevia rebaudiana</i>	Kaurene synthase	KS-1	4959241	AAD34295
<i>Stevia rebaudiana</i>	KO	KO-1	76446107	ABA42921
<i>Arabidopsis thaliana</i>	KAH	KAH-3	15238644	NP_197872
<i>Stevia rebaudiana</i>	UGT74G1			
<i>Stevia rebaudiana</i>	UGT85C2			
<i>Stevia rebaudiana</i>	CPR	CPR-1	93211213	ABB88839

5

EFSC1859 + maize full-length CDPS plasmid, and EFSC + maize truncated CDPS plasmid were grown in selective yeast medium with 4% glucose. Rubusoside and 19-SMG production were measured by LC-MS to estimate the production level. The removal of the plastid leader sequence did not appear to increase steviol glycoside production as compared to the wild-type sequence, and demonstrates that the CDPS transit peptide can be removed without causing a loss of steviol glycoside biosynthesis.

10

Example 15 -- Yeast Strain EFSC1923

Saccharomyces cerevisiae strain CEN.PK 111-61A was modified to produce steviol glycosides by introduction of steviol glycoside pathway enzymes from various organisms. The modified strain was designated EFSC1923.

15

Strain EFSC1923 contains an *Aspergillus nidulans* GGPP synthase gene expression cassette in the *S. cerevisiae* *PRP5-YBR238C* intergenic region, a *Zea mays* full-length CDPS and *Stevia rebaudiana* CPR gene expression cassette in the *MPT5-*

YGL176C intergenic region, a *Stevia rebaudiana* kaurene synthase and CDPS-1 gene expression cassette in the *ECM3-YOR093C* intergenic region, an *Arabidopsis thaliana* KAH and *Stevia rebaudiana* KO gene expression cassette in the *KINI-INO2* intergenic region, a *Stevia rebaudiana* UGT74G1 gene expression cassette in the MGA1-YGR250C intergenic region and a *Stevia rebaudiana* UGT85C2 gene expression cassette integrated by displacing the *TRP1* gene ORF. See Table 15. In addition, the endogenous promoter for the yeast ERG9 gene was replaced with the copper inducible promoter CUP1.

Strain EFSC1923 produced approximately 5 μ M of the steviol glycoside, steviol 19-*O*-monoside, on selective yeast medium with 4% glucose.

Example 16 – Expression of a Truncated Maize CDPS in Yeast Strain EFSC1923

The 150 nucleotides at the 5' end of the *Zea mays* CDP synthase coding sequence in Table 15 (SEQ ID NO:157, see FIG. 14) was deleted, the remainder of the coding sequence was provided with a new translation start ATG, and the truncated sequence was operably linked to the GPD1 promoter in the multicopy plasmid p423GPD in *Saccharomyces cerevisiae* EFSC1923. Plasmid p423GPD is described in Mumberg, D et al, Gene, **156** : 119-122 (1995). EFSC1923 and EFSC1923 plus p423GPD-Z.m.tCDPS were grown in for 96 hours in selective yeast medium containing 4% glucose. The amount of steviol 19-*O*-monoside produced by EFSC1923 + p423GPD-Z.m.tCDPS (the truncated *Zea mays* CDPS) under these conditions was approximately 2.5 fold more than that produced by EFSC1923 without the plasmid.

The *Arabidopsis thaliana* KAH coding sequence from Table 15 was inserted in a multicopy plasmid designated p426GPD, under the control of the GPD1 promoter. Plasmid p426GPD is described in Mumberg, D et al, Gene, **156** : 119-122 (1995). No significant difference was observed between the amount of steviol 19-*O*-monoside produced by EFSC1923 + p426GPD-A.t.KAH, and EFSC1923 lacking the plasmid.

EFSC1923 was transformed with both p423GPD-Z.m.tCDPS and p426GPD-A.t.KAH. Surprisingly, the amount of steviol 19-*O*-monoside produced under these conditions by EFSC1923 harboring both plasmids (i.e., the truncated *Zea mays*

CDPS and *Arabidopsis* KAH) was more than 6 fold greater than the amount produced by EFSC1923 alone.

A bifunctional CDPS-KS from *Gibberella fujikuroi* (NCBI Accession no: Q9UVY5.1, FIG. 15) was cloned and compared to the truncated CDPS-5. The
5 bifunctional *Gibberella* CDPS-KS was cloned into a 2 μ plasmid with a GPD promoter and transformed with a plasmid expressing the *Arabidopsis thaliana* KAH-3 from a 2 μ based-plasmid from a GPD promoter into EFSC1923. In shake flask studies, this bi-functional CDPS-KS was about 5.8 times more active in producing steviol 19-O-monoside than strain EFSC1923 with the KAH-3 alone. However, it was found to be less
10 optimal than the KAH-3 and truncated CDPS combination under the conditions tested. Therefore, further strains were constructed with KS-5 and truncated CDPS.

Example 17 - Toxicity of Intermediates

The effect on *S. cerevisiae* vitality of geranyl geranyl pyrophosphate (GGPP), *ent*-copalyl diphosphate (CDP) or *ent*-kaurene production was investigated by expression of
15 *Synechococcus* sp GGPPS alone (GGPP production), the GGPPS and the 50 amino acid N-terminally truncated *Zea mays* CDPS (see Example 16) together (CDP production), or the GGPPS, truncated CDPS and the *Arabidopsis thaliana* kaurene synthase (KS5) together (*ent* kaurene production) in the laboratory *S. cerevisiae* strain CEN.PK
20 background. Genes were expressed from 2 μ plasmids with GPD promoters driving transcription of truncated CDPS and KS5, while transcription of the GGPPS was driven by the ADH1 promoter. The growth of *S. cerevisiae* CEN.PK transformed with various combinations of these plasmids (GGPPS alone; GGPPS + truncated CDPS; or GGPPS + truncated CDPS + KS5) or plasmids without gene insertions was observed. GGPP
25 production, and especially CDP production, was toxic to *S. cerevisiae* when produced as end products. Interestingly, *ent*-kaurene appeared to not be toxic to yeast in the amounts produced in this experiment.

Example 18 - Disruption of endogenous phosphatase activity

The yeast genes *DPPI* and *LPPI* encode phosphatases that can degrade FPP and GGPP to farnesol and geranylgeraniol, respectively. The gene-encoding *DPPI* was deleted in strain EFSC1923 (described in Example 15) to determine if there was an effect on steviol glycoside production. When this *dpp1* mutant strain was further transformed with a plasmid expressing the *Z. mays* CDPS lacking the chloroplast transit sequence (Example 16), both small and large transformants emerged. Strains of the “large colony” type produced ~40% more 19-SMG as compared to “small colony” type and the non-*DPPI* deleted strain, under the conditions tested. These results indicate that deletion of *DPPI* can have a positive effect on steviol glycoside production and that the degradation of prenyl pyrophosphates in yeast therefore could influence steviol glycoside production negatively.

Example 19 - Construction of a genetically stable yeast reporter strain producing vanillin glucoside from glucose with a disrupted SUC2 gene

A yeast strain producing vanillin glucoside from glucose was created basically as described in Brochado et al. ((2010) *Microbial Cell Factories* 9:84-98) (strain VG4), but with additional integration into the ECM3 inter-locus region in the yeast genome of an expression cassette with *E. coli* EntD PPTase controlled by the yeast TPI1 promoter (as described in Hansen et al. (2009) *Appl. Environ. Microbiol.* 75(9):2765–2774), disruption of SUC2 by replacing coding sequence with a MET15 expression cassette, and disruption of LEU2 by replacing coding sequence with a Tn5ble expression cassette conferring resistance to phleomycin. The resulting yeast strain was called V28. This strain also encodes a recombinant *A. thaliana* UDP-glycosyltransferase (UGT72E2, GenBank Accession No. Q9LVR1) having the amino acid sequence set forth in FIG. 19 (SEQ ID NO:178).

Example 20 - Expression of sucrose transporter and sucrose synthase in yeast already biosynthesizing vanillin glucoside

A sucrose transporter SUC1 from *Arabidopsis thaliana* was isolated by PCR amplification from cDNA prepared from *A. thaliana*, using proof-reading PCR

polymerase. The resulting PCR fragment was transferred by restriction digestion with *SpeI* and *EcoRI* and inserted into the corresponding in the low copy number yeast expression vector p416-TEF (a CEN-ARS based vector), from which the gene can be expressed from the strong TEF promoter. The resulting plasmid was named pVAN192.

5 The sequence of the encoded sucrose transporter is set forth in FIG. 19B (GenBank Accession No. AEE35247, SEQ ID NO:179).

A sucrose synthase SUS1 from *Coffea arabica* (Accession No. CAJ32596) from was isolated by PCR amplification from cDNA prepared from *C. arabica*, using proof-reading PCR polymerase. The PCR fragment was transferred by restriction digestion with *SpeI* and *SalI* and inserted into the corresponding position in the high copy number yeast expression vector p425-GPD (a 2 μ m based vector), from which the gene can be expressed from the strong GPD promoter. The resulting plasmid was named pMUS55. The sequence of the encoded sucrose synthase is set forth in FIG. 19C (GenBank Accession No. CAJ32596; SEQ ID NO:180).

15 pVAN192 and pMUS55 were introduced into the yeast strain V28 by genetic transformation, using a lithium acetate transformation protocol, creating the yeast strain V28::pVAN192::pMUS55. A control strain was made by transforming V28 with the empty plasmids P146-TEF and P425-GPD.

These two yeast strains were grown in 200 ml cultures in 500 ml Erlenmeyer shake flasks using SC (synthetic complete) growth medium without aromatic amino acids supplemented with 2% glucose and 2% sucrose and adjusted to pH 5.0. Cultures were incubated at moderate revolution (150 rpm), at 30°C for 72 hours. Samples were taken at 72 hours, and the content of vanillin glucoside determined. As can be seen from the table below, VG production in the control strain (containing empty plasmids p416-TEF and p425-GPD) was 330 mg/L VG, while the yeast strain V28::pVAN192::pMUS55 expressing sucrose synthase and sucrose transporter produced 445 mg/l VG, corresponding to a 34.8% increase in VG production.

Strain	Vanillin glucoside (g/L after 72 h)
V28 (p416-TEF + P425-GPD)	330
V28::pVAN192::pMUS55	445

This indicates that co-expression of a sucrose synthase and a sucrose transporter together with a glucosyltransferase increased the ability to glycosylate a small molecule aglycon, and concentration of the glycosylated aglycon was significantly increased. In this case, a significant improvement in vanillin glucosylation was achieved, resulting in a significant increase in titer of the end product, vanillin-O- β -glucoside.

Example 21 - Improved Steviol Glycoside Producing Strains

Strain construction of Saccharomyces cerevisiae EFSC2763

EFSC2763 yeast strain is derived from a wild type *Saccharomyces cerevisiae* strain containing three auxotrophic modifications, namely the deletions of *URA3*, *LEU2* and *HIS3*. The genetics of the strain have been stabilized and can be used as a regular diploid or haploid yeast strain. EFSC2763 has been converted to a steviol glycoside producing yeast by genomic-integration of four DNA constructs. Each construct contains multiple genes that were introduced into the yeast genome by homologous recombination. Furthermore, construct one and two were assembled by homologous recombination.

The first construct contains eight genes and is inserted in the *DPPI* locus and disrupts and partially deletes *DPPI* (see Example 18). The DNA inserted contains: the *A. gossypii* TEF promoter expressing the NatMX gene (selectable marker) followed by the TEF terminator from *A. gossypii*; Gene Art codon optimized *S. rebaudiana* *UGT85C2* (see Example 10) expressed from the native yeast GPD1 promoter and followed by the native yeast CYC1 terminator; *S. rebaudiana* *CPR-8* (see FIG. 13) expressed using the TPI1 promoter followed by the native yeast TDH1 terminator; *A. thaliana* Kaurene synthase (KS-5, see Example 13, SEQ ID NO:156) expressed from the PDC1 promoter and followed by the native yeast FBA1 terminator; *Synechococcus* sp. GGPPS (GGPPS-7) expressed using the TEF2 promoter and followed by the native yeast PFI1 terminator;

DNA2.0 codon-optimized *S. rebaudiana* KAHe1 (see Example 11, SEQ ID NO:165), expressed from the TEF1 promoter and followed by the ENO2 terminator; *S. rebaudiana* KO-1 expressed using the FBA1 promoter and followed by the native yeast TDH2 terminator; and *Zea mays* truncated CDPS (see Example 14) expressed using the PGK1 promoter and followed by the native yeast ADH2 terminator.

The second construct was inserted at the *YPRCΔ15* locus and contains the native yeast TEF promoter from *A. gossypii* in front expressing the KanMX gene (selectable marker) followed by the TEF terminator from *A. gossypii*, the Gene Art codon optimized *A. thaliana* ATR2 (see FIG. 13B) expressed from the PGK1 promoter followed by the yeast ADH2 terminator, *S. rebaudiana* UGT74G1 expressed from the TPI1 promoter followed by the yeast TDH1 terminator, Gene Art codon-optimized *S. rebaudiana* UGT76G1 expressed from the TEF1 promoter followed by the yeast ENO2 terminator, and GeneArt codon-optimized *S. rebaudiana* UGT91D2e-b (see Example 6) expressed from the GPD1 promoter and followed by the yeast CYC1 terminator.

The first and the second construct were combined in the same spore clone by mating and dissection. This yeast strain was subsequently transformed with construct three and four in two successive events.

Construct three was integrated between genes *PRP5* and *YBR238C* and contained the TEF promoter from *A. gossypii* in expressing the *K. lactis* LEU2 gene followed by the TEF terminator from *A. gossypii*, the GPD1 promoter expressing the DNA2.0-optimized *S. rebaudiana* KAHe1 followed by the CYC1 terminator, and the TPI1 promoter expressing the *Zea mays* truncated CDPS. Construct four was integrated in the genome between genes *ECM3* and *YOR093C* with an expression cassette containing the TEF promoter from *A. gossypii* expressing the *K. pneumoniae* hph gene followed by the TEF terminator from *A. gossypii*, *Synechococcus* sp. GGPPS expressed from the GPD1 promoter followed by the CYC1 terminator, and the TPI1 promoter expressing the *A. thaliana* Kaurene synthase. The four utilized genetic markers were subsequently removed.

As analyzed by LC-MS following the DMSO-extraction of total steviol glycosides from cells and broth, EFSC2772 produces between 40-50 μ M or 2-3

μM/OD600 Rebaudioside A, after growth for four days in 3 ml SC (Synthetic Complete) media at 30°C with 320 RPM shaking in deep-well plates.

Strain construction of Saccharomyces cerevisiae EFSC2772

5 EFSC2772 is very similar to strain 2763 with the exception that the genetic markers were not removed, and the strain was made prototrophic by introduction of the two plasmids p413TEF (public domain CEN/ARS shuttle plasmid with *HIS3* marker) and p416-TEF (public domain CEN/ARS shuttle plasmid with *URA3* marker) by transformation, and designated EFSC2772.

10 As analyzed by LC-MS following the DMSO-extraction of total steviol glycosides from cells and broth, EFSC2772 produces similar levels of Rebaudioside A as 2763, after growth in deep-well plates. Higher optical densities and higher titers were obtained through aerobic fed-batch growth in 2L (working volume) fermentors which included a ~16 hour growth phase in the base medium (Synthetic Complete media) 15 followed by ~100 hours of feeding with glucose utilized as the carbon and energy source combined with trace metals, vitamins, salts, and Yeast Nitrogen Base (YNB) and/or amino acid supplementation. The pH was kept near pH 5 and the temperature setpoint was 30°C. As evidenced by LC-MS, combined cellular and extracellular product concentrations were between 920-1660 mg/L of Reb-A and approximately 300-320 mg/L 20 of Reb-D in the two different experiments, approximately 700 mg/L of Reb-A was detected in the broth when the higher titer results were obtained. Additionally a large peak was seen for Reb-B, and one skilled in the art will recognize that additional copies of UGT74G1 or upregulation of UGT74G1 will further increase the conversion of RebB to RebA.

25 Strain EFSC2743 was made in a similar manner as above, but without the two plasmids conferring prototrophy and with the addition of a p416 (CEN/ARS)-based plasmid expressing EUGT11 from the TEF promoter. This strain was grown in a fed-batch fermentation as above. This strain produced a total amount of RebD of 920 mg/L and furthermore approximately a 9:1 ratio of RebD to RebA was seen. Approximately 30 360 mg/L of RebD was found in the broth.

Example 22 - UDP-glucose capacity

In Example 21, it was shown that yeast can fully glycosylate over 1 mM steviol e.g., to RebD, RebB, and RebA. Similarly, *Saccharomyces* strains are able to glycosylate as much as 60 mM of other small molecule products (data not shown). However, the glycosylation limit of the yeast native UDP-glucose regenerating system is unknown, or the rate at which it replenishes the UDP-glucose pool needed for cell wall synthesis. Therefore, experiments were designed to investigate if an increase in UDP-glucose production would increase the glycosylation rate in yeast. A *suc2* deletion mutant was transformed with plasmids harboring the *A. thaliana suc1* gene encoding a sucrose transporter, UGT74G1 and *A. thaliana* SUS. UGT74G1 can rapidly glycosylate steviol to steviol 19-O-monoglucoside (19-SMG). Transformants were pre-grown overnight in 13-ml culture tubes containing 4 ml of SC medium lacking leucine, histidine and uracil. The next day, cells corresponding to 2 OD₆₀₀ units were spun down and resuspended in 2 ml of fresh media was containing 2% sucrose and or 100 µM steviol. Cultures were shaken at 30°C for 3 days in culture tubes. After 1h, 3h, 6h, 21h and 46h, aliquots were taken. Aliquots of 100 µl of culture were spun down and an equal volume of DMSO was added. Samples were vortexed, heated at 80°C for 15 minutes, centrifuged, and the 19-SMG content analyzed by LC-MS. No difference in the rate of glycosylation of steviol was observed between wild-type and SUS1-augmented strains at the time points tested. This suggests that glycosylation of steviol by UGT74G1 proceeds at a slower rate than UDP-glucose is regenerated by the yeast and that extra UDP-glucose may not be needed to achieve high titers of small molecule glycosylation *in vivo*. Nevertheless, the use of a SUS to recycle UDP-glucose *in vitro* is shown in Example 8 and therefore its use in an *in vivo* system is expected to increase the rate of production of steviol glycosides, if UDP-glucose should become limiting.

Example 23 - Reb-C and Reb-F production *in vivo* from glucose

Production of RebC from steviol

Previous experiments (Publication No. WO/2011/153378) have shown that recombinantly expressed *Arabidopsis thaliana* RHM2 (rhamnose synthetase, locus tag AT1G53500) is able to convert UDP-glucose to UDP-rhamnose. This UDP-rhamnose can be used to produce steviol-13-*O*-glucopyranosyl-1,2-rhamnoside, when incubated with UGT91D2e and steviol-13-*O*-monoglucoside *in vitro*.

Further experiments were conducted to confirm production of RebC from steviol by expressing all 4 UGTs and the RHM2 in yeast *in vivo*, followed by steviol feeding. EFSC301 strain (MAT alpha, *lys2ADE8 his3ura3leu2trp1*) was transformed with the following plasmids expressing wild type gene sequences: p424GPD expressing wild type UGT74G1 (Accession no: AY345982); p423GPD expressing wild type 85C2 (Accession no.: AY345978.1); and a p426GPD derived-plasmid expressing wildtype UGT76G1 (Accession no: AY345974) and UGT91D2e under GPD promoters. Plasmid p425GPD expressing either RHM2 or an empty p425GPD control plasmid was cotransformed with the UGTs. Transformants were pre-grown overnight in 13 mL culture tubes containing 2-3 ml of SC medium lacking leucine, histidine, tryptophan and uracil. The next day, after growth had reached 0.4 OD₆₀₀ units, cells were spun down, resuspended in fresh medium containing 25 µM steviol and shaken at 30°C for 3 days in culture tubes. An aliquot of 100 µL of culture was spun down. An equal volume of DMSO was added to the supernatant of this sample while 200 µL of 50% DMSO was added to the pellet. Samples were vortexed, heated at 80°C for 15 minutes, centrifuged, and the steviol glycoside content analyzed by LC-MS. RebC was detected in growth media and cellular extracts only when the RHM2 gene was coexpressed with the UGTs. Quantification showed that approximately equal amounts of RebA and RebC were produced. This shows that RHM2 is able to produce significant quantities of UDP-rhamnose *in vivo* and that UGT91D2e is capable of efficient rhamnosylation *in vivo*. Two other compounds were observed via LC-MS with retention times of 5.64 and 5.33 minutes and m/z ratios corresponding to steviol with 1 glucose- and 1 rhamnose (steviol-1,2 rhamnobioside), and 2 glucoses- and 1 rhamnose (Dulcoside A), respectively. This suggests that the remaining UGTs in the steviol glycoside pathway are capable of accepting rhamnosylated intermediates, i.e, the rhamnosylation step does not need to occur last.

In addition, a series of sequential *in vitro* experiments were conducted to determine whether any dead-end reactions occur in the rebaudioside C pathway. See FIG.2B. For example, the rhamnosylation activity of UGT91D2e on rubusoside and subsequent conversion of the product to RebC by UGT76G1 was demonstrated using *in vitro* reactions. In this experiment, UGT91D2e and RHM2 recombinantly expressed in *E. coli* and purified were incubated overnight with rubusoside, NADPH, NAD⁺ and UDP-glucose. The reaction mixture was subsequently boiled to denature the enzymes. An aliquot of the reaction was added to an enzyme preparation of UGT76G1 with UDP-glucose. The rubusoside was converted in the presence of UGT91D2e and RHM2 to a compound with m/z corresponding to steviol with 2-glucoses and 1-rhamnose. Subsequently, this compound was converted in the presence of UGT76G1 to RebC, which indicates that the intermediate is Dulcoside A. This experiment therefore demonstrates that UGT91D2e is able to rhamnosylate rubusoside and that UGT76G1 is able to convert the product to RebC.

Similarly, it was shown through *in vitro* reactions that rhamnosylation of 13-SMG by UGT91D2e (forming a steviol compound with one glucose and one rhamnose) and subsequent formation of a compound with 2 glucoses and 1 rhamnose by UGT76G1. This compound has a unique retention time (4.56 min) and is thought to be steviol 13-*O*-1,3-diglycoside-1,2-rhamnoside. This compound also was observed when steviol was fed to yeast expressing the four UGTs and RHM2.

From the current data, it is shown that UGT91D2e is able to rhamnosylate 13-SMG and rubusoside. It is also shown that UGT74G1 and UGT76G1 are able to metabolize the rhamnosylated compound produced by UGT91D2e from 13-SMG. When these compounds are incubated with the remaining UGT (UGT74G1 or UGT76G1 depending on which UGT was used for the previous step), RebC is formed. This indicates that the order of glycosylation is of little importance as UGT74G1 and UGT76G1 are able to glycosylate rhamnosylated substrates.

Production of RebC from glucose

Plasmids expressing RHM2 and UGTs 76G1 and 91D2e were transformed into a stable rubusoside producer, the EFSC1923 strain (see Example 15). This yeast is a *Saccharomyces cerevisiae* CEN.PK 111-61A derivative with the UGTs 85C2 (Accession no.: AY345978.1) and 74G1 (Accession no: AY345982) integrated into the genome as well as auxotrophic modifications. In strain EFSC1923 (see Example 15), expression of squalene synthase, which is encoded by ERG9, was downregulated by displacement of the endogenous promoter with the CUP1 copper-inducible promoter. Strain EFSC1923 also contains an *Aspergillus nidulans* GGPP synthase (GGPPS-10) expression cassette in the *S. cerevisiae* PRP5-YBR238C intergenic region, a *Zea mays* full-length CDPS (CDPS-5) and *Stevia rebaudiana* CPR (CPR-1) gene expression cassette in the *MPT5-YGL176C* intergenic region, a *Stevia rebaudiana* Kaurene synthase and CDPS (KS-1/CDPS-1) gene expression cassette in the *ECM3-YOR093C* intergenic region, an *Arabidopsis thaliana* KAH (KAH-3) and *Stevia rebaudiana* KO (KO-1) gene expression cassette in the *KIN1-INO2* intergenic region, a *Stevia rebaudiana* UGT74G1 gene expression cassette in the MGA1-YGR250C intergenic region and a *Stevia rebaudiana* UGT85C2 gene expression cassette integrated by displacing the *TRP1* gene ORF20. Inserted steviol pathway genes are described in Table 11 of published PCT WO/2011/153378.

EFSC1923 strain was transformed with a p423GPD-derived plasmid expressing wildtype UGT74G1 and UGT85C2 sequences using GPD promoters and a p426GPD-derived plasmid expressing wildtype UGT76G1 (Accession no: AY345974) and UGT91D2e (see SEQ ID NO:5) under the control of GPD promoters. Plasmid p425GPD expressing *Arabidopsis thaliana* RHM2 (enzyme locus tag AT1G53500) or an empty p425GPD control plasmid was co-transformed. Transformants were pre-grown overnight in 13-ml culture tubes containing 2-3 ml of SC medium lacking leucine, histidine and uracil. The next day, when the culture reached an OD₆₀₀ of 0.4 units it was centrifuged, resuspended in fresh medium, and shaken at 30°C for 3 days in culture tubes. One hundred μ L of culture were spun down; to this an equivalent volume of DMSO was added to the supernatant while 200 μ L of 50% DMSO was added to the pellet. Samples

were vortexed, heated at 80°C for 15 minutes, spun down and the steviol glycoside content analyzed by LC-MS.

Analyses of the medium and normalized intracellular content of this strain showed production of RebC. Approximately 8 μ M RebC and 4 μ M RebA was produced as determined by LC-MS. Furthermore, the intermediates produced following steviol feeding were not detected in this experiment. Accumulation of RebC was strictly dependent on expression of RHM2. This example demonstrates *de novo* biosynthesis of RebC from glucose.

Production of additional Steviol glycosides from steviol and glucose

Using the same GPD-based plasmids described above, the stable steviol-producing strain EFSC1923 containing UGT74G1 and UGT85C2 was transformed with the UGTs required to produce RebB (UGT76G1 and UGT91D2e/EUGT11), RebE (UGT91D2e/EUGT11) and dulcoside A (RHM2, UGT91D2e/EUGT11). Wildtype EUGT11 (NCBI: NP_001051007), which was found to have higher diglycosylation activity, was cloned into p424GPD for this experiment. Transformants were pre-grown overnight in 13-ml culture tubes containing 2-3 ml of SC medium lacking leucine, histidine, tryptophan and uracil. The next day, after growth had reached 0.4 OD₆₀₀ units, cells were spun down, resuspended in fresh medium containing 25 μ M steviol (except for glucose experiments) and shaken at 30°C for 3 days in culture tubes. An aliquot of 100 μ L of culture was spun down. An equal volume of DMSO was added to the supernatant of this sample while 200 μ L of 50% DMSO was added to the pellet. Samples were vortexed, heated at 80°C for 15 minutes, centrifuged, and the steviol glycoside content analyzed by LC-MS. LC-MS analyses confirmed *in vivo* production of RebB, RebE, and Dulcoside A in *S. cerevisiae* from glucose or steviol. See, e.g., FIGs. 2A and 2B. A higher concentration of steviol-glycosides was observed following steviol-feeding (as judged by chromatograms).

Characterization of RebF pathway intermediates using EUGT11.

The xylosylating properties of UGT91D2e and EUGT11 were compared *in vitro*. By using UDP-xylose as the sugar-donor, UGT91D2e was previously shown to xylosylate steviol-13-O-monoglucoside forming a key intermediate in RebF biosynthesis

(Publication No. WO/2011/153378). Similar *in vitro* experiments using EUGT11 and UGT91D2e have shown that these UGTs are capable of xylosylating rubusoside. When UGT91D2e is used, the LC-MS analysis shows a new peak with an m/z ratio corresponding to steviol with 2 glucose molecules and 1 xylose. See, FIG. 26. Because
5 of the shift in the retention time this peak is thought to correspond to rubusoside xylosylated on the 13-O-glucose. When EUGT11 is used, the LC-MS analysis shows two new, similar sized peaks at retention time 3.99 and 4.39 minutes with m/z ratios corresponding to steviol with 2 glucoses and 1 xylose. These products most likely correspond to rubusoside xylosylated on either of the two positions--the 13-O-glucose or
10 the 19-O-glucose.

Production of RebF from glucose

In vivo production of RebF requires cloning of UGD1 (UDP-glucose dehydrogenase) and USX3 (UDP-glucuronic acid decarboxylase) from *Arabidopsis* for
15 production of UDP-xylose. UGD1 and UXS3 were inserted in a high copy (2 μ) vector, derived from P425-GPD, containing two expression cassettes, and expressed from strong constitutive promoters (*TPII* and *GPD1*, respectively). The plasmid was transformed into the RebA producer strain EFSC2763 (described in Example 21) and cultivated during 3 days in selection medium (SC -leu). The LC-MS results clearly show the appearance of a
20 new peak at retention time 4.13 minutes with m/z ratios corresponding to steviol with 3 glucoses and 1 xylose and identified as RebF (based on a commercial RebF standard), as well as other new peaks with m/z ratios corresponding to steviol with 2 glucoses and 1 xylose (as above), indicating that UGT91D2e was capable of carrying out xylosylation *in vivo*. These peaks were not seen in the negative controls.

Example 24 - Effect of squalene synthase (ERG9) down regulation using a heterologous insert

In yeast such as *Saccharomyces cerevisiae*, the mevalonate pathway produces a number of isoprenoid phosphate intermediates in the biosynthetic pathway to squalene
30 (See FIG. 20). The squalene synthase in yeast is *ERG9*. See GenBank Accession No.

P29704.2 for the *Saccharomyces cerevisiae* squalene synthase; P36596 for the *Schizosaccharomyces pombe* squalene synthase; Q9Y753 for the *Yarrowia lipolytica* squalene synthase; Q9HGZ6 for the *Candida glabrata* squalene synthase; Q752X9 for the *Ashbya gossypii* squalene synthase; O74165 for the *Cyberlindnera jadinii* squalene synthase; P78589 for the *Candida albicans* squalene synthase; P38604 for the *Saccharomyces cerevisiae* lanosterol synthase; P37268 for the *Homo sapiens* squalene synthase; P53798 for the *Mus musculus* squalene synthase; and Q02769 for the *Rattus norvegicus* squalene synthase. See FIG. 25 (SEQ ID NOs:192-202).

Introduction of stemloop structure in 5'UTR of ERG9 gene

The wild-type *ERG9* promoter region was replaced with the CYC1 promoter sequence and a 5'UTR sequence by homologous recombination. The 5'UTR region contains a sequence that can form a stemloop structure. See SEQ ID NOs. 181-183. SEQ ID NO:184 is another sequence that also can be used.

SEQ ID NO: 181 (heterologous insert 1): TGAATTCGTTAACGAATTC

SEQ ID NO: 182 (heterologous insert 2): TGAATTCGTTAACGAACTC

SEQ ID NO: 183 (heterologous insert 3): TGAATTCGTTAACGAAGTC

SEQ ID NO: 184 (heterologous insert 4): TGAATTCGTTAACGAAATT

Without being bound to a particular mechanism, the stemloop may partially block the 5'-3' directed ribosomal scanning for the AUG and reduce the translation of the transcript. Stemloops with different degree of basepairing were tested to find stemloops that reduced the *ERG9* transcript translation sufficiently to boost FPP levels without affecting the growth of the yeast strain.

DNA fragments encompassing an *ERG9* promoter upstream sequence (for homologous recombination), an expression cassette for the gene (NatR) that confers resistance to Nourseothricin, a CYC1 promoter (SEQ ID NO: 185, FIG. 21), a 5' UTR sequence with a stemloop structure, and an *ERG9* ORF sequence (for homologous recombination) were generated by PCR. DNA fragments that contained either the CYC1

promoter or the KEX2 promoter (SEQ ID NO: 186) but no stemloops were also generated as controls. The flanking ERG9 sequences for recombination as well as the stemloop structure were introduced via the PCR oligos. An overview of the construct for homologous recombination is shown in FIG. 22. The DNA fragments were transformed into an *S.cerevisiae* host strain that subsequently was selected on nourseothricin containing growth plates. Clones with successful exchange of the native ERG9 promoter with the CYC1 promoter and stemloop-containing 5'UTR sequence were identified. Overview and sequence of the stem-loop region is provided in FIG. 23. The sequence identified as 5% corresponds with the heterologous insert having SEQ ID NO:181; the sequence identified as 20% corresponds with the heterologous insert having SEQ ID NO:182; and the sequence identified as 50% corresponds with the heterologous insert having SEQ ID NO:183.

Assessment of FPP accumulation (boosting effect)

The Amorpha-4,11-diene Synthase (ADS) gene catalyzes the chemical reaction that turns one FPP molecule into Amorpha-4,11-diene in the plant *Artemisia annua*. The gene is functional and efficient in *S.cerevisiae* and can be used to indirectly assess the accumulation of FPP in the strains with the stemloop structure introduced in the heterologous 5'UTR of the ERG9 gene. An *S.cerevisiae* codon optimized nucleic acid encoding ADS (GenBank Accession No. AAF61439) was cloned on a multicopy plasmid (2 μ) under the control of the PGK1 promoter and transformed in the wild type and engineered *S. cerevisiae* strains. Amorpha-4,11-diene production was measured and compared to the standard compound caryophyllene, as described by (Ro *et al.* 2006. *Nature* 440(7086):940–943; Paradise *et al. Biotechnol Bioeng.* 2008 Jun 1;100(2):371-8; Newman *et al. Biotechnol Bioeng* 95(4):684–691).

Chemicals

Dodecane and caryophyllene were purchased from Sigma-Aldrich (St.Louis, MO). Complete Supplement Mixtures for formulation of Synthetic Complete (SC) media were purchased from Formedium (UK). All others chemical were purchased from Sigma-Aldrich.

Yeast cultivation

Engineered yeast strains were grown in SC 2% glucose with uracil dropped out. Cultures were grown at 30°C overnight and then used to inoculate main cultures in 250 mL shake flasks containing 25 mL SC medium, and grown to an optical density of 0.1 at 600nm. The main cultures were grown for 72h at 30°C. Because amorphaadiene at very low concentrations is volatile from aqueous cultures, 2.5 mL dodecane was added to each culture flask in order to trap and retain the amorphaadiene produced. 10 µl of the dodecane layer was sampled and diluted 100 fold in ethyl acetate for quantification by GC-MS

GC-MS analysis of amorphaadiene

GC-MS was used to measure amorphaadiene production from yeast cultures. Samples were analysed using the method as follow: The GC oven temperature program used 80°C for 2 min, followed by a ramping of 30°C/min to 160°C, then 3°C/min up to 170°C, and finally 30°C/min up to 300°C with a 2 min final hold. Injector and MS quadrupole detector temperatures were 250°C and 150°C, respectively. 1µL was injected in split less mode. The MS was operated in full scan mode. Amorphaadiene concentration was calculated in (-)-tran-caryophyllene equivalents using a caryophyllene standard curve using the total ions.

The analysis of the different strains, including the different promoter constructs, showed an increased production of amorphaadiene ((2.5 x) when using the heterologous insert having the nucleotide sequence set forth in SEQ ID NO: 181 compared to either no insert or the inserts having the nucleotide sequences set forth in SEQ ID NO:182 and 183. See FIG. 24. The heterologous insert set forth in SEQ ID NO:181 has the most stable secondary structure. For comparison the wild type yeast, with unmodified ERG9, was also analyzed (FIG. 24: CTRL-ADS) and this strain showed even lower production of amorphaadiene. Conversely, the construct that comprised the very weak promoter ScKex2 showed an even higher level of amorphaadiene (6 x).

Example 25 - Analysis of the effect of Squalene Synthase (ERG9) down regulation and GGPPS overexpression on GGPP production.

Assessment of GGPP accumulation

S.cerevisiae contains a GGPPS (BTS1). In addition to BTS1 there are several heterologous GGPPS enzymes that are functional and efficient in *S. cerevisiae*. When a functional GGPPS is overexpressed in *S.cerevisiae*, it leads to accumulation of GGPP, which may be converted to geranylgeraniol (GGOH) by the *S. cerevisiae* enzymes DPP1 and LPP1. The GGOH is partly exported to the yeast culture medium. GGOH can be measured by GC-MS and its accumulation can indirectly be used to assess the potential pool of GGPP that is available for enzymes that use GGPP as substrate.

Four different GGPPSs (GGPPS-1 (*S.acidocaldarius*, see Table 7), GGPPS-2 (*A. nidulans*, FIG. 25, SEQ ID NO:203), GGPPS-3 (*S.cerevisiae*, BTS1, FIG. 25, SEQ ID NO:167), and GGPPS-4 (*M. musculus*, see Table 7)) were assessed. The nucleotide sequences encoding GGPPS-1, GGPPS-2, and GGPPS-4 were *S. cerevisiae* codon optimized. All nucleic acids encoding the GGPPS polypeptides were cloned on a multicopy plasmid (2 μ) under the control of the PGK1 promoter and transformed in two different ERG9 down regulated strains: KEX2-ERG9 and CYC1(5%)-ERG9 (see Example 24).

Engineered yeast strains were grown in SC 2% glucose with uracil dropped out. Complete Supplement Mixtures for formulation of Synthetic Complete (SC) media were purchased from Formedium (UK). All others chemical were purchased from Sigma-Aldrich (St.Louis, MO). All optical density measurements were done at OD 600nm. Cultures were grown at 30°C overnight and then used to inoculate 250 ml unbaffled culture flasks containing 25ml SC medium at an OD600 of 0.1. The main cultures were grown for 72h at 30°C.

To measure GGOH accumulation, yeast cells (pellet) and yeast culture medium (supernatant) were extracted separately and then combined before analysis by GC-MS. The supernatant was extracted with Hexane in a 1:1 ratio. The pellet was first subjected to a saponification in solution containing 20% KOH and 50% Ethanol and the lysed cells were finally extracted with Hexane in a 1:1 ratio. The GC oven temperature program used was 80°C for 2 min, followed by a ramp to 160°C at 30°C/min, then to 170°C at 3°C/min and finally to 300°C at 30°C/min with a 2 min hold. Injector and MS quadrupole

detector temperatures were 250°C and 150°C, respectively. 2ul was injected in split less mode. The MS was operated in full scan mode.

When the GGPPS were overexpressed in the CYC1(5%)-ERG9 strain or KEX2-ERG9 strain, there was a significant increase in GGOH (GGPP) production observed
5 with all four GGPPS polypeptides compared to the control where no GGPPS was expressed. Notably, the CYC1(5%)-ERG9 strain showed a 2-4 fold higher GGOH (GGPP) accumulation than the KEX2-ERG9 strain. The results are shown in FIG. 26.

OTHER EMBODIMENTS

It is to be understood that while the invention has been described in conjunction
10 with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

SeqLst

SEQUENCE LISTING

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<120> Recombinant Production of Steviol
Glycosides

<130> 30998-0010W01

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<151> 2011-08-08

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<151> 2012-02-27

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<211> 460

<212> PRT

<213> Stevia rebaudiana

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Arg Leu Ile Ser Lys Gly Val Lys Thr Thr Leu Val Thr Thr Ile His
35 40 45

Thr Leu Asn Ser Thr Leu Asn His Ser Asn Thr Thr Thr Thr Ser Ile
50 55 60

Glu Ile Gln Ala Ile Ser Asp Gly Cys Asp Glu Gly Gly Phe Met Ser
65 70 75 80

Ala Gly Glu Ser Tyr Leu Glu Thr Phe Lys Gln Val Gly Ser Lys Ser
85 90 95

SeqLst

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

Ala Ile Ile Tyr Asp Ser Met Thr Glu Trp Val Leu Asp Val Ala Ile
115 120 125

Glu Phe Gly Ile Asp Gly Gly Ser Phe Phe Thr Gln Ala Cys Val Val
130 135 140

Asn Ser Leu Tyr Tyr His Val His Lys Gly Leu Ile Ser Leu Pro Leu
145 150 155 160

Gly Glu Thr Val Ser Val Pro Gly Phe Pro Val Leu Gln Arg Trp Glu
165 170 175

Thr Pro Leu Ile Leu Gln Asn His Glu Gln Ile Gln Ser Pro Trp Ser
180 185 190

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

Phe Thr Asn Ser Phe Tyr Lys Leu Glu Glu Glu Val Ile Glu Trp Thr
210 215 220

Arg Lys Ile Trp Asn Leu Lys Val Ile Gly Pro Thr Leu Pro Ser Met
225 230 235 240

Tyr Leu Asp Lys Arg Leu Asp Asp Asp Lys Asp Asn Gly Phe Asn Leu
245 250 255

Tyr Lys Ala Asn His His Glu Cys Met Asn Trp Leu Asp Asp Lys Pro
260 265 270

Lys Glu Ser Val Val Tyr Val Ala Phe Gly Ser Leu Val Lys His Gly
275 280 285

Pro Glu Gln Val Glu Glu Ile Thr Arg Ala Leu Ile Asp Ser Asp Val
290 295 300

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

Asn Leu Ser Glu Val Ile Lys Thr Gly Lys Gly Leu Ile Val Ala Trp
325 330 335

Cys Lys Gln Leu Asp Val Leu Ala His Glu Ser Val Gly Cys Phe Val
340 345 350

SeqLst

Thr His Cys Gly Phe Asn Ser Thr Leu Glu Ala Ile Ser Leu Gly Val
355 360 365

Pro Val Val Ala Met Pro Gln Phe Ser Asp Gln Thr Thr Asn Ala Lys
370 375 380

Leu Leu Asp Glu Ile Leu Gly Val Gly Val Arg Val Lys Ala Asp Glu
385 390 395 400

Asn Gly Ile Val Arg Arg Gly Asn Leu Ala Ser Cys Ile Lys Met Ile
405 410 415

Met Glu Glu Glu Arg Gly Val Ile Ile Arg Lys Asn Ala Val Lys Trp
420 425 430

Lys Asp Leu Ala Lys Val Ala Val His Glu Gly Gly Ser Ser Asp Asn
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Asp Ile Val Glu Phe Val Ser Glu Leu Ile Lys Ala
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<210> 2

<211> 1383

<212> DNA

<213> Stevia rebaudiana

<400> 2

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gccggtgaat cttacttggg aacattcaag caagtgggat ccaagtctct ggccgatcta	300
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aacatcgatc aagcaagatg ggtctttact aattcattct ataagttaga ggaagaggta	660
attgaatgga ctaggaagat ctggaatttg aaagtcattg gtccaacatt gccatcaatg	720
tatttgga caaagacttg tgatgataaa gataatgggt tcaatttgta caaggcta	780
catcacgaat gtatgaattg gctggatgac aaaccaaagg aatcagttgt atatgttgct	840

	SeqLst	
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aacctttctg aagtgataaa gaccggaaaa ggtctaatacg ttgcttggtg taaacaattg		1020
gatgttttag ctcatgaatc tgtaggctgt tttgtaacac attgcggatt caactctaca		1080
ctagaagcca tttccttagg cgtacctgtc gttgcaatgc ctcagttctc cgatcagaca		1140
accaacgcta aacttttgga cgaaatacta ggggtgggtg tcagagttaa agcagacgag		1200
aatggtatcg tcagaagagg gaacctagct tcatgtatca aaatgatcat ggaagaggaa		1260
agaggagtta tcataaggaa aaacgcagtt aagtggaagg atcttgcaaa ggttgccgtc		1320
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taa		1383

<210> 3
 <211> 481
 <212> PRT
 <213> Stevia rebaudiana

Met Asp Ala Met Ala Thr Thr Glu Lys Lys Pro His Val Ile Phe Ile	1	5	10	15
Pro Phe Pro Ala Gln Ser His Ile Lys Ala Met Leu Lys Leu Ala Gln	20	25	30	
Leu Leu His His Lys Gly Leu Gln Ile Thr Phe Val Asn Thr Asp Phe	35	40	45	
Ile His Asn Gln Phe Leu Glu Ser Ser Gly Pro His Cys Leu Asp Gly	50	55	60	
Ala Pro Gly Phe Arg Phe Glu Thr Ile Pro Asp Gly Val Ser His Ser	65	70	75	80
Pro Glu Ala Ser Ile Pro Ile Arg Glu Ser Leu Leu Arg Ser Ile Glu	85	90	95	
Thr Asn Phe Leu Asp Arg Phe Ile Asp Leu Val Thr Lys Leu Pro Asp	100	105	110	
Pro Pro Thr Cys Ile Ile Ser Asp Gly Phe Leu Ser Val Phe Thr Ile	115	120	125	
Asp Ala Ala Lys Lys Leu Gly Ile Pro Val Met Met Tyr Trp Thr Leu	130	135	140	

SeqLst

Ala Ala Cys Gly Phe Met Gly Phe Tyr His Ile His Ser Leu Ile Glu
145 150 155 160

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

Leu Asp Thr Val Ile Asp Trp Val Pro Gly Met Glu Gly Ile Arg Leu
180 185 190

Lys Asp Phe Pro Leu Asp Trp Ser Thr Asp Leu Asn Asp Lys Val Leu
195 200 205

Met Phe Thr Thr Glu Ala Pro Gln Arg Ser His Lys Val Ser His His
210 215 220

Ile Phe His Thr Phe Asp Glu Leu Glu Pro Ser Ile Ile Lys Thr Leu
225 230 235 240

Ser Leu Arg Tyr Asn His Ile Tyr Thr Ile Gly Pro Leu Gln Leu Leu
245 250 255

Leu Asp Gln Ile Pro Glu Glu Lys Lys Gln Thr Gly Ile Thr Ser Leu
260 265 270

His Gly Tyr Ser Leu Val Lys Glu Glu Pro Glu Cys Phe Gln Trp Leu
275 280 285

Gln Ser Lys Glu Pro Asn Ser Val Val Tyr Val Asn Phe Gly Ser Thr
290 295 300

Thr Val Met Ser Leu Glu Asp Met Thr Glu Phe Gly Trp Gly Leu Ala
305 310 315 320

Asn Ser Asn His Tyr Phe Leu Trp Ile Ile Arg Ser Asn Leu Val Ile
325 330 335

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

Arg Gly Phe Ile Ala Ser Trp Cys Ser Gln Glu Lys Val Leu Lys His
355 360 365

Pro Ser Val Gly Gly Phe Leu Thr His Cys Gly Trp Gly Ser Thr Ile
370 375 380

Glu Ser Leu Ser Ala Gly Val Pro Met Ile Cys Trp Pro Tyr Ser Trp
385 390 395 400

SeqLst

Asp Gln Leu Thr Asn Cys Arg Tyr Ile Cys Lys Glu Trp Glu Val Gly
 405 410 415

Leu Glu Met Gly Thr Lys Val Lys Arg Asp Glu Val Lys Arg Leu Val
 420 425 430

Gln Glu Leu Met Gly Glu Gly Gly His Lys Met Arg Asn Lys Ala Lys
 435 440 445

Asp Trp Lys Glu Lys Ala Arg Ile Ala Ile Ala Pro Asn Gly Ser Ser
 450 455 460

Ser Leu Asn Ile Asp Lys Met Val Lys Glu Ile Thr Val Leu Ala Arg
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Asn

<210> 4

<211> 1446

<212> DNA

<213> Stevia rebaudiana

<400> 4

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ataactttcg tgaataccga cttcatccat aatcaatttc tggaatctag tggccctcat	180
tgtttgacg gagccccagg gtttagattc gaaacaattc ctgacggtgt ttcacattcc	240
ccagaggcct ccatcccaat aagagagagt ttactgaggt caatagaaac caactttttg	300
gacggtttca ttgacttggt cacaaaactt ccagaccac caacttgcac aatctctgat	360
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tactggactc ttgctgcatg cggtttcatg ggtttctatc acatccattc tcttatcgaa	480
aagggttttg ctccactgaa agatgcatca tacttaacca acggctacct ggatactggt	540
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gtttcacatc atatctttca cacctttgat gaattggaac catcaatcat caaaaccttg	720
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cctgaagaga aaaagcaaac tgggtattaca tccttacacg gctactcttt agtgaaagag	840
gaaccagaat gttttcaatg gctacaaagt aaagagccta attctgtggt ctacgtcaac	900
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SeqLst

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gaccaactta caaattgtag gtatatctgt aaagagtggg aagttggatt agaaatggga	1260
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<210> 5
 <211> 473
 <212> PRT
 <213> Stevia rebaudiana

<400> 5
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Leu Ser Lys Leu Ile Ala Glu Lys Gly His Lys Val Ser Phe Leu Ser
 35 40 45

Thr Thr Arg Asn Ile Gln Arg Leu Ser Ser His Ile Ser Pro Leu Ile
 50 55 60

Asn Val Val Gln Leu Thr Leu Pro Arg Val Gln Glu Leu Pro Glu Asp
 65 70 75 80

Ala Glu Ala Thr Thr Asp Val His Pro Glu Asp Ile Pro Tyr Leu Lys
 85 90 95

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

His Ser Pro Asp Trp Ile Ile Tyr Asp Tyr Thr His Tyr Trp Leu Pro
 115 120 125

Ser Ile Ala Ala Ser Leu Gly Ile Ser Arg Ala His Phe Ser Val Thr
 130 135 140

Thr Pro Trp Ala Ile Ala Tyr Met Gly Pro Ser Ala Asp Ala Met Ile
 145 150 155 160

SeqLst

Asn Gly Ser Asp Gly Arg Thr Thr Val Glu Asp Leu Thr Thr Pro Pro
 165 170 175
 Lys Trp Phe Pro Phe Pro Thr Lys Val Cys Trp Arg Lys His Asp Leu
 180 185 190
 Ala Arg Leu Val Pro Tyr Lys Ala Pro Gly Ile Ser Asp Gly Tyr Arg
 195 200 205
 Met Gly Leu Val Leu Lys Gly Ser Asp Cys Leu Leu Ser Lys Cys Tyr
 210 215 220
 His Glu Phe Gly Thr Gln Trp Leu Pro Leu Leu Glu Thr Leu His Gln
 225 230 235 240
 Val Pro Val Val Pro Val Gly Leu Leu Pro Pro Glu Ile Pro Gly Asp
 245 250 255
 Glu Lys Asp Glu Thr Trp Val Ser Ile Lys Lys Trp Leu Asp Gly Lys
 260 265 270
 Gln Lys Gly Ser Val Val Tyr Val Ala Leu Gly Ser Glu Val Leu Val
 275 280 285
 Ser Gln Thr Glu Val Val Glu Leu Ala Leu Gly Leu Glu Leu Ser Gly
 290 295 300
 Leu Pro Phe Val Trp Ala Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser
 305 310 315 320
 Asp Ser Val Glu Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg
 325 330 335
 Gly Leu Val Trp Thr Ser Trp Ala Pro Gln Leu Arg Ile Leu Ser His
 340 345 350
 Glu Ser Val Cys Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val
 355 360 365
 Glu Gly Leu Met Phe Gly His Pro Leu Ile Met Leu Pro Ile Phe Gly
 370 375 380
 Asp Gln Pro Leu Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile
 385 390 395 400
 Glu Ile Pro Arg Asn Glu Glu Asp Gly Cys Leu Thr Lys Glu Ser Val

SeqLst

405 410 415

Ala Arg Ser Leu Arg Ser Val Val Val Glu Lys Glu Gly Glu Ile Tyr
 420 425 430

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

Glu Lys Glu Tyr Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala
 450 455 460

Arg Ala Val Ala Ile Asp His Glu Ser
 465 470

<210> 6
 <211> 1422
 <212> DNA
 <213> Stevia rebaudiana

<400> 6

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ggacataaag tgtcattcct ttcaacaact agaaacattc aaagattatc ttcccacata	180
tcaccattga ttaacgtcgt tcaattgaca cttccaagag tacaggaatt accagaagat	240
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ccaggaatct cagacggcta tagaatgggt ttagtcctta aagggctga ctgcctattg	660
tctaagtgtt accatgagtt tgggacacaa tggctaccac ttttggaac attacacaa	720
gttcctgtcg taccagtgg tctattacct ccagaaatcc ctggtgatga gaaggacgag	780
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SeqLst

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cgttccgttg tcgttgaaaa ggaaggcgaa atctacaagg ccaatgcccg tgaactttca	1320
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<210> 7
 <211> 458
 <212> PRT
 <213> Stevia rebaudiana

<400> 7
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Ala Asn Val Leu Tyr Ser Lys Gly Phe Ser Ile Thr Ile Phe His Thr
 35 40 45

Asn Phe Asn Lys Pro Lys Thr Ser Asn Tyr Pro His Phe Thr Phe Arg
 50 55 60

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

Thr His Gly Pro Leu Ala Gly Met Arg Ile Pro Ile Ile Asn Glu His
 85 90 95

Gly Ala Asp Glu Leu Arg Arg Glu Leu Glu Leu Leu Met Leu Ala Ser
 100 105 110

Glu Glu Asp Glu Glu Val Ser Cys Leu Ile Thr Asp Ala Leu Trp Tyr
 115 120 125

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

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

Phe Asp Glu Leu Gly Tyr Leu Asp Pro Asp Asp Lys Thr Arg Leu Glu
 165 170 175

Glu Gln Ala Ser Gly Phe Pro Met Leu Lys Val Lys Asp Ile Lys Ser
 180 185 190

SeqLst

Ala Tyr Ser Asn Trp Gln Ile Leu Lys Glu Ile Leu Gly Lys Met Ile
 195 200 205
 Lys Gln Thr Lys Ala Ser Ser Gly Val Ile Trp Asn Ser Phe Lys Glu
 210 215 220
 Leu Glu Glu Ser Glu Leu Glu Thr Val Ile Arg Glu Ile Pro Ala Pro
 225 230 235 240
 Ser Phe Leu Ile Pro Leu Pro Lys His Leu Thr Ala Ser Ser Ser Ser
 245 250 255
 Leu Leu Asp His Asp Arg Thr Val Phe Gln Trp Leu Asp Gln Gln Pro
 260 265 270
 Pro Ser Ser Val Leu Tyr Val Ser Phe Gly Ser Thr Ser Glu Val Asp
 275 280 285
 Glu Lys Asp Phe Leu Glu Ile Ala Arg Gly Leu Val Asp Ser Lys Gln
 290 295 300
 Ser Phe Leu Trp Val Val Arg Pro Gly Phe Val Lys Gly Ser Thr Trp
 305 310 315 320
 Val Glu Pro Leu Pro Asp Gly Phe Leu Gly Glu Arg Gly Arg Ile Val
 325 330 335
 Lys Trp Val Pro Gln Gln Glu Val Leu Ala His Gly Ala Ile Gly Ala
 340 345 350
 Phe Trp Thr His Ser Gly Trp Asn Ser Thr Leu Glu Ser Val Cys Glu
 355 360 365
 Gly Val Pro Met Ile Phe Ser Asp Phe Gly Leu Asp Gln Pro Leu Asn
 370 375 380
 Ala Arg Tyr Met Ser Asp Val Leu Lys Val Gly Val Tyr Leu Glu Asn
 385 390 395 400
 Gly Trp Glu Arg Gly Glu Ile Ala Asn Ala Ile Arg Arg Val Met Val
 405 410 415
 Asp Glu Glu Gly Glu Tyr Ile Arg Gln Asn Ala Arg Val Leu Lys Gln
 420 425 430
 Lys Ala Asp Val Ser Leu Met Lys Gly Gly Ser Ser Tyr Glu Ser Leu

435

440

SeqLst

445

Glu Ser Leu Val Ser Tyr Ile Ser Ser Leu
 450 455

<210> 8

<211> 1377

<212> DNA

<213> Stevia rebaudiana

<400> 8

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<210> 9

<211> 1422

<212> DNA

SeqLst

<213> Stevia rebaudiana

<400> 9

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<210> 10

<211> 473

<212> PRT

<213> Stevia rebaudiana

<400> 10

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Ala Thr Phe Pro Trp Leu Ala Phe Gly His Ile Leu Pro Tyr Leu Gln

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															SeqLst									
20					25					30														
Leu	Ser	Lys ₃₅	Leu	Ile	Ala	Glu	Lys ₄₀	Gly	His	Lys	Val	Ser ₄₅	Phe	Leu	Ser									
Thr	Thr ₅₀	Arg	Asn	Ile	Gln	Arg ₅₅	Leu	Ser	Ser	His	Ile ₆₀	Ser	Pro	Leu	Ile									
Asn	Val	Val	Gln	Leu	Thr ₇₀	Leu	Pro	Arg	Val	Gln ₇₅	Glu	Leu	Pro	Glu	Asp ₈₀									
Ala	Glu	Ala	Thr	Thr ₈₅	Asp	Val	His	Pro	Glu ₉₀	Asp	Ile	Pro	Tyr	Leu ₉₅	Lys									
Lys	Ala	Ser	Asp ₁₀₀	Gly	Leu	Gln	Pro	Glu ₁₀₅	Val	Thr	Arg	Phe	Leu ₁₁₀	Glu	Gln									
His	Ser	Pro ₁₁₅	Asp	Trp	Ile	Ile	Tyr ₁₂₀	Asp	Tyr	Thr	His	Tyr ₁₂₅	Trp	Leu	Pro									
Ser	Ile ₁₃₀	Ala	Ala	Ser	Leu	Gly ₁₃₅	Ile	Ser	Arg	Ala	His ₁₄₀	Phe	Ser	Val	Thr									
Thr	Pro	Trp	Ala	Ile	Ala ₁₅₀	Tyr	Met	Gly	Pro	Ser ₁₅₅	Ala	Asp	Ala	Met	Ile ₁₆₀									
Asn	Gly	Ser	Asp	Gly ₁₆₅	Arg	Thr	Thr	Val	Glu ₁₇₀	Asp	Leu	Thr	Thr	Pro ₁₇₅	Pro									
Lys	Trp	Phe	Pro ₁₈₀	Phe	Pro	Thr	Lys	Val ₁₈₅	Cys	Trp	Arg	Lys	His ₁₉₀	Asp	Leu									
Ala	Arg	Leu	Val ₁₉₅	Pro	Tyr	Lys	Ala ₂₀₀	Pro	Gly	Ile	Ser	Asp ₂₀₅	Gly	Tyr	Arg									
Met	Gly ₂₁₀	Leu	Val	Leu	Lys	Gly ₂₁₅	Ser	Asp	Cys	Leu	Leu ₂₂₀	Ser	Lys	Cys	Tyr									
His	Glu	Phe	Gly	Thr	Gln ₂₃₀	Trp	Leu	Pro	Leu	Leu ₂₃₅	Glu	Thr	Leu	His	Gln ₂₄₀									
Val	Pro	Val	Val	Pro ₂₄₅	Val	Gly	Leu	Leu	Pro ₂₅₀	Pro	Glu	Val	Pro	Gly ₂₅₅	Asp									
Glu	Lys	Asp	Glu ₂₆₀	Thr	Trp	Val	Ser	Ile ₂₆₅	Lys	Lys	Trp	Leu	Asp ₂₇₀	Gly	Lys									

SeqLst

Gln Lys Gly Ser Val Val Tyr Val Ala Leu Gly Ser Glu Val Leu Val
275 280 285

Ser Gln Thr Glu Val Val Glu Leu Ala Leu Gly Leu Glu Leu Ser Gly
290 295 300

Leu Pro Phe Val Trp Ala Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser
305 310 315 320

Asp Ser Val Glu Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg
325 330 335

Gly Leu Val Trp Thr Ser Trp Ala Pro Gln Leu Arg Ile Leu Ser His
340 345 350

Glu Ser Val Cys Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val
355 360 365

Glu Gly Leu Met Phe Gly His Pro Leu Ile Met Leu Pro Ile Phe Gly
370 375 380

Asp Gln Pro Leu Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile
385 390 395 400

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

Ala Arg Ser Leu Arg Ser Val Val Val Glu Lys Glu Gly Glu Ile Tyr
420 425 430

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

Glu Lys Glu Tyr Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Thr
450 455 460

Arg Ala Val Ala Ile Asp His Glu Ser
465 470

<210> 11
<211> 1422
<212> DNA
<213> Stevia rebaudiana

<400> 11
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tggcttgctt tcggtcacat cctcccttac cttcagcttt cgaaattgat agctgaaaag 120
ggtcacaaag tctcgtttct ttctaccacc agaaacattc aacgtctctc ttctcatatc 180

SeqLst

```

tcgccactca taaatgttgt tcaactcaca cttccacgtg tccaagagct gccggaggat 240
gcagaggcga cactgacgt ccaccctgaa gatattccat atctcaagaa ggcttctgat 300
ggctttcaac cggaggtcac ccggtttcta gaacaacact ctccggactg gattatttat 360
gattatactc actactgggt gccatccatc gcggctagcc tcggtatctc acgagcccac 420
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aatggttcag atggtcgaac cacggttgag gatctcacga caccgcccac gtggtttccc 540
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ccggggatat ctgatggata ccgtatgggg ctggttctta agggatctga ttgtttgctt 660
tccaaatggt accatgagtt tggaactcaa tggctacctc ttttggagac actacaccaa 720
gtaccggtgg ttccggtggg attactgcca ccggaagtac ccggagacga gaaagatgaa 780
acatgggtgt caatcaagaa atggctcgat ggtaaacaaa aaggcagtgt ggtgtacggt 840
gcattaggaa gcgaggtttt ggtgagccaa accgaggttg ttgagttagc attgggtctc 900
gagctttctg gggtgccatt tgtttgggct tatagaaaac caaaagggtcc cgcgaagtca 960
gactcggtagg agttgccaga cgggttcgtg gaacgaactc gtgaccgtgg gttggtctgg 1020
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cattgtgggt ctggatcaat tgtggaaggg ctaatgtttg gtcaccctct aatcatgcta 1140
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gagataccaa gaaatgagga agatggttgc ttgaccaagg agtcggttgc tagatcactg 1260
agggtccgtt ttgtggaaaa agaaggggag atctacaagg cgaacgcgag ggagctgagt 1320
aaaatctata acgacactaa ggttgaaaaa gaatatgtaa gccaatcgt agactatttg 1380
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```

<210> 12

<211> 473

<212> PRT

<213> Stevia rebaudiana

<400> 12

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Met Ala Thr Ser Asp Ser Ile Val Asp Asp Arg Lys Gln Leu His Val
1           5           10           15

```

```

Ala Thr Phe Pro Trp Leu Ala Phe Gly His Ile Leu Pro Phe Leu Gln
          20          25          30

```

```

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

```

```

Thr Thr Arg Asn Ile Gln Arg Leu Ser Ser His Ile Ser Pro Leu Ile

```

															SeqLst	
50					55					60						
Asn	Val	Val	Gln	Leu	Thr	Leu	Pro	Arg	Val	Gln	Glu	Leu	Pro	Glu	Asp	
65					70					75					80	
Ala	Glu	Ala	Thr	Thr	Asp	Val	His	Pro	Glu	Asp	Ile	Gln	Tyr	Leu	Lys	
				85					90					95		
Lys	Ala	Val	Asp	Gly	Leu	Gln	Pro	Glu	Val	Thr	Arg	Phe	Leu	Glu	Gln	
			100					105					110			
His	Ser	Pro	Asp	Trp	Ile	Ile	Tyr	Asp	Phe	Thr	His	Tyr	Trp	Leu	Pro	
		115					120					125				
Ser	Ile	Ala	Ala	Ser	Leu	Gly	Ile	Ser	Arg	Ala	Tyr	Phe	Cys	Val	Ile	
	130					135					140					
Thr	Pro	Trp	Thr	Ile	Ala	Tyr	Leu	Ala	Pro	Ser	Ser	Asp	Ala	Met	Ile	
145					150					155					160	
Asn	Asp	Ser	Asp	Gly	Arg	Thr	Thr	Val	Glu	Asp	Leu	Thr	Thr	Pro	Pro	
				165					170					175		
Lys	Trp	Phe	Pro	Phe	Pro	Thr	Lys	Val	Cys	Trp	Arg	Lys	His	Asp	Leu	
			180					185					190			
Ala	Arg	Met	Glu	Pro	Tyr	Glu	Ala	Pro	Gly	Ile	Ser	Asp	Gly	Tyr	Arg	
		195					200					205				
Met	Gly	Met	Val	Phe	Lys	Gly	Ser	Asp	Cys	Leu	Leu	Phe	Lys	Cys	Tyr	
	210					215					220					
His	Glu	Phe	Gly	Thr	Gln	Trp	Leu	Pro	Leu	Leu	Glu	Thr	Leu	His	Gln	
225					230					235					240	
Val	Pro	Val	Val	Pro	Val	Gly	Leu	Leu	Pro	Pro	Glu	Ile	Pro	Gly	Asp	
				245					250					255		
Glu	Lys	Asp	Glu	Thr	Trp	Val	Ser	Ile	Lys	Lys	Trp	Leu	Asp	Gly	Lys	
			260				265						270			
Gln	Lys	Gly	Ser	Val	Val	Tyr	Val	Ala	Leu	Gly	Ser	Glu	Ala	Leu	Val	
		275				280						285				
Ser	Gln	Thr	Glu	Val	Val	Glu	Leu	Ala	Leu	Gly	Leu	Glu	Leu	Ser	Gly	
	290					295					300					

SeqLst

Leu Pro Phe Val Trp Ala Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser
 305 310 315 320

Asp Ser Val Glu Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg
 325 330 335

Gly Leu Val Trp Thr Ser Trp Ala Pro Gln Leu Arg Ile Leu Ser His
 340 345 350

Glu Ser Val Cys Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val
 355 360 365

Glu Gly Leu Met Phe Gly His Pro Leu Ile Met Leu Pro Leu Phe Gly
 370 375 380

Asp Gln Pro Leu Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile
 385 390 395 400

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

Ala Arg Ser Leu Arg Ser Val Val Val Glu Asn Glu Gly Glu Ile Tyr
 420 425 430

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

Glu Lys Glu Tyr Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala
 450 455 460

Arg Ala Val Ala Ile Asp His Glu Ser
 465 470

<210> 13
 <211> 1422
 <212> DNA
 <213> Stevia rebaudiana

<400> 13
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 tggcttgctt tcggtcacat cctccctttc cttcagcttt cgaaattgat agctgaaaag 120
 ggtcacaaag tctcgtttct ttctaccacc agaaacattc aacgtctctc ttctcatatc 180
 tcgccactca taaatgttgt tcaactcaca cttccacgtg tccaagagct gccggaggat 240
 gcagaggcga ccactgacgt ccaccctgaa gatattcaat atctcaagaa ggctgttgat 300
 ggtcttcaac cggagggtcac ccggtttcta gaacaacact ctccggactg gattatttat 360
 gattttactc actactgggt gccatccatc gcggctagcc tcggtatctc acgagcctac 420

SeqLst

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ttctgcggtca tcaactccatg gaccattgct tatttggcac cctcatctga cgccatgata      480
aatgattcag atggtcgaac cacggttgag gatctcacga caccgcccaa gtggtttccc      540
tttccgacca aagtatgctg gcggaagcat gatcttgccc gaatggagcc ttacgaagct      600
ccagggatat ctgatggata ccgtatgggg atggttttta agggatctga ttgtttgctt      660
ttcaaagtgt accatgagtt tggaaactcaa tggctacctc ttttggagac actacaccaa      720
gtaccggtgg ttccggtggg attactgccg ccggaaatac ccggagacga gaaagatgaa      780
acatgggtgt caatcaagaa atggctcgat ggtaaacaaa aaggcagtgt ggtgtacgtt      840
gcattaggaa gcgaggcttt ggtgagccaa accgaggttg ttgagttagc attgggtctc      900
gagctttctg ggttgccatt tgtttgggct tatagaaaac caaaagggtcc cgcaagtca      960
gactcgggtg agttgccaga cgggttcgtg gaacgaactc gtgaccgtgg gttggtctgg     1020
acgagttggg cacctcagtt acgaatactg agccatgagt cggtttgtgg tttcttgact     1080
cattgtgggt ctggatcaat tgtggaaggg ctaatgtttg gtcaccctct aatcatgcta     1140
ccgctttttg gggaccaacc tctgaatgct cgattactgg aggacaaaca ggtgggaatc     1200
gagataccaa gaaatgagga agatggttgc ttgaccaagg agtcggttgc tagatcactg     1260
agggccgttg ttgtggaaaa cgaaggggag atctacaagg cgaacgcgag ggagctgagt     1320
aaaatctata acgacactaa ggtggaaaaa gaatatgtaa gccaattcgt agactatttg     1380
gaaaagaatg cgcgtgctgg tgccatcgat catgagagtt aa                        1422

```

<210> 14

<211> 485

<212> PRT

<213> Stevia rebaudiana

<400> 14

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Met Tyr Asn Val Thr Tyr His Gln Asn Ser Lys Ala Met Ala Thr Ser
1          5          10         15

```

```

Asp Ser Ile Val Asp Asp Arg Lys Gln Leu His Val Ala Thr Phe Pro
          20         25         30

```

```

Trp Leu Ala Phe Gly His Ile Leu Pro Phe Leu Gln Leu Ser Lys Leu
          35         40         45

```

```

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

```

```

Ile Gln Arg Leu Ser Ser His Ile Ser Pro Leu Ile Asn Val Val Gln
          65         70         75         80

```

```

Leu Thr Leu Pro Arg Val Gln Glu Leu Pro Glu Asp Ala Glu Ala Thr

```

SeqLst															
85								90				95			
Thr	Asp	Val	His 100	Pro	Glu	Asp	Ile	Gln 105	Tyr	Leu	Lys	Lys	Ala 110	Val	Asp
Gly	Leu	Gln 115	Pro	Glu	Val	Thr	Arg 120	Phe	Leu	Glu	Gln	His 125	Ser	Pro	Asp
Trp	Ile 130	Ile	Tyr	Asp	Phe	Thr 135	His	Tyr	Trp	Leu	Pro 140	Ser	Ile	Ala	Ala
Ser 145	Leu	Gly	Ile	Ser	Arg 150	Ala	Tyr	Phe	Cys	Val 155	Ile	Thr	Pro	Trp	Thr 160
Ile	Ala	Tyr	Leu	Ala 165	Pro	Ser	Ser	Asp	Ala 170	Met	Ile	Asn	Asp	Ser 175	Asp
Gly	Arg	Thr	Thr 180	Val	Glu	Asp	Leu	Thr 185	Thr	Pro	Pro	Lys	Trp 190	Phe	Pro
Phe	Pro	Thr 195	Lys	Val	Cys	Trp	Arg 200	Lys	His	Asp	Leu	Ala 205	Arg	Met	Glu
Pro	Tyr 210	Glu	Ala	Pro	Gly	Ile 215	Ser	Asp	Gly	Tyr	Arg 220	Met	Gly	Met	Val
Phe 225	Lys	Gly	Ser	Asp	Cys 230	Leu	Leu	Phe	Lys	Cys 235	Tyr	His	Glu	Phe	Gly 240
Thr	Gln	Trp	Leu	Pro 245	Leu	Leu	Glu	Thr	Leu 250	His	Gln	Val	Pro	Val 255	Val
Pro	Val	Gly	Leu 260	Leu	Pro	Pro	Glu	Ile 265	Pro	Gly	Asp	Glu	Lys 270	Asp	Glu
Thr	Trp	Val 275	Ser	Ile	Lys	Lys	Trp 280	Leu	Asp	Gly	Lys	Gln 285	Lys	Gly	Ser
Val	Val 290	Tyr	Val	Ala	Leu	Gly 295	Ser	Glu	Ala	Leu	Val 300	Ser	Gln	Thr	Glu
Val 305	Val	Glu	Leu	Ala	Leu 310	Gly	Leu	Glu	Leu	Ser 315	Gly	Leu	Pro	Phe	Val 320
Trp	Ala	Tyr	Arg	Lys 325	Pro	Lys	Gly	Pro	Ala 330	Lys	Ser	Asp	Ser	Val 335	Glu

SeqLst

Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg Gly Leu Val Trp
340 345 350

Thr Ser Trp Ala Pro Gln Leu Arg Ile Leu Ser His Glu Ser Val Cys
355 360 365

Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val Glu Gly Leu Met
370 375 380

Phe Gly His Pro Leu Ile Met Leu Pro Ile Phe Cys Asp Gln Pro Leu
385 390 395 400

Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile Glu Ile Pro Arg
405 410 415

Asn Glu Glu Asp Gly Cys Leu Thr Lys Glu Ser Val Ala Arg Ser Leu
420 425 430

Arg Ser Val Val Val Glu Asn Glu Gly Glu Ile Tyr Lys Ala Asn Ala
435 440 445

Arg Ala Leu Ser Lys Ile Tyr Asn Asp Thr Lys Val Glu Lys Glu Tyr
450 455 460

Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala Arg Ala Val Ala
465 470 475 480

Ile Asp His Glu Ser
485

<210> 15
<211> 1458
<212> DNA
<213> Stevia rebaudiana

<400> 15
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cctttccttc agctttcgaa attgatagct gaaaagggtc acaaagtctc gtttctttct 180
accaccagaa acattcaacg tctctcttct catatctcgc cactcataaa tgttgttcaa 240
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cctgaagata ttcaatatct caagaaggct gttgatggtc ttcaaccgga ggtcaccggg 360
tttctagaac aacactctcc ggactggatt atttatgatt ttactcacta ctggttgcc 420
tccatcgcgg ctagcctcgg tatctcacga gcctacttct gcgtcatcac tccatggacc 480
attgcttatt tggcaccctc atctgacgcc atgataaatg attcagatgg tcgaaccacg 540

SeqLst

```

gttgaggatc tcacgacacc gcccaagtgg ttccctttc cgaccaaagt atgctggcgg      600
aagcatgatc ttgccgaat ggagccttac gaagctccgg ggatatctga tggataccgt      660
atggggatgg tttttaaggg atctgattgt ttgcttttca aatgttacca tgagtttgga      720
actcaatggc tacctctttt ggagacacta caccaagtac cggtgggttcc ggtgggatta      780
ctgccgccgg aaatacccgg agacgagaaa gatgaaacat ggggtgtcaat caagaaatgg      840
ctcgatggta aacaaaaagg cagtgtggtg tacgttgcac taggaagcga ggctttggtg      900
agccaaaccg aggttggtga gttagcattg ggtctcgagc tttctgggtt gccatttggt      960
tgggcttata gaaaaccaa aggtcccgcg aagtcagact cggtggagtt gccagacggg     1020
ttcgtggaac gaactcgtga ccgtgggttg gtctggacga gttgggcacc tcagttacga     1080
atactgagcc acgagtcagt ttgtggtttc ttgactcatt gtggttcttg atcaattgtg     1140
gaagggctaa tgtttggtca ccctctaata atgctaccga ttttttgatga ccaacctctg     1200
aatgctcgat tactggagga caaacagggtg ggaatcgaga taccaagaaa tgaggaagat     1260
ggttgcttga ccaaggagtc ggttgctaga tctactgaggt ccgttggtgt ggaaaacgaa     1320
ggggagatct acaaggcgaa cgcgagggcg ctgagtaaaa tctataacga cactaagggtg     1380
gaaaaagaat atgtaagcca attcgtagac tatttggaag agaatgcgcg tgcggttgcc     1440
atcgatcatg agagttaa                                     1458

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<210> 16

<211> 473

<212> PRT

<213> Stevia rebaudiana

<400> 16

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Met Ala Thr Ser Asp Ser Ile Val Asp Asp Arg Lys Gln Leu His Val
1          5          10          15

```

```

Ala Thr Phe Pro Trp Leu Ala Phe Gly His Ile Leu Pro Phe Leu Gln
20          25          30

```

```

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

```

```

Thr Thr Arg Asn Ile Gln Arg Leu Ser Ser His Ile Ser Pro Leu Ile
50          55          60

```

```

Asn Val Val Gln Leu Thr Leu Pro Arg Val Gln Glu Leu Pro Glu Asp
65          70          75          80

```

```

Ala Glu Ala Thr Thr Asp Val His Pro Glu Asp Ile Gln Tyr Leu Lys
85          90          95

```


SeqLst

Lys Ala Val Asp Gly Leu Gln Pro Glu Val Thr Arg Phe Leu Glu Gln
 100 105 110
 His Ser Pro Asp Trp Ile Ile Tyr Asp Phe Thr His Tyr Trp Leu Pro
 115 120 125
 Ser Ile Ala Ala Ser Leu Gly Ile Ser Arg Ala Tyr Phe Cys Val Ile
 130 135 140
 Thr Pro Trp Thr Ile Ala Tyr Leu Ala Pro Ser Ser Asp Ala Met Ile
 145 150 155 160
 Asn Asp Ser Asp Gly Arg Thr Thr Val Glu Asp Leu Thr Thr Pro Pro
 165 170 175
 Lys Trp Phe Pro Phe Pro Thr Lys Val Cys Trp Arg Lys His Asp Leu
 180 185 190
 Ala Arg Met Glu Pro Tyr Glu Ala Pro Gly Ile Ser Asp Gly Tyr Arg
 195 200 205
 Met Gly Met Val Phe Lys Gly Ser Asp Cys Leu Leu Phe Lys Cys Tyr
 210 215 220
 His Glu Phe Gly Thr Gln Trp Leu Pro Leu Leu Glu Thr Leu His Gln
 225 230 235 240
 Val Pro Val Val Pro Val Gly Leu Leu Pro Pro Glu Ile Pro Gly Asp
 245 250 255
 Glu Lys Asp Glu Thr Trp Val Ser Ile Lys Lys Trp Leu Asp Gly Lys
 260 265 270
 Gln Lys Gly Ser Val Val Tyr Val Ala Leu Gly Ser Glu Ala Leu Val
 275 280 285
 Ser Gln Thr Glu Val Val Glu Leu Ala Leu Gly Leu Glu Leu Ser Gly
 290 295 300
 Leu Pro Phe Val Trp Ala Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser
 305 310 315 320
 Asp Ser Val Glu Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg
 325 330 335
 Gly Leu Val Trp Thr Ser Trp Ala Pro Gln Leu Arg Ile Leu Ser His
 340 345 350

SeqLst

Glu Ser Val Cys Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val
 355 360 365

Glu Gly Leu Met Phe Gly His Pro Leu Ile Met Leu Pro Ile Phe Cys
 370 375 380

Asp Gln Pro Leu Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile
 385 390 395 400

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

Ala Arg Ser Leu Arg Ser Val Val Val Glu Asn Glu Gly Glu Ile Tyr
 420 425 430

Lys Ala Asn Ala Arg Ala Leu Ser Lys Ile Tyr Asn Asp Thr Lys Val
 435 440 445

Glu Lys Glu Tyr Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala
 450 455 460

Arg Ala Val Ala Ile Asp His Glu Ser
 465 470

<210> 17

<211> 1422

<212> DNA

<213> Stevia rebaudiana

<400> 17

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ggtcacaaag tctcgtttct ttctaccacc agaaacattc aacgtctctc ttctcatatc	180
tcgccactca taaatgttgt tcaactcaca cttccacgtg tccaagagct gccggaggat	240
gcagaggcga ccactgacgt ccaccctgaa gatattcaat atctcaagaa ggctgttgat	300
ggctttcaac cggagggtcac ccggtttcta gaacaacact ctccggactg gattatttat	360
gattttactc actactggtt gccatccatc gcggctagcc tcggtatctc acgagcctac	420
ttctgcgtca tcaactccatg gaccattgct tatttggcac cctcatctga cgccatgata	480
aatgattcag atggtcgaac cacggttgag gatctcacga caccgcccac gtgggtttccc	540
tttccgacca aagtatgctg gcggaagcat gatcttgccc gaatggagcc ttacgaagct	600
ccggggatat ctgatggata ccgtatgggg atggttttta agggatctga ttgtttgctt	660
ttcaaagtgt accatgagtt tggaactcaa tggctacctc ttttgagac actacaccaa	720

SeqLst

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gcattaggaa	gcgaggcttt	ggtgagccaa	accgaggttg	ttgagttagc	attgggtctc	900
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cattgtgggt	ctggatcaat	tgtggaagg	ctaattgttg	gtcacctctt	aatcatgcta	1140
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agggtccgtt	ttgtggaaaa	cgaaggggag	atctacaagg	cgaacgcgag	ggcgctgagt	1320
aaaatctata	acgacactaa	ggtggaaaaa	gaatatgtaa	gccaattcgt	agactatttg	1380
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<210> 18

<211> 1086

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 18

atggcttttg	taaacccaac	cgctcttttc	tatggtacct	ctatcagaac	aagacctaca	60
aacttactaa	atccaactca	aaagctaaga	ccagtttcat	catcttcctt	accttctttc	120
tcatcagtta	gtgcgattct	tactgaaaaa	catcaatcta	atccttctga	gaacaacaat	180
ttgcaaactc	atctagaaac	tcctttcaac	tttgatagtt	atatgttgga	aaaagtcaac	240
atggttaacg	aggcgcttga	tgcattctgt	ccactaaaag	acccaatcaa	aatccatgaa	300
tccatgagat	actctttatt	ggcaggcggt	aagagaatca	gaccaatgat	gtgtattgca	360
gcctgcgaaa	tagtcggagg	taatatcctt	aacgccatgc	cagccgcatg	tgccgtggaa	420
atgattcata	ctatgtcttt	ggtgcatgac	gatcttccat	gtatggataa	tgatgacttc	480
agaagaggta	aacctatttc	acacaagggt	tacggggagg	aaatggcagt	attgaccggc	540
gatgctttac	taagtattat	tttcgaacat	atagctactg	ctacaaaggg	tgtatcaaag	600
gatagaatcg	tcagagctat	aggggagttg	gcccgttcag	ttggctccga	aggttttagtg	660
gctggacaag	ttgtagatat	cttgtcagag	ggtgctgatg	ttggattaga	tcacctagaa	720
tacattcaca	tccacaaaac	agcaatgttg	cttgagtcct	cagtagttat	tggcgctatc	780
atgggaggag	gatctgatca	gcagatcgaa	aagttgagaa	aattcgctag	atctattggt	840

SeqLst

ctactattcc aagttgtgga tgacattttg gatgttacaa aatctaccga agagttgggg	900
aaaacagctg gtaaggattt gttgacagat aagacaactt acccaaagtt gttaggtata	960
gaaaagtcca gagaatttgc cgaaaaactt aacaaggaag cacaagagca attaagtggc	1020
tttgatagac gtaaggcagc tcctttgatc gcgttagcca actacaatgc gtaccgtcaa	1080
aattga	1086

<210> 19

<211> 1029

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 19

atggctgagc aacaaatata taacttgctg tctatgtttg atgcttcaca tgctagtcag	60
aaattagaaa ttactgtcca aatgatggac acataccatt acagagaaac gcctccagat	120
tcctcatctt ctgaaggcgg ttcatgtctt agatacgacg agagaagagt ctctttgcct	180
ctcagtcata atgctgcctc tccagatatt gtatcacaaac tatgtttttc cactgcaatg	240
tcttcagagt tgaatcacag atggaaatct caaagattaa aggtggccga ttctccttac	300
aactatatcc taacattacc atcaaaagga attagagggtg cctttatcga ttccctgaac	360
gtatggttgg aggttccaga ggatgaaaca tcagtcatca aggaagttat tggatatgctc	420
cacaactctt cattaatcat tgatgacttc caagataatt ctccacttag aagaggaaag	480
ccatctaccc atacagtctt cggccctgcc caggctatca atactgctac ttacgttata	540
gttaaagcaa tcgaaaagat acaagacata gtgggacacg atgcattggc agatgttacg	600
gggtactatta caactatfff ccaagggtcag gccatggact tgtggtggac agcaaatgca	660
atcgttccat caatacagga atacttactt atggtaaacy ataaaaccgg tgctctcttt	720
agactgagtt tggagttggt agctctgaat tccgaagcca gtatttctga ctctgcttta	780
gaaagtttat ctagtgctgt ttccttgcta ggtcaatact tccaaatcag agacgactat	840
atgaacttga tcgataacaa gtatacagat cagaaaggct tctgcgaaga tcttgatgaa	900
ggcaagtact cactaacact tattcatgcc ctccaaactg attcatccga tctactgacc	960
aacatccttt caatgagaag agtgcaagga aagttaacgg cacaaaagag atgttggttc	1020
tggaatatga	1029

<210> 20

<211> 903

<212> DNA

<213> Artificial Sequence

SeqLst

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 20

atggaaaaga ctaaggagaa agcagaacgt atcttgctgg agccatacag atacttatta	60
caactaccag gaaagcaagt ccgttctaaa ctatcacaaag cgttcaatca ctgggttaaaa	120
gttcctgaag ataagttaca aatcattatt gaagtcacag aaatgctaca caatgcttct	180
ttactgatcg atgatataga ggattcttcc aaactgagaa gaggttttcc tgtcgtcat	240
tccatatacg gggtagcaag tgtaatcaac tcagctaatt acgtctactt cttgggattg	300
gaaaaagtat tgacattaga tcatccagac gctgtaaagc tattcaccag acaacttctt	360
gaattgcatc aagggtcaagg tttggatatac tattggagag acacttatac ttgccaaca	420
gaagaggagt acaaagcaat gggttctaaa aagactggcg gtttggtcgg acttgccggt	480
ggctctgatgc aacttttctc tgattacaag gaggacttaa agcctctgtt ggataccttg	540
ggcttggtttt tccagattag agatgactac gctaacttac attcaaagga atattcagaa	600
aacaaatcat tctgtgaaga tttgactgaa ggggaagtta gttttccaac aatccacgcc	660
atttgggtcaa gaccagaatc tactcaagtg caaaacattc tgcgtcagag aacagagaat	720
attgacatca aaaagtattg tgttcagtac ttggaagatg ttgggttcttt tgcttacaca	780
agacatacac ttagagaatt agaggcaaaa gcatacaagc aaatagaagc ctgtggaggc	840
aatccttctc tagtggcatt gggttaaacat ttgtccaaaa tgttcaccga ggaaaacaag	900
taa	903

<210> 21

<211> 1020

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 21

atggcaagat tctatcttct taacgcacta ttgatgggta tctcattaca atcaactaca	60
gccttcactc cagctaaact tgcttatcca acaacaacaa cagctctaaa tgtcgcctcc	120
gccgaaactt ctttcagtct agatgaatac ttggcctcta agataggacc tatagagtct	180
gccttggaag catcagtcaa atccagaatt ccacagaccg ataagatctg cgaatctatg	240
gcctactctt tgatggcagg aggcaagaga attagaccag tggtgtgtat cgctgcatgt	300
gagatgttcg gtggatccca agatgtcgct atgcctactg ctgtggcatt agaaatgata	360
cacacaatgt ctttgattca tgatgatttg ccatccatgg ataacgatga cttgagaaga	420

					SeqLst	
ggtaaacc	caaaccatgt	cgttttcggc	gaagatgtag	ctattcttgc	aggtgactct	480
ttattgtcaa	cttccttcga	gcacgtcgct	agagaaacaa	aaggagtgtc	agcagaaaag	540
atcgtggatg	ttatcgctag	attaggcaaa	tctgttggtg	ccgagggcct	tgctggcggt	600
caagttatgg	acttagaatg	tgaagctaaa	ccaggtacca	cattagacga	cttgaaatgg	660
attcatatcc	ataaaaccgc	tacattgtta	caagttgctg	tagcttctgg	tgcagttcta	720
ggtggtgcaa	ctcctgaaga	ggttgctgca	tgcgagttgt	ttgctatgaa	tataggtctt	780
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actgcaggca	aagatgaagc	tactgataag	acaacttacc	caaagttatt	aggattagaa	900
gagagtaagg	catacgcaag	acaactaatc	gatgaagcca	aggaaagttt	ggctcctttt	960
ggagatagag	ctgccccctt	attggccatt	gcagatttca	ttattgatag	aaagaattga	1020

<210> 22

<211> 1068

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 22

atgcacttag	caccacgtag	agtccttaga	ggtagaagat	caccacctga	cagagttcct	60
gaaagacaag	gtgccttggg	tagaagacgt	ggagctggct	ctactggctg	tgcccgtgct	120
gctgctggtg	ttcaccgtag	aagaggagga	ggcgaggctg	atccatcagc	tgctgtgcat	180
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gccttagaaa	tgtttcatgc	ttttgcttta	atccatgatg	atatcatgga	tgatagtgca	300
actagaagag	gctccccaac	tgttcacaga	gccctagctg	atcgtttagg	cgctgctctg	360
gaccagatc	aggccggtca	actaggagtt	tctactgcta	tcttggttgg	agatctggct	420
ttgacatggt	ccgatgaatt	gttatacgct	ccattgactc	cacatagact	ggcagcagta	480
ctaccattgg	taacagctat	gagagctgaa	accgttcatg	gccaatatct	tgatataact	540
agtgctagaa	gacctgggac	cgatacttct	cttgcatgga	gaatagccag	atataagaca	600
gcagcttaca	caatggaacg	tccactgcac	attgggtgcag	ccctggctgg	ggcaagacca	660
gaactattag	cagggccttc	agcatacgcc	ttgccagctg	gagaagcctt	ccaattggca	720
gatgacctgc	taggcgtctt	cggtgatcca	agacgtacag	ggaaacctga	cctagatgat	780
cttagagggtg	gaaagcatac	tgtcttagtc	gccttggtgaa	gagaacatgc	cactccagaa	840
cagagacaca	cattggatac	attattgggt	acaccagggtc	ttgatagaca	aggcgcttca	900
agactaagat	gcgtattggt	agcaactggt	gcaagagccg	aagccgaaag	acttattaca	960

	SeqLst	
gagagaagag atcaagcatt aactgcattg aacgcattaa cactgccacc tccttttagct		1020
gaggcattag caagattgac attagggctt acagctcatc ctgcctaa		1068

<210> 23
 <211> 993
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 23	
atgtcatatt tcgataacta cttcaatgag atagttaatt ccgtgaacga catcattaag	60
tccttacatct ctggcgacgt accaaaacta tacgaagcct cctaccattt gtttacatca	120
ggaggaaaga gactaagacc attgatcctt acaattttctt ctgatctttt cgggtggacag	180
agagaaagag catactatgc tggcgacgca atcgaagttt tgcacacatt cactttgggt	240
cacgatgata tcatggatca agataacatt cgtagagggtc ttcctactgt acatgtcaag	300
tatggcctac ctttggccat tttagctggg gacttattgc atgcaaaagc ctttcaattg	360
ttgactcagg cattgagagg tctaccatct gaaactatca tcaaggcggt tgatatcttt	420
acaagatcta tcattatcat atcagaagggt caagctgtcg atatggaatt cgaagataga	480
attgatatca aggaacaaga gtatttggat atgatatctc gtaaaaccgc tgccttattc	540
tcagcttctt cttccattgg ggcgttgata gctggagcta atgataacga tgtgagatta	600
atgtccgatt tcggtacaaa tcttggggtc gcattttcaa ttgtagatga tatacttggt	660
ttaacagctg atgaaaaaga gctaggaaaa cctgttttca gtgatatcag agaaggtaaa	720
aagaccatat tagtcattaa gacttttagaa ttgtgtaagg aagacgagaa aaagattgtg	780
ttaaaagcgc taggcaacaa gtcagcatca aaggaagagt tgatgagttc tgctgacata	840
atcaaaaagt actcattgga ttacgcctac aacttagctg agaaatacta caaaaacgcc	900
atcgattctc taaatcaagt ttcaagtaaa agtgatattc caggggaaggc attgaaatat	960
cttgctgaat tcaccatcag aagacgtaag taa	993

<210> 24
 <211> 894
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 24	
atggctgcac aaactttcaa cctggatacc tacttatccc aaagacaaca acaagttgaa	60
gaggccctaa gtgctgctct tgtgccagct taccctgaga gaatatacga agctatgaga	120

SeqLst

tactccctcc	tggcaggtgg	caaaagatta	agacctatct	tatgttttagc	tgcttgcgaa	180
ttggcaggtg	gttctgttga	acaagccatg	ccaactgcgt	gtgcacttga	aatgatccat	240
acaatgtcac	taattcatga	tgacctgcca	gccatggata	acgatgattt	cagaagagga	300
aagccaacta	atcacaaggt	gttcggggaa	gatatagcca	tcttagcggg	tgatgcgctt	360
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gtcgtagacc	ttgaatctga	aggtaaagct	atttccttag	aaacattgga	gtatattcac	540
tcacataaga	ctggagcctt	gctggaagca	tcagttgtct	caggcggtat	tctcgcaggg	600
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agacagaaag	cggaagagtt	gattcaatct	gctaaggaag	ccttaagacc	ttacggttca	840
caagcagagc	cactcctagc	gctggcagac	ttcatcacac	gtcgtcagca	ttaa	894

<210> 25

<211> 1116

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 25

atggcctctg	ttactttggg	ttcctggatc	gtcgtccacc	accataacca	tcaccatcca	60
tcatttatcc	taactaaatc	tcgttcaaga	tcctgtccta	ttactaac	caaaccaatc	120
tcttttcgtt	caaagagaac	agtttctct	agtagttcta	tcgtgtcctc	tagtgtcgtc	180
actaaggaag	acaatctgag	acagtctgaa	ccttcttcct	ttgatttcat	gtcatatatc	240
attactaagg	cagaactagt	gaataaggct	cttgattcag	cagttccatt	aagagagcca	300
ttgaaaatcc	atgaagcaat	gagatactct	cttctagctg	gcgggaagag	agtcagacct	360
gtactctgca	tagcagcgtg	cgaattagtt	ggtaggcgag	aatcaaccgc	tatgcctgcc	420
gcttgctgctg	tagaaatgat	tcatacaatg	tcactgatac	acgatgattt	gccatgtatg	480
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attggaactg	agggtttagt	tgcagggtcaa	gtcgtcgata	tctcttccga	agggtcttgat	720
ttgaatgatg	taggtcttga	acatctcgaa	ttcatccatc	ttcacaagac	agctgcactt	780

SeqLst

ttagaagcca gtgcggttct cggcgcaatt gttggcggag ggagtgatga cgaaattgag	840
agattgagga agtttgctag atgtatagga ttactgttcc aagtagtaga cgatatacta	900
gatgtgacaa agtcttccaa agagttggga aaaacagctg gtaaagattt gattgccgac	960
aaattgacct accctaagat tatggggcta gaaaaatcaa gagaatttgc cgagaaactc	1020
aatagagagg cgcgtgatca actgttgggt ttcgattctg ataaagttgc accactctta	1080
gccttagcca actacatcgc ttacagacaa aactaa	1116

<210> 26

<211> 1086

<212> DNA

<213> Stevia rebaudiana

<400> 26

atggctcttg taaatcccac agctttgttc tatggaacct ccataagaac cagacccaca	60
aacttgctca acccgaccca aaaacttcga cccgtttcct cgtcttcttt gccttccttc	120
tcttcagttt ctgcaatctt gacggaaaaa caccaatcaa acccatcaga aaacaataac	180
ttgcaaacc atctcgaaac accattcaat ttcgactctt acatgctgga gaaagtaaac	240
atggtgaatg aagctctgga cgcctcgggt ccaactcaaag acccgataaa gatccatgaa	300
tccatgcggt actcccttct agctggcggg aaacgcatcc gaccgatgat gtgcatcgcc	360
gcttgcgaaa tagtcggagg caacatatta aacgccatgc cagctgcatg cgcggtcgag	420
atgattcaca ccatgtcact agttcatgac gaccttccat gcatggataa cgacgacttc	480
cgacgtggaa aaccaataag ccacaagggtg tacgggtgaag aaatggcgggt tctaaccggg	540
gacgcgttac tctcattatc cttcgaacat atcgcgaccg cgacaaaagg cgtatccaaa	600
gacaggatcg tccgagccat tgggtgaactc gcaagggtccg ttggctcgga gggtttggtc	660
gccggtcagg tgggtgatat ttatccgaa ggggctgatg ttgggttaga ccacttgag	720
tatattcata tacacaagac tgcaatgttg cttgagagct cggtcgtgat cggcgcgatc	780
atgggcgggtg ggtctgacca acagatcgaa aagttgcgaa agtttgcgag atcgattggt	840
ttgttgtttc aggtggtaga tgatattctt gatgtcacia agtcgactga ggaattgggg	900
aaaacggcgg gaaaagattt gctgacggac aagacaacgt atccgaagtt gttggggatc	960
gaaaaatcga gagaatttgc ggagaaatta aacaaggaag cgcaagaaca attgtcgggg	1020
tttgatcgcc gcaaggcggc tccgttaatt gcccttgcta attacaatgc ttataggcaa	1080
aactga	1086

<210> 27

<211> 1029

<212> DNA

<213> Gibberella fujikuroi

SeqLst

<400> 27

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aagttggaga ttacggttca gatgatggat acctaccatt acagagaaac tcctccagac	120
tcttcctctt cagaaggcgg ttccttatct cgctatgatg agcgacgggt ctcccttccg	180
ctctctcaca atgcagcctc cccagacata gtctcccagt tatgcttctc aacagctatg	240
agctcggagc tcaatcacag gtggaagtca cagcgctca aggttgctga ctctccctac	300
aactacatcc tgactcttcc atctaaagggt attcgtgggg ctttcattga ctactgaat	360
gtctggctcg aggtccccga agacgagacc tcggtgatca aagaggatgat tggcatgctc	420
cacaactcgt ctctcataat cgatgacttc caagacaact cccacttcg gcggggcaag	480
ccatctacac atactgtctt cgggccagca caagcaatca acacagcaac atatgtcatc	540
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aggttatcgc ttgaactact ggcgtgaac tctgaagcat ccatcagtga cagcgcgctt	780
gaatctctca gcagcgctgt ctactgctc gggcagtatt tccagataag agatgattac	840
atgaatctca ttgacaacaa gtatactgat cagaaaggat tttgcgagga tctggacgag	900
gggaaatact cgttgactct aatccatgct ctgcagaccg actccagcga ctttctcacc	960
aacatcttat cgatgagaag agtccaagga aaacttacgg cgcagaaaag atgctggttt	1020
tggaagtga	1029

<210> 28

<211> 903

<212> DNA

<213> Mus musculus

<400> 28

atggagaaaa ctaaagagaa agctgagagg attcttctag agccctatag gtacttactt	60
cagttaccag gtaaacagggt gagaagcaaa ctttcacagg catttaatca ctggctgaaa	120
gttcagaag acaagctaca gattatcatt gaagtgactg aaatgttgca taatgccagt	180
ttactcattg atgatattga agacagttca aagctccgac gtgggttccc agtggctcac	240
agcatctatg gtgtcccatc tgtcattaat tctgccatt acgtctactt ccttggactg	300
gaaaaagtct taaccttga tccccggat gcggtgaagc ttttcacacg ccagcttctg	360
gaacttcac agggacaagg cctcgatatt tactggaggg acacctacac ttgtccaact	420
gaagaagaat ataaagccat ggtgttgacg aagacagggt gtttgtttg attagcagta	480
ggtcttatgc agctgttctc tgattacaaa gaagatctaa agccactgct tgacacactt	540

	SeqLst	
gggctctttt tccagattag agatgattat gccaatctac actccaaaga atacagtgaa		600
aacaaaagtt tctgtgaaga cttgacagaa gggaagttct cattccccac tatccatgcc		660
atttgggtcaa ggccagaaag caccaggtta cagaacatcc tgcgccagag aacagagaat		720
atagatatta aaaagtattg tgtgcagtac ctggaggatg taggttcttt tgcatacact		780
cgacacactc ttagagagct tgaagctaaa gcctacaaac aaattgaggc ctgtggtggg		840
aacccttcac tagtggcttt agtcaagcac ttaagtaaga tgttcacaga agaaaataaa		900
taa		903

<210> 29
 <211> 1020
 <212> DNA
 <213> *Thalassiosira pseudonana*

<400> 29		
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gcattcacc cggcaaaact cgcctaccca acaaccacca ctgcattaaa cgttgcctct		120
gccgaaacat catttagcct cgatgaatac ctagcctcca aaatcggacc cattgaatca		180
gctctcgagg catctgtcaa atctcgcat cctcaaactg acaagatatg cgagtctatg		240
gcatactcac tcatggctgg aggaaagcgt atccgtccc ttttggtcat tgctgcttgt		300
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ggaaagccaa ctaatcatgt tgtctttgga gaggatgttg ctattcttgc tggggattct		480
cttctcagta cgtcttttga acatgttgcc cgtgaaacca aaggagtgtc agctgaaaag		540
attgtagatg ttatcgctcg cctcgggaag tctgtgggtg cagaggggtct tgctggtgga		600
caggttatgg atcttgagtg tgaggcgaag ccaggaacta ccctcgacga tctcaagtgg		660
attcacattc acaaaactgc cactcttctt caagtggcag tggcatcagg tgctgttctt		720
ggagggggcca caccagagga ggttgctgct tgtgaactgt tcgcaatgaa tattggactt		780
gccttccagg tcgctgatga tattttggac gtgacggcat cgagtgagga tcttggcaaa		840
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gagagtaagg catacgctcg acaactcata gacgaagcaa aggaatcttt ggctcctttc		960
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<210> 30
 <211> 1068
 <212> DNA
 <213> *Streptomyces clavuligerus*

<400> 30		
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SeqLst

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gaacggcgcg	accaggccct	caccgcgctc	aacgccctga	cactgcccc	accgctcgcc	1020
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<210> 31

<211> 993

<212> DNA

<213> *Sulfolobus acidicaldarius*

<400> 31

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tcggcatcct	caagtatagg	cgcacttatt	gctgggtgcta	atgataatga	tgtaagactg	600
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SeqLst

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ctaaaggcgt taggtaataa gtcagcctca aaagaagaat taatgagctc agcagatata	840
attaagaaat actctttaga ttatgcatac aatttagcag agaaatatta taaaaatgct	900
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<210> 32

<211> 894

<212> DNA

<213> *Synechococcus* sp.

<400> 32

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tacagcctgc tggcgggggg gaaacgcctg aggccgatcc tctgtctggc ggcctgtgag	180
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cggcagaaag ctgaggaact gatccaatcg gccaaaggagg cgttgcgccc ctacggatcc	840
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<210> 33

<211> 1116

<212> DNA

<213> *Arabidopsis thaliana*

<400> 33

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tcctttcgat caaaacgcac cgtttcatca tcttcttcaa tcgtttcttc ttccgttggt	180

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aagttgacgt atcctaagat tatgggtttg gagaaatcga gagagtttgc tgagaaattg		1020
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<210> 34

<211> 2364

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 34

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gacatcaact tcagatgtaa agcagtttct aaagagtact ctgatctggt gcagaaagat		180
gaggcttctt tcacaaaatg ggacgatgac aagggtgaaag atcatcttga taccaacaaa		240
aacttataacc caaatgatga gattaaggaa ttgttgtaat cagtaaaggc tatgttcggt		300
agtatgaatg acggggagat aaacgtctct gcatacgata ctgcatgggt tgctttgggt		360
caagatgtcg atggatcagg tagtcctcag ttcccttctt ctttagaatg gattgccaac		420
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atcaacacat tagcatgcgt tattgcactt acaagttgga atgttcatcc ttctaagtgt		540
gaaaaagggt tgaattttct gagagaaaac atttgcaa atagaagatga aaacgcagaa		600

SeqLst						
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cacaatttca	aggagaattc	caccacagtg	gattcaaagg	ttcaggaact	agtccagttg	2220
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aaagttttcg	aatcgtaat	ttga				2364

<210> 35
 <211> 1584

SeqLst

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 35

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gatctattgt taccaccatt gtaa	1584

SeqLst

<210> 36
 <211> 1551
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

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<400> 36
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SeqLst

<210> 37

<211> 2364

<212> DNA

<213> Stevia rebaudiana

<400> 37

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SeqLst

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<210> 38

<211> 1584

<212> DNA

<213> Streptomyces clavuligerus

<400> 38

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gccttcctgc tggagcggca gcatgaggac ggctcgtggg gcccgcccgg cgggtaccgt	240
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tcgctccttg agggcatcca gcacctcctg gacccggcgc acccgcatc ccgacccgct	480
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gccttgcgct cccacgcccgc agccggcaca cctgtcccgg gcaagggtgtg gcacgcctcg	600
gaaaccttgg ggctatcgac cgaggcagcc tcccaccttc aacccgcca gggcatcatc	660
ggtggctccg ccgcccgcac agcaacatgg ctaccagggt tcgccccgtc gcaacagagc	720
gacagcgcac ggcgctacct ggaagaactc cagcaccgat acagcggccc ggtgccctcc	780
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gttccatgag aggtccggc agcccttctc gacagcctgg aggcagcgct cacaccacag	900
ggcgctccag cgggtgcggg actgccgccg gacgcggatg acaccgccgc cgttctgctg	960
gcgcttgcca cgcacggccg cgggcgccgt cccgagggtcc tcatggacta ccgcacggac	1020

SeqLst

ggctactttcc agtgcttcat cggcgaacgc acccctttcca tcagcaccaa tgcccatgtc	1080
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gccatggaca ccgcatcagc gtggctcctc gcggctcaga agcaggatgg cagctggctc	1200
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cacgctttccc ctgccaccgc ccccgcacgg cagcgtgctg tgcggtgggg gctggcaaca	1320
caacgctcgg acggcggctg gggcctgtgg cactccacgg tcgaggagac cgcctacgcc	1380
ctgcagatcc tcgccccacc ttccggcggc gggaacatcc ccgtgcaaca ggcgctcacc	1440
agggggcgcg cccgcctctg cggcgctttg ccgctgactc ccctatggca tgacaaggac	1500
ctgtacacgc cgggtacgtgt cgtccgcgcc gcccgtgccg ccgccctgta caccaccgct	1560
gacctgtttc tgccgcccct gtga	1584

<210> 39

<211> 1551

<212> DNA

<213> Bradyrhizobium japonicum

<400> 39

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gatggcggca gcgtcgggtcc gtccgtctac gacacggcgc aggcgctgcg cttccacggc	120
aacgtcaccg gtcggcagga cgcatacgcg tggctcatcg cgcagcaaca ggccgacggc	180
ggatggggaa gcgcggactt cccgctgttc cgccatgcgc ccacgtgggc ggcgttactg	240
gcattgcagc gtgccgatcc tcttcccggg gctgcggacg cagtccagac tgcaacgagg	300
ttcctccagc gccagcccga tccctacgca catgcggtgc cagaagacgc gccgatcggc	360
gcggagctga tcctgccgca gttttgcggg gaggccgcat gggtgctggg tggcgtagcg	420
tttccgcgcc atcctgcgct gttgccattg cggcaagcgt gcctgggtcaa gctgggggcg	480
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ccgaccaccg catgcccgga tgacgacggc agcatcggca tcagtccggc ggccaccgcc	600
gcgtggcgtg cccaggccgt gacacggggg agcacgccgc aggtcgggcg cgccgatgcg	660
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gttgcgttgt gcgtcctgca ccttgaggc cgtgacccgg cggtcgatgc gttgcgcat	960
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SeqLst

tacgtcgagg ccaatcgcaa cccgcacggt ctatgggaca acgaaaaatg gcacgtttcg	1140
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gatgagcgcg cgctggcggc gctgctgcag gcgcagcgcg acgacggtgg ctggggcgcg	1260
ggtcgcgggt ccacgttcga ggaaaccgcc tatgctgtgt ttgctgtgca cgtgatggat	1320
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tggatgctcg cccgccatgc ggcgcattga ttgccgcaga cgccgctgtg gatcggcaag	1440
gaactgtatt gcccactcg ggtcgtgcgc gtggccgaac tcgccgggtt gtggctggcg	1500
cttcgttggg ggcggcgcg cctggccgag ggggcaggag cgccgccatg a	1551

<210> 40

<211> 2355

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 40

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ttatcagcaa ttcatacagc tagtacatcc catggtggcc aaaccaaccc tacgaatctg	120
ataatcgata cgaccaagga gagaatacaa aaacaattca aaaatgttga aatttcagtt	180
tcttcttatg atactgcgtg ggttgccatg gttccatcac ctaattctcc aaagtctcca	240
tgtttcccag aatgtttgaa ttggctgatt aacaaccagt tgaatgatgg atcttgggggt	300
ttagtcaatc acacgcacaa tcacaaccat ccacttttga aagattcttt atcctcaact	360
ttggcttgca tcgtggccct aaagagatgg aacgtaggtg aggatcagat taacaagggg	420
cttagtttca ttgaatctaa cttggcttcc gcgactgaaa aatctcaacc atctccaata	480
ggattcgata tcatctttcc aggtctgtta gagtacgcca aaaatctaga tatcaactta	540
ctgtctaagc aaactgattt ctactaatg ttacacaaga gagaattaga acaaaagaga	600
tgtcattcaa acgaaatgga tggttacctt gcttatatct ctgaagggtt tggtaatctt	660
tacgattgga atatggtgaa aaagtaccag atgaaaaatg gctcagtttt caattcccct	720
tctgcaactg cggcagcatt cattaaccat caaaatccag gatgcctgaa ctatttgaat	780
tcactactag acaaattcgg caacgcagtt ccaactgtat accctcacga tttgtttatc	840
agattgagta tgggtggatac aattgaaaga cttggtatat cccaccactt tagagtcgag	900
atcaaaaatg ttttggatga gacataccgt tgttgggtgg agagagatga acaaatcttt	960
atggatgttg tgacgtgcgc gttggccttt agattgttgc gtattaacgg ttacgaagtt	1020
agtccagatc cacttgccga aattacaaac gaattagctt taaaggatga atacgccgct	1080

SeqLst

cttgaaacat atcatgcgtc acatatcctt taccaagagg acttatcatc tggaaaacaa	1140
attctttaa at ctgctgattt cctgaaggaa atcatatcca ctgatatgtaa tagactgtcc	1200
aaactgatcc ataaagaggt tgaaaatgca ctttaagttcc ctattaacac cggcttagaa	1260
cgtattaaca caagacgtaa catccagctt tacaacgtag acaatactag aatcttgaaa	1320
accacttacc attcttccaa catatcaaac actgattacc taagattagc tgttgaagat	1380
ttctacacat gtcagtctat ctatagagaa gagctgaaag gattagagag atgggtcggt	1440
gagaataagc tagatcaatt gaaatttgcc agacaaaaga cagcttattg ttacttctca	1500
gttgccgcca ctttatcaag tccagaattg tcagatgcac gtatttcttg ggctaaaaac	1560
ggaattttga caactgttgt tgatgatttc tttgatattg gcgggacaat cgacgaattg	1620
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gaacatgtta gaatactgtt cttggctctg aaagatgcta tctgttggat cggggatgag	1740
gctttcaa at ggcaagctag agatgtgacg tctcacgtca ttcaaacctg gctagaactg	1800
atgaactcta tgttgagaga agcaatttgg actagagatg catacgttcc tacattaac	1860
gagtatatgg aaaacgctta tgtctccttt gctttgggtc ctatcgtaa gcctgccata	1920
tactttgtag gaccaaagct atccgaggaa atcgtcgaat catcagaata ccataacttg	1980
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gtcgaagagg aagtagttga ggaaatgatg atgatgatca aaaacaagag aaaggagttg	2160
atgaaactaa tcttcgaaga gaacggttca attgttccta gagcatgtaa ggatgcattt	2220
tggaacatgt gtcattgtgct aaactttttc tacgcaaacg acgatgggtt tactgggaac	2280
acaatactag atacagtaaa agacatcata tacaacctt tggtcttagt aaacgaaaac	2340
gaggagcaaa gataa	2355

<210> 41

<211> 2355

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 41

atgaatctgt cctttgtat agctagtcca ctgttgacaa aatcttctag accaactgct	60
ctttctgcaa ttcatactgc cagtactagt catggagggtc aaacaaaccc aacaaatttg	120
ataatcgata ctactaagga gagaatccaa aagctattca aaaatgttga aatctcagta	180
tcattcttatg acaccgcatg gggtgcaatg gtgccatcac ctaattcccc aaaaagtcca	240

SeqLst

tgttttccag	agtgccttgaa	ttgggttaatc	aataatcagt	taaacgatgg	ttcttggggt	300
ttagtcaacc	acactcataa	ccacaatcat	ccattattga	aggactcttt	atcatcaaca	360
ttagcctgta	ttgttgcat	gaaaagatgg	aatgtaggtg	aagatcaa	caacaagggt	420
ttatcattca	tagaatccaa	tctagcttct	gctaccgaca	aatcacacc	atctccaatc	480
gggttcgaca	taatcttccc	tggtttgctg	gagtatgcc	aaaaccttga	tatcaactta	540
ctgtctaaac	aaacagattt	ctctttgatg	ctacacaaaa	gagagttaga	gcagaaaaga	600
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tctgcaactg	ccgcagcatt	cattaatcat	caaaaccctg	ggtgtcttaa	ctacttgaac	780
tcactattag	ataagtttgg	aaatgcagtt	ccaacagtct	atcctttgga	cttgtagatc	840
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agaatcaata	ctaggagaaa	cattcagctg	tacaacgtag	ataatacaag	gattcttaag	1320
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ttcaagttaa	tgtcaacaca	aggcagactt	ctgaacgata	tccactcctt	caaaagagaa	2040
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	SeqLst	
gtggaagagg aagtcgttga ggaaatgatg atgatgatca aaaacaagag aaaggaattg		2160
atgaaattga ttttcgagga aaatggttca atcgtaaccta gagcttgtaa agatgctttt		2220
tggaatatgt gccatgttct taacttcttt tacgctaattg atgatggctt cactggaaat		2280
acaatattgg atacagttaa agatatcatc tacaaccac ttgttttggt caatgagaac		2340
gaggaacaaa gataa		2355

<210> 42

<211> 1773

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 42

atggctatgc cagtgaagct aacacctgcg tcattatcct taaaagctgt gtgctgcaga	60
ttctcatccg gtggccatgc tttgagattc gggagtagtc tgccatgttg gagaaggacc	120
cctacccaaa gatctacttc ttctctact actagaccag ctgccgaagt gtcatcaggt	180
aagagtaaac aacatgatca ggaagctagt gaagcgacta tcagacaaca attacaactt	240
gtggatgtcc tggagaatat ggaatatcc agacattttg ctgcagagat aaagtgcata	300
ctagacagaa cttacagatc ttggttaca agacacgagg aaatcatgct ggacactatg	360
acatgtgcta tggcttttag aatcctaaga ttgaacggat acaacgtttc atcagatgaa	420
ctataccacg ttgtagaggc atctggctctg cataattctt tgggtgggta tcttaacgat	480
accagaacac tacttgaatt acacaaggct tcaacagtta gtatctctga ggatgaatct	540
atcttagatt caattggctc tagatccaga acattgctta gagaacaatt ggagtctggt	600
ggcgcactga gaaagccttc ttatttcaa gaggttgaac atgcactgga tggacctttt	660
tacaccacac ttgatagact tcatcatagg tggaatatg aaaacttcaa cattattgag	720
caacacatgt tggagactcc atacttatct aaccagcata catcaaggga taccctagca	780
ttgtcaatta gagatttttc ctctcaca ttcacttatc aacaagagct acagcatctg	840
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tctaaagagg aattggaaaa cttagtcatg ctggtcgaaa tgtgggatga acatcacaaa	1080
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caattgggtg agaaggcctc tttggttcaa gacagatcaa ttacaaaaca ccttgttgaa	1200
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				SeqLst	
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tctagtcaag	tcgaaagagc	aaaagaggta	gacgctgtca	taaatgagcc	actgaagttg 1740
caaggttctc	atacactggg	atctgatggt	taa		1773

<210> 43

<211> 2232

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 43

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acaccttggt	ttccagaatg	tactaaatgg	atcctagaaa	atcagttggg	tgatggtagt	180
tggtcacttc	ctcatggcaa	tccacttcta	gttaaagatg	cattatcttc	cactcttgct	240
tgtattctgg	ctcttaaaag	atggggaatc	ggtgagggaac	agattaacaa	aggactgaga	300
ttcatagAAC	tcaactctgc	tagtgtaacc	gataacgaac	aacacaaacc	aattggattt	360
gacattatct	ttccaggtat	gattgaatac	gctatagact	tagacctgaa	tctaccacta	420
aaaccaactg	acattaactc	catgttgcat	cgtagagccc	ttgaattgac	atcaggtgga	480
ggcaaaaatc	tagaaggtag	aagagcttac	ttggcctacg	tctctgaagg	aatcggttaag	540
ctgcaagatt	gggaaatggc	tatgaaatac	caacgtaaaa	acggatctct	gttcaatagt	600
ccatcaacaa	ctgcagctgc	attcatccat	atacaagatg	ctgaatgcct	ccactatatt	660
cgttctcttc	tccagaaatt	tggaacgca	gtccctacaa	tataccctct	cgatatctat	720
gccagacttt	caatggtaga	tgccctggaa	cgtcttggtg	ttgatagaca	tttcagaaag	780
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gtctctcttg	aagatcactt	ctctaactct	ctgggcggtt	acttaaagga	ctcaggagca	960
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SeqLst						
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<210> 44

<211> 2355

<212> DNA

<213> Stevia rebaudiana

<400> 44

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atcattgata	caaccaaaga	acggatccaa	aaacagttta	aaaatgtaga	aatttctggt	180
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tgtttccctg	agtgtctcaa	ttgggttaatt	aataatcagc	ttaatgatgg	ttcatggggg	300
cttggttaatc	acactcataa	tcataatcac	ccgttgctta	aagattctct	atcttcaaca	360
ttagcatgta	ttgttgcatt	aaaaagatgg	aatgttgggg	aagatcaaat	aaataaaggt	420

					SeqLst	
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2355

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<211> 2355

<212> DNA

<213> Stevia rebaudiana

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<211> 1773

<212> DNA

<213> Zea mays

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SeqLst

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<211> 2232

<212> DNA

<213> Populus trichocarpa

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<210> 48

<211> 2952

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 48

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SeqLst

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<211> 2646

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

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<211> 2952

<212> DNA

<213> *Phomopsis amygdali*

<400> 50

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<210> 51

<211> 2646

<212> DNA

<213> Physcomitrella patens

<400> 51

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SeqLst

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<210> 52

<211> 1542

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 52

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aagcatagaa ttcacagaga tatcatgatg gataacatat ctactcaact tcatgaattc	540
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	SeqLst	
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gaatggaaac tgaaggatat gactcaagag gaagtgaaca cgataggcct aactacacaa		1500
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<210> 53

<211> 1530

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 53

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ttgccaagtg ttccagtagt gcctggtttt ccagttattg ggaatttggt gcaactaaag		180
gagaaaaagc ctcataaaac tttcactaga tggtcagaga tatatggacc tatctactct		240
ataaagatgg gttcttcatc tcttattgta ttgaacagta cagaaactgc taaggaagca		300
atggtcacta gattttcatc aatatctacc agaaaattgt caaacgccct aacagttcta		360
acctgcgata agtctatggt cgccacttct gattatgatg acttcacaa attagttaag		420
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gatgctttga ttgaaaatgt gagttccaag ctacatgcac acgctagaga tcatccacaa		540
gagccagtta actttagagc aattttcgaa cacgaattgt ttggtgtagc attaaagcaa		600
gccttcggta aagacgtaga atccatatac gtcaaggagt taggcgtaac attatcaaaa		660
gatgaaatct ttaaggtgct tgtacatgat atgatggagg gtgcaattga tgtagattgg		720
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	SeqLst	
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gatggtgaag aggaaaatgt cgatacttat gggttaacat ctcaaaagtt ataccacta		1500
atggcaatca tcaatcctag aagatcctaa		1530

<210> 54

<211> 1578

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 54

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gcatggttat gttcttatgt gatacatgtt ttatcatctt cctctacagt aaaagtgcc		180
gttgttggat acaggctctg attcgaacct acatggttgc ttagacttag attcgtctgg		240
gaagggtggc ctatcatagg tcaagggtag aataagttta aagactctat tttccaagtt		300
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tcacttagag atgaatga		1578

<210> 55

<211> 1500

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 55

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ctatcttaca tcggcgact aagatggaca agacgtggca gagagatact tcaagagggga		180
tatgatggct acagaggatc tacattcaaa atcgcgatgt tagaccgttg gatcgtgatc		240
gcaaatgggc ctaaactagc tgatgaagtc agacgtagac cagatgaaga gttaaacttt		300
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gatccatacc atgtcgatat cataagagaa aaactaaca gaggccttcc agccgtgctt		420
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agagtctttg taggtttgcc tgcttgacaga aaccaagggt acttagattt ggcaatagac		600
tttacattgt ctgttgtaa ggatagagcc atcatcaata tgtttccaga attgttgaag		660
ccaatagttg gcagagttgt aggtaacgcc accagaaatg ttcgtagagc tgttcctttt		720

SeqLst						
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gtgaaggcaa	tcgcagagag	attgttaatg	gtgaacttcg	cggtctattca	tacctcatca	900
aacactatca	ctcatgcttt	gtaccacctt	gccgaaatgc	ctgaaacttt	gcaaccactt	960
agagaagaga	tcgaaccatt	agtcaaagag	gagggctgga	ccaaggctgc	tatgggaaaa	1020
atgtggtggt	tagattcatt	tctaagagaa	tctcaaagat	acaatggcat	taacatcgta	1080
tctttaacta	gaatggctga	caaagatatt	acattgagtg	atggcacatt	tttgccaaaa	1140
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aactatgatg	taaagttgcc	tggtgacggg	aaacgtccat	tgaacatgta	ttgggggtcca	1440
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<210> 56
 <211> 1542
 <212> DNA
 <213> Stevia rebaudiana

<400> 56		
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gaaattgcaa	aggaggcatt gggtaccaga tttcaatcta tctcaaccag aaacctatca	360
aaggcattaa	aggttctcac agcagataaa accatggtgg cgatgagtga ttatgatgat	420
tatcataaga	ctgtcaaacg ccatatactg accgctgttt tgggaccaa tgctcagaag	480
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cttaaaatca	ccatgaaccg agacgagata tttcaggtag tggttgttga cccgatgatg	720
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aagtttgaaa	acacgatcca acaaatgtat atccggagag aagctgtgat gaagtctctt	840
attaaagaac	ataaaaaacg tattgcatcc ggagagaaat taaacagcta cattgattac	900

SeqLst						
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attattgaat	catcagacac	cactatgggt	acaactgaat	gggctatgta	tgaacttgca	1020
aaaaacccca	aacttcagga	tcgtttgtat	cgggatatca	aaagtgtttg	cgggtcagag	1080
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ttaggagggg	accatgtgcc	agctggaacc	gagctagcgg	taaacattta	tggatgtaac	1260
atggataaga	atgtgtggga	gaatcctgaa	gaatggaatc	cagagagatt	catgaaggaa	1320
aatgaaacga	tagattttcca	gaaaacaatg	gcgtttggag	gtggaaagcg	cgtatgtgct	1380
ggttcgcctt	aagcattggt	gactgcttcc	attggaattg	gaagaatggg	gcaagagttt	1440
gagtggaaac	tgaaagayat	gacccaagaa	gaagttaata	cgattgggct	tacgaccag	1500
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<210> 57
 <211> 1530
 <212> DNA
 <213> Arabidopsis thaliana

<400> 57						
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ctccccctctg	ttccagtggg	accaggggtt	cctgttattg	ggaacttgct	gcaactaaaa	180
gagaagaaac	ctcacaagac	tttcactaga	tggtcagaga	tttatgggtcc	tatttactct	240
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acttgtgaca	aatctatggg	tgctactagt	gattatgatg	atttccacaa	gttgggtgaaa	420
cgggtgtctct	tgaacgggtc	tttgggtgct	aatgcacaga	aacgaaaaag	acattacaga	480
gatgcactca	ttgaaaatgt	gtcttccaag	ttgcatgccc	atgctaggga	ccatccacaa	540
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aatggttcag	aatcggatga	tgattgctat	ctcaacttct	tgatgtcgga	agcgaaaaca	900
ctaaccaagg	agcaaattgc	tatcttgggt	tgggagacga	ttatcgagac	agctgacact	960
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SeqLst						
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cctctagtcc	ccattcgcta	tgtccacgaa	gatacgcaaa	tcggaggcta	tcatgtccct	1200
gcaggaagtg	agattgcaat	aaacatctat	ggatgcaaca	tggataagaa	gcgttgggag	1260
agaccagagg	actggtggcc	ggagcggttt	cttgatgatg	gcaaatacga	aacgtcggat	1320
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tctctcatgg	caggcattgc	cattgggagg	ttagtgcaag	aattcgagtg	gaagcttaga	1440
gacggtgaag	aagagaatgt	ggatacatat	ggcttgacct	ctcagaagct	ttatcctctt	1500
atggctatta	tcaatccaag	gcgttcttaa				1530

<210> 58

<211> 1578

<212> DNA

<213> *Gibberella fujikoro*

<400> 58

atgagtaagt	ccaacagcat	gaacagtacc	agccatgaaa	cgttattcca	gcagctcgtc	60
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gcttggttat	gctcttatgt	catccatgtc	ctatcgctct	cttctacagt	caaagtgtcc	180
gtcgtaggct	accgcagcgt	ctttgagcct	acatggcttc	tccgtttgcg	ctttgtttgg	240
gaagggggat	ctatcatcgg	ccaaggctac	aacaaattta	aagactctat	cttccagggtg	300
cgaaagcttg	gtaccgatat	cgatcatcat	ccgccaaact	acatcgatga	ggtcagaaaag	360
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acacggggca	tgggtctttct	gcaaagtgat	ttgcagaacc	gtgtgattca	gcagcgggtg	480
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caagaatggt	tgacgaccac	tgcagagtac	agcgagagcc	tgttcataac	tggctttatt	720
ctccgcgttg	tccccatat	tctaagacca	ttcatagccc	cgctgctacc	ctcctacaga	780
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aagcaaattg	acaacattgc	ccagcggatg	cttatcctga	gtctcgcgtc	tattcacact	960
acggcaatga	cgatgacgca	tgctatgtat	gacttatgtg	cttgccctga	gtacatagag	1020
cctcttagag	atgagggtcaa	aagtgtcggt	ggcgctagtg	gttgggacaa	gacggcggtg	1080
aatcgattcc	acaaactcga	cagctttctc	aaagagtcac	aacgcttcaa	ccccgtgttc	1140

	SeqLst	
ctcttaacgt tcaatcgc	ttatcaccaa tccatgacac tctcagatgg caccaacatc	1200
ccatcaggca ctcgcatcgc	ggttccctct cacgcgatgc ttcaggactc agcgcgatgc	1260
ccaggccccga cgccaccaac	cgagtttgat ggatttagat actcaaagat tcgctcagac	1320
tcaaactatg cacagaaata	tctcttctcc atgactgatt ctagtaacat ggcgtttggg	1380
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gcgatactcc ttttacaatt	tgagttcaag ttgccagatg ggaaaggaag accacgaaat	1500
atcactattg atagtgcac	gatacctgat ccgagagcta ggctgtgcgt taggaagcga	1560
tcactgagag atgaatga		1578

<210> 59

<211> 1500

<212> DNA

<213> *Trametes versicolor*

<400> 59

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agatggtaca gagacccgct	tcggtccatt cctacggttg ggggctctga ctttcccatc	120
ctctcataca tcggggcgct	caggtggacc cgccgcggaa gagagatact gcaagaaggt	180
tatgatgggt atcgcggatc	cacgttcaag atcgcgatgc tcgaccggtg gatcgtcatc	240
gccaacggcc caaagctcgc	cgacgaggtg aggaggcgtc ctgacgaaga gctaaacttc	300
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gacccgtacc acgtggacat	tattcgtgag aagctgacgc gaggcctccc ggcagtcctg	420
ccggacgtca tcgaggaact	cacgctagcc gttcgccagt acatcccgcg ggaaggagat	480
gaatgggtca gcgtgaactg	ctccaaagca gcgcgggaca tcgtcgcccg ggcaagcaac	540
cgcgctctttg tcgggttgcc	cgcttgccgc aaccagggtt atctcgacct cgccattgac	600
ttcaccttga gcgttgtaa	agacagggcg atcatcaata tggtcccgga gttgctgaaa	660
cctatcgtcg gacgcgtggt	tggaaatgcc actaggaacg tgcgccgcgc ggtcccattc	720
gtagcgccgt tgggtggagga	acgtcgccgc ctcatggagg agtacggtga ggattggctg	780
gagaaaccga acgacatgct	ccagtggatc atggacgagg cagcctcgcg ggactcctcc	840
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tccctgacgc gcatggccga	caaggacata acgctcagcg acggcacgtt cctcccgaag	1140
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	SeqLst	
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aagcaccagt tcgtcaacac ctccgtggag tacgtgccct tcggccacgg gaagcacgcc		1320
tgccccgggc gggtcttcgc ggccaacgag ctgaaggcga tgctcgcgta catcgtgctc		1380
aactacgacg tgaagctgcc cggcgatggc aagcgcccc tgaacatgta ctggggcccg		1440
acggtcttgc ctgctccggc tgggcagggt ctcttccgca agaggcagg gtcgctgtag		1500

<210> 60

<211> 1578

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 60

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ctggctttgt actatctact gtctttcatc tacaaaacat ctaaaaagac atgtacacct	120
cctaaagcat ctggtgaaat cattccaatt acaggaatca tattgaatct gctatctggc	180
tcaagtggtc tacctattat cttagcactt gcctcttttag cagacagatg tggtcctatt	240
ttcaccatta ggctgggtat taggagagt ctagtagtat caaattggga aatcgctaag	300
gagattttca ctaccacga tttgatagtt tctaatagac caaaatactt agccgctaag	360
attcttgggt tcaattatgt ttcatctct ttcgctccat acggcccata ttgggtcgga	420
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gcaaagcgta tctccgagtt attcagagaa tggtttctact acactggcag atttgtcggt	720
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caagctaacg atgacaaaaa ggaggatatg gatttcatgg atatcatgat ctccatgaca	900
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aaagaggctt taagacttta cccagcagcg ttcttaggcg gaccaagagc attcttggaa	1200
gattgtactg ttgctgggta tagaattcca aagggcacct gcttggtgat taacatgtgg	1260

	SeqLst	
aaactgcata gagatccaaa catttggagt gatccttgcg aattcaagcc agaaagattt		1320
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ggtgccggca gaagatattg tccaggtact agattggctt tacagatggt gcatatcgta		1440
ttagcgacat tgctgcaaaa cttcgaaatg tcaacaccaa acgatgcgcc agtcgatatg		1500
actgcttctg ttggcatgac aaatgccaaa gcatcacctt tagaagtctt gctatcacct		1560
cgtgttaa at ggctcctaa		1578

<210> 61
 <211> 1431
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 61		
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tacaaacatc aaaagactaa aatcaatcta ccaccagggt ccttcggctg gccatttttg		120
ggtgaaacct tagccttact tagagcaggc tgggattctg agccagaaag attcgtaaga		180
gagcgtatca aaaagcatgg atctccactt gttttcaaga catcactatt tggagacaga		240
ttcgtgttc tttgcggtcc agctggtaat aagtttttgt tctgcaacga aaacaaatta		300
gtggcatctt ggtggccagt ccctgtaagg aagttgttcg gtaaaagttt actcacaata		360
agaggagatg aagcaaaatg gatgagaaaa atgctattgt cttacttggg tccagatgca		420
tttgccacac attatgccgt tactatggat gttgtaacac gtagacatat tgatgtccat		480
tggaggggca aggaggaagt taatgtattt caaacagtta agttgtacgc attcgaatta		540
gctttagat tattcatgaa cctagatgac ccaaaccaca tcgcgaaact cggtagtctt		600
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tactccagta aaaaggccgc agctgccatt agaattgaat tgaaaaagct cattaaagct		720
agaaaactcg aattgaagga gggtaaggcg tcttcttcac aggacttgct ttctcatcta		780
ttaacatcac ctgatgagaa tgggatgttc ttgacagaag aggaaatagt cgataacatt		840
ctacttttgt tattcgctgg tcacgatacc tctgcactat caataacact tttgatgaaa		900
accttaggtg aacacagtga tgtgtacgac aaggttttga aggaacaatt agaaatttcc		960
aaaacaaagg aggcttgga atcactaaag tgggaagata tccagaagat gaagtactca		1020
tggtcagtaa tctgtgaagt catgagattg aatcctcctg tcatagggac atacagagag		1080
gcgttggttg atatcgacta tgctgggttac actatcccaa aaggatggaa gttgcattgg		1140
tcagctgttt ctactcaaag agacgaagcc aatttcgaag atgtaactag attcgatcca		1200

	SeqLst	
tccagatttg aaggggcagg ccctactcca ttcacatttg tgcctttcgg tggaggtcct		1260
agaatgtgtt taggcaaaga gtttgccagg ttagaagtgt tagcatttct ccacaacatt		1320
gttaccaact ttaagtggga tcttctaata cctgatgaga agatcgaata tgatccaatg		1380
gctactccag ctaagggtt gccaaattaga cttcatccac accaagtcta a		1431

<210> 62

<211> 1578

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 62

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ttctcagttg gttatcacgt ttacggtaga gctgtggctg aacaatggag aatgagaaga	120
tcactgaagc tacaagggtg taaaggccca ccaccatcca tcttcaatgg taacgtctca	180
gaaatgcaac gtatccaatc cgaagctaaa cactgctctg gcgataacat tatctcacat	240
gattattctt cttcattatt cccacacttc gatcactgga gaaaacagta cggcagaatc	300
tacacatact ctactggatt aaagcaacac ttgtacatca atcatccaga aatggtgaag	360
gagctatctc agactaacac attgaacttg ggtagaatca cccatataac caaaagattg	420
aatcctatct taggtaacgg aatcataacc tctaattggc ctcatgggc ccatcagcgt	480
agaattatcg cctacgagtt tactcatgat aagatcaagg gtatgggttg tttgatggtt	540
gagtctgcta tgcctatgtt gaataagtgg gaggagatgg taaagagagg cggagaaatg	600
ggatgcgaca taagagttga tgaggacttg aaagatgttt cagcagatgt gattgcaaaa	660
gcctgtttcg gatcctcatt ttctaaagggt aaggctatct tctctatgat aagagatttg	720
cttacagcta tcacaaagag aagtgttcta ttcagattca acggattcac tgatatggtc	780
tttgggagta aaaagcatgg tgacgttgat atagacgctt tagaaatgga attggaatca	840
tccatttggtg aaactgtcaa ggaacgtgaa atagaatgta aagatactca caaaaaggat	900
ctgatgcaat tgatttttga aggggcaatg cgttcatgtg acggtaacct ttgggataaa	960
tcagcatata gaagatttgt tgtagataat tgtaaatcta tctacttcgc agggcatgat	1020
agtacagctg tctcagtgtc atgggtgtttg atgttactgg ccctaaaccc atcatggcaa	1080
gttaagatcc gtgatgaaat tctgtcttct tgcaaaaatg gtattccaga tgccgaaagt	1140
atcccaaacc ttaaaacagt gactatgggtt attcaagaga caatgagatt ataccctcca	1200
gcaccaatcg tcgggagaga agcctctaaa gatatcagat tgggcatct agttgttcct	1260
aaaggcgtct gtatatggac actaatacca gctttacaca gagatcctga gatttgggga	1320

	SeqLst	
ccagatgcaa acgatttcaa accagaaaga ttttctgaag gaatttcaaa ggcttgtaag		1380
tatcctcaaa gttacattcc atttggctctg ggtcctagaa catgcgttgg taaaaacttt		1440
ggcatgatgg aagtaaaggt tcttgtttcc ctgattgtct ccaagttctc tttcactcta		1500
tctcctacct accaacatag tcctagtcac aaacttttag tagaaccaca acatgggggtg		1560
gtaattagag tggtttaa		1578

<210> 63

<211> 1590

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 63

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gctgccgctg catggcctat tatcggccac ctccacttac ttgcagggtg atcccatcaa	180
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ataggcttgc atagagctgt agttgtctca tcttgggaaa tggcaaagga atgttcaaca	300
gctaattgatc aagtgtcttc ttcaagacct gaactattag cttctaagtt gttgggttat	360
aactacgcca tgtttggttt ttcaccatac ggttcatact ggagagaaat gagaaagatc	420
atctctctcg aattactatc taattccaga ttggaactat tgaaagatgt tagagcctca	480
gaagttgtca catctattaa ggaactatac aaattgtggg cggaagaa gaatgagtca	540
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cagcgttgta gaagagtctt cagagaattc ttccatctct ccggcttggt tgtggttgct	720
gatgctatac cttttcttgg atggctcgat tggggaagac acgagaagac cttgaaaaag	780
accgccatag aaatggattc catcgcccag gagtggcttg aggaacatag acgtagaaaa	840
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aacaatagag atactttgaa aaaggcacag gaagagttag acatccaagt cggtaaggaa	1080
agattgggta acgagcaaga catcagtaag ttagtttact tgcaagcaat agtaaaagag	1140
acactcagac tttatccacc aggtcctttg ggtgggttga gacaattcac tgaagattgt	1200
acactagggtg gctatcacgt ttcaaaagga actagattaa tcatgaactt atccaagatt	1260

	SeqLst	
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actcataaag atgtcgatcc acgtggtaaa cactttgaat tcattccatt cggcgcagga		1380
agacgtgcat gtcctgggtat cacattcgga ttacaagtac tacatctaac attggcatct		1440
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ttaggcttta cgaatatgaa atctacccca ttagaagttt tgattttctcc aagactatcc		1560
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<210> 64

<211> 1440

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 64

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taccctatca taggtgaaag tttagaattc ctatccacag gctggaaggg acatcctgaa	180
aagttcatat ttgatagaat gcgtaagtac agtagtgagt tattcaagac ttctattgta	240
ggcgaatcca cagttgtttg ctgtggggca gctagtaaca aattcctatt ctctaacgaa	300
aacaaactgg taactgcctg gtggccagat tctgttaaca aaatcttccc aacaacttca	360
ctggattcta atttgaagga ggaatctata aagatgagaa agttgctgcc acagttcttc	420
aaaccagaag cacttcaaag atacgtcggc gttatggatg taatcgaca aagacatfff	480
gtcactcact gggacaacaa aaatgagatc acagtttatc cacttgctaa aagatacact	540
ttcttgcttg cgtgtagact gttcatgtct gttgaggatg aaaatcatgt ggcgaaattc	600
tcagacctat tccaactaat cgctgcaggc atcatttcac ttcctatcga tcttcctggg	660
actccattca acaaggccat aaaggcttca aatttcatta gaaaagagct gataaagatt	720
atcaaacaaa gacgtgttga tctggcagag ggtacagcat ctccaacca ggatatcttg	780
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gaaattgcca agtccaaacc tgctggggaa ttgttgaatt gggatgactt gaaaaagatg	1020
aagtattcat ggaatgtggc atgtgaggta atgagattgt caccaccttt acaagggtgg	1080
tttagagagg ctataactga ctttatgttt aacggtttct ctattccaaa agggtggaag	1140
ttatactggg ccgccaactc tacacacaaa aatgcagaat gtttcccaat gcctgagaaa	1200

	SeqLst	
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ggaggcccta gaatgtgtcc tggaaaggaa tacgctagat tagaaatctt ggttttcatg		1320
cataatctgg tcaaacgttt taagtgggaa aagggttattc cagacgaaaa gattattgtc		1380
gatccattcc caatcccagc taaagatctt ccaatccggt tgtatcctca caaagcttaa		1440

<210> 65
 <211> 1572
 <212> DNA
 <213> Stevia rebaudiana

<400> 65		
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ccacctaaag caagcgggtga gcaccctata acaggccact taaaccttct tagtggttca		180
tccggtcttc cccatctagc cttagcatct ttggctgacc gatgtgggccc catattcacc		240
atccgacttg gcatacgtag agttttggtg gttagtaatt gggaaattgc taaggagatc		300
ttcactaccc atgatttgat tgtttcaaac cgtcccaa atctcgtctgc aaagattttg		360
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gttttcgaac tagaaaactc catgaaaagc atacgcgagt cttggaaaga gaaaaaagac		540
gaagaaggta aagtgttggt ggagatgaaa aaatgggtttt gggaattgaa tatgaatata		600
gttcttagaa ctgttgctgg taaacagtac actggaactg ttgatgatgc ggatgcgaag		660
aggattagtg aattgttttag agaatgggtt cattacacag gaaggtttgt tgtgggagat		720
gcttttcctt ttcttgggtg gttggatttg ggtggatata agaagaccat ggaactagt		780
gcttccagac tagattccat ggtctcaaaa tgggttagacg agcatcgcaa aaagcaggct		840
aacgacgaca aaaaagagga catggatttc atggacatca tgatatcgat gactgaagcc		900
aattccccct tggaggggtta tgggtacggat acaataatta aaaccacttg catgactctt		960
attgtcagtg gtgtagatac aacctccatc gtgctaactt gggcactctc gttactactg		1020
aacaaccgtg acactcttaa gaaagctcaa gaagagctag acatgtgtgt gggaaaagg		1080
cgacaagtaa acgaatcaga tctagtaaac ctaatctacc ttgaagccgt attaaaagaa		1140
gcattgcgac tatacccagc agcattcctt ggaggtccta gagcctttttt agaagactgc		1200
accgtggcag ggtaccgtat cccaaaaggc acatgtctac ttattaacat gtggaaactt		1260
catcgtgatc caaacatatg gtcagaccca tgtgagttta aaccagagag gttcttaacc		1320
ccaaacaaaa aggacgtaga tgttattgga atggattttg agttaatccc atttggtgcg		1380
ggaagaagggt attgtccagg gacacgtttg gcattacaaa tgttacacat agttctggcc		1440

	SeqLst	
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aagtgg	tc	1572

<210> 66
 <211> 1431
 <212> DNA
 <213> Stevia rebaudiana

<400> 66		
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tacaagcacc agaaaaccaa aatcaatcct ccaccgggaa gcttcggatg gccatttctg		120
ggcgaaactc tggcactcct acgtgcagg	tgggactcag agccggagag atttggtcgt	180
gaacggatca agaaacacgg aagtcctcta gtgtttaaga cgtcgttggt tggcgaccgt		240
tttgcggtgt tgtgtggacc tgccggaaac aagttcctgt tctgcaacga gaacaagctg		300
gtggcgctgt ggtggccggt tccggtgagg aagcttttcg gcaagtctct gctcacgatt		360
cggtgtgatg aagctaagt gatgaggaag atgttggtat cgtatctcgg tcctgatgct		420
ttcgcaactc attatgccgt caccatggac gtcgtcacc gtcggcatat cgacgttcat		480
tggcgaggga aggaagagg gaacgtattc caaacgtta agttatatgc ctttgagctt		540
gcatgtcgtt tattcatgaa cctagacgac ccaaaccaca ttgcaaaact cggttccttg		600
ttcaacattt tcttgaaagg catcattgag cttccaatcg acgtcccagg gacacgattt		660
tatagctcca aaaaagcagc agcagctatc aggattgaac taaaaaaatt gattaaagca		720
agaaaactgg aactgaaaga aggggaaggca tcatcttcac aagacctctt atcacatttg		780
cttacatctc cagatgaaaa tggatatgtt ctaaccgaag aagagattgt agacaacatc		840
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aagacgaaag aagcatggga gtccctgaaa tgggaggaca taaaaagat gaaatactcc		1020
tggagtgtta tatgtgaagt catgagacta aatccacctg ttataggaac ctatagagag		1080
gcccttgtgg atattgatta tgcgggttat accatcccca aaggatggaa gctgcactgg		1140
agtgtgtgtat cgacacaaag ggacgaggct aactttgaag acgtaacacg ttttgacca		1200
tcacggtttg aaggcgcagg accgactcca ttcaccttg ttcggtttgg aggggggcct		1260
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<210> 67

SeqLst

<211> 1578

<212> DNA

<213> *Arabidopsis thaliana*

<400> 67

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agtttaaagt tgcaaggcgt gaagggtcct ccaccgtcga tctttaacgg caatgtgtcg	180
gagatgcaac ggattcagtc ggaggctaaa cactgttccg gcgataacat catttctcat	240
gactattctt cttctctatt tcctcatttc gatcactggc gaaaacaata cggaaggatt	300
tacacatact caacgggggt aaagcagcac ctttacataa accacccgga aatggtgaag	360
gagcttagcc aaaccaacac acttaacctt ggtagaatca ctcacatcac caaacgcctt	420
aacccattc tcggcaatgg catcatcacc tctaattggc ctcatgggc ccatcaacgt	480
cgtatcattg cctatgagtt taccacgac aaaatcaagg gaatggttg tttaatggtg	540
gaatctgcca tgccaatgtt gaacaaatgg gaagagatgg tgaaaagagg aggagaaatg	600
ggttgtagaca taagagtgg cgaagacctt aaggatgtct cagctgatgt catcgctaag	660
gcttgctttg ggagctcttt ttcaaaaggc aaagcaatat tctctatgat tagggatctt	720
ttaaccgcca ttactaaacg aagcgtcctc ttcagattca atggcttcac tgatatggtg	780
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ggtatgatgg aagtgaaagt gcttgtttca cttattgtct caaagttcag ttttactctt	1500
tccccgactt atcagcactc tccaagccat aaactccttg tagagcctca acatggtggt	1560
gtcattaggg ttgtttga	1578

<210> 68

<211> 1590

<212> DNA

SeqLst

<213> vitis vinifera

<400> 68

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gctgctgctg catggcccat aatcggtcac ctacacctgt tagctggtgg ttctcatcag	180
cttccccaca taaccttggg aaacatggcc gacaaatatg gaccggtctt cacaattcgg	240
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cttggactta caaatatgaa atctacccca cttgaagttc tcatttctcc acgcttatca	1560
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<210> 69

<211> 1440

<212> DNA

<213> Medicago trunculata

SeqLst

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tacccaatca taggtgaaag ctttgagttc ttatcaacag gatggaaagg acatcctgaa      180
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ggagaatcta cggtggtttg ttgcggagca gcaagtaaca agtttttggt ttcaaacgag      300
aataaacttg tgactgcatg gtggccagat agtgtaaaca aaatcttccc tactacttct      360
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cacaatttgg tgaaaagggt taagtgggaa aagggtgattc cagatgagaa gattattggt     1380
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<210> 70

<211> 2133

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 70

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aaggcaatgg aaaagttgaa cgctagtgaa tctgaagatc caacaacatt gcctgcacta     120

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SeqLst

aagatgctag	ttgaaaatag	agaattgttg	acactgttca	caacttcctt	cgcagttctt	180
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ccagttccac	aagttatcgt	tgtaaagaag	aaagagaagg	agtcagaggt	tgatgacggg	300
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gatgactacg	ctgcagatga	tgatgaatat	gaggaaaaac	tgaaaaagga	atccttagcc	480
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cgtaatagaa	aagttgactt	tatctacgag	gacgagctta	acaattttgt	tgagacagga	1860
gcattgtcag	aattgatcgt	cgcattttca	agagaaggga	ctgccaaaga	gtacgttcag	1920
cacaagatga	gtcaaaaagc	ctccgatata	tggaaaacttc	taagtgaagg	tgccatatctt	1980

	SeqLst	
tatgtctgtg gcgatgcaaa gggcatggcc aaggatgtcc atagaactct gcatacaatt		2040
gttcaggaac aagggagtct ggattcttcc aaggctgaat tgtacgtcaa aaacttacag		2100
atgtctggaa gatacttaag agatgtttgg taa		2133

<210> 71
 <211> 2079
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

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actatagtcc aggaacagga aggcgttagt tcttctgaag cggaagcaat tgtgaaaaag		2040
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<210> 72

<211> 2142

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 72

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SeqLst						
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<210> 73

<211> 2133

<212> DNA

<213> Stevia rebaudiana

<400> 73

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ccggtgccgc	aggtaatcgt	tgtaagaag	aaagagaagg	agtctgaggt	tgatgatggc	300
aagaagaaag	tttcgatatt	ctacggaact	caaacaggaa	ccgctgaagg	ttttgccaag	360

SeqLst							
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<210> 74
 <211> 2079

SeqLst

<212> DNA

<213> *Arabidopsis thaliana*

<400> 74

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SeqLst

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cttcaaaccg aaggaagata cctcagagat gtctggtga	2079

<210> 75

<211> 2142

<212> DNA

<213> Giberella fujikuroi

<400> 75

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SeqLst

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<210> 76

<211> 459

<212> PRT

<213> Ipomoea purpurea

<400> 76

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Gly Val Gly His Leu Thr Gly Phe Phe Arg Leu Ala Asn Lys Leu Ala
20          25          30

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Gly Lys Gly His Arg Ile Ser Phe Leu Ile Pro Lys Asn Thr Gln Ser
35          40          45

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Lys Leu Glu Ser Phe Asn Leu His Pro His Leu Ile Ser Phe Val Pro
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Ile Val Val Pro Ser Ile Pro Gly Leu Pro Pro Gly Ala Glu Thr Thr
65          70          75          80

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Ser Asp Val Pro Phe Pro Ser Thr His Leu Leu Met Glu Ala Met Asp
85          90          95

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Lys Thr Gln Asn Asp Ile Glu Ile Ile Leu Lys Asp Leu Lys Val Asp
100         105         110

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Val Val Phe Tyr Asp Phe Thr His Trp Leu Pro Ser Leu Ala Arg Lys

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SeqLst															
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Glu	Ala	Asp	Met	Met	Lys	Ala	Pro	Ala	Ser	Phe	Pro	Asp	Pro	Ser	Ile
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Lys	Leu	His	Ala	His	Glu	Ala	Arg	Gly	Phe	Thr	Ala	Arg	Thr	Val	Met
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Lys	Phe	Gly	Gly	Asp	Ile	Thr	Phe	Phe	Asp	Arg	Ile	Phe	Thr	Ala	Val
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Cys	Gly	Trp	Ala	Ser	Leu	Ser	Glu	Ala	Leu	Val	Asn	Asp	Cys	Gln	Ile
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SeqLst

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 385 390 395 400

Gly Val Phe Ser Arg Glu Ser Val Cys Lys Ala Val Lys Ala Val Met
 405 410 415

Asp Glu Lys Ser Glu Ile Gly Arg Glu Val Arg Gly Asn His Asp Lys
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Ser Phe Asn Gln Lys Leu Gln Asp Leu Leu Gly
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<210> 77
 <211> 1380
 <212> DNA
 <213> Ipomoea purpurea

<400> 77
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 ctaattccta aaaacactca atctaagtta gaatctttca accttcatcc acacttaatc 180
 tcttttgtgc ctatcgttgt cccaagtata ccaggcctgc cacctgggtgc agagactaca 240
 tcagatgttc ctttcccaag tacacatttg ctaatggaag caatggacaa gactcaaaac 300
 gatatagaga ttatcctgaa ggatcttaaa gtagatgttg ttttctatga ttttactcac 360
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 cctttaatgc atggatatgc tttatcacca gaaagacgtg tagttggtaa gcaattgaca 480
 gaggcagata tgatgaaggc cccagcttct tttccagacc catccattaa gctacatgca 540
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 ttcgatagaa tattcacagc agtttccgaa agtgatggcc tggcctactc tacttgtaga 660
 gagatcgagg gacaattctg tgattacatt gaaacacaat tccagaagcc agtcttggtta 720
 gccggtccag ctttgccagt cccatccaaa tccactatgg aacaaaagtg gtcagattgg 780
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 gctgctctga agccaccttt tgagactgag tctgttgagg ctgctatccc tgaggaacta 960
 aaggaaaaga ttcagggaag aggtatagta catggagaat gggtaacaaca acaattgttt 1020

SeqLst

cttcaacacc catctgtcgg gtgcttcggt tctcactgcg gctgggcaag tttatctgaa 1080
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 gccagaataa tgtcagtatc acttaaagtg ggcgtggaag ttgaaaaggg tgaggaggac 1200
 ggtgtctttt caagagaatc tgtgtgcaag gctgttaaag cagtaatgga tgaaaaatct 1260
 gaaatcggtg gagaagtcag aggtaatcat gataaactga ggggtttctt gatgaatgca 1320
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<210> 78

<211> 438

<212> PRT

<213> Bellis perennis

<400> 78

Met Asp Ser Lys Ile Asp Ser Lys Thr Phe Arg Val Val Met Leu Pro
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Trp Leu Ala Tyr Ser His Ile Ser Ser Phe Leu Val Phe Ala Lys Arg
20 25 30

Leu Thr Asn His Asn Phe His Ile Tyr Ile Cys Ser Ser Gln Thr Asn
35 40 45

Met Gln Tyr Leu Lys Asn Asn Leu Thr Ser Gln Tyr Ser Lys Ser Ile
50 55 60

Gln Leu Ile Glu Leu Asn Leu Pro Ser Ser Ser Glu Leu Pro Leu Gln
65 70 75 80

Tyr His Thr Thr His Gly Leu Pro Pro His Leu Thr Lys Thr Leu Ser
85 90 95

Asp Asp Tyr Gln Lys Ser Gly Pro Asp Phe Glu Thr Ile Leu Ile Lys
100 105 110

Leu Asn Pro His Leu Val Ile Tyr Asp Phe Asn Gln Leu Trp Ala Pro
115 120 125

Glu Val Ala Ser Thr Leu His Ile Pro Ser Ile Gln Leu Leu Ser Gly
130 135 140

Cys Val Ala Leu Tyr Ala Leu Asp Ala His Leu Tyr Thr Lys Pro Leu
145 150 155 160

Asp Glu Asn Leu Ala Lys Phe Pro Phe Pro Glu Ile Tyr Pro Lys Asn
165 170 175

SeqLst

Arg Asp Ile Pro Lys Gly Gly Ser Lys Tyr Ile Glu Arg Phe Val Asp
 180 185 190
 Cys Met Arg Arg Ser Cys Glu Ile Ile Leu Val Arg Ser Thr Met Glu
 195 200 205
 Leu Glu Gly Lys Tyr Ile Asp Tyr Leu Ser Lys Thr Leu Gly Lys Lys
 210 215 220
 Val Leu Pro Val Gly Pro Leu Val Gln Glu Ala Ser Leu Leu Gln Asp
 225 230 235 240
 Asp His Ile Trp Ile Met Lys Trp Leu Asp Lys Lys Glu Glu Ser Ser
 245 250 255
 Val Val Phe Val Cys Phe Gly Ser Glu Tyr Ile Leu Ser Asp Asn Glu
 260 265 270
 Ile Glu Asp Ile Ala Tyr Gly Leu Glu Leu Ser Gln Val Ser Phe Val
 275 280 285
 Trp Ala Ile Arg Ala Lys Thr Ser Ala Leu Asn Gly Phe Ile Asp Arg
 290 295 300
 Val Gly Asp Lys Gly Leu Val Ile Asp Lys Trp Val Pro Gln Ala Asn
 305 310 315 320
 Ile Leu Ser His Ser Ser Thr Gly Gly Phe Ile Ser His Cys Gly Trp
 325 330 335
 Ser Ser Thr Met Glu Ser Ile Arg Tyr Gly Val Pro Ile Ile Ala Met
 340 345 350
 Pro Met Gln Phe Asp Gln Pro Tyr Asn Ala Arg Leu Met Glu Thr Val
 355 360 365
 Gly Ala Gly Ile Glu Val Gly Arg Asp Gly Glu Gly Arg Leu Lys Arg
 370 375 380
 Glu Glu Ile Ala Ala Val Val Arg Lys Val Val Val Glu Asp Ser Gly
 385 390 395 400
 Glu Ser Ile Arg Glu Lys Ala Lys Glu Leu Gly Glu Ile Met Lys Lys
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 Asn Met Glu Ala Glu Val Asp Gly Ile Val Ile Glu Asn Leu Val Lys
 420 425 430

SeqLst

Leu Cys Glu Met Asn Asn
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<210> 79
<211> 1317
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<213> *Bellis perennis*

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gaatccataa gggagaaggc aaaggaattg ggagaaatca tgaaaaaaaa catggaggcc 1260
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<210> 80
<211> 2490
<212> DNA
<213> *Zea mays*

<400> 80

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gcaaagggca	gcagtttgac	ccctatagtg	agaactgacg	ctgagtcaag	240
tggccaaccg	atgacgatga	cgccgaacct	ttagtggtatg	agatcagggc	300
tccatgtctg	atggtgacat	ttccgtgagc	gcatacgata	cagcctgggt	360
ccaagattag	acggcggtga	aggtcctcaa	tttccagcag	ctgtgagatg	420
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atcaataccc	ttgcctgcgt	tgtaaactttg	acaaggtggt	ccctagaacc	540
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ggtgtccatg	acttccctta	tgatcaccag	gccctacaag	gaatctactc	720
atcaaaatga	agaggattcc	aaaagaagtg	atgcataccg	ttccaacatc	780
agtttgagg	gtatgcctgg	cctagattgg	gctaaactac	ttaaactaca	840
ggaagttttt	tgttctcacc	agctgccact	gcatatgctt	taatgaatac	900
aggtgtttta	gctacatcga	tagaacagta	aagaaattca	acggcggcgt	960
tatccagtgg	atctatttga	acataatttg	gccgttgata	gacttgaaag	1020
tccaggtact	tccaaaagga	gatcgaacaa	tgcatggatt	atgtaaacag	1080
gaggacggta	tttggtgggc	aaggaactct	gatgtcaaag	aggtggacga	1140
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gaaaaggacg	gtgaattttt	cgcatttgtc	ggacagtcta	atcaagctgt	1260
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ggtgccttct	catatgagtt	cttgaggaga	aaagaagcag	agggagcttt	1380
tggatcattt	ctaaagatct	acctggtgaa	gttgtgtata	ctttggattt	1440
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gcatgggcta	gagccgcaat	actagctaac	gccgtgagca	cccacttaag	1800
tcattcagag	aaagggttaga	gcattctctt	aggtgtagac	ctagtgaaga	1860
tcctggttta	actcctcaag	tggctctgat	gcagtttttag	taaaggctgt	1920

SeqLst

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 cagacctgtc tattattggc tagaatgatac gaaattttctg ccggtagggc agctggtgaa 2160
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 gaaaaaaga ctggatctag cgaaaccagg caaacatttt taagtatagt gaaatcatgt 2400
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<210> 81
 <211> 827
 <212> PRT
 <213> Zea mays

<400> 81
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Ala Val Val Gln Leu Gly Pro Trp Ser Ser Arg Ile Lys Lys Lys Thr
 20 25 30

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

Ala Arg Ala Gln His Thr Ser Glu Ser Ala Ala Val Ala Lys Gly Ser
 50 55 60

Ser Leu Thr Pro Ile Val Arg Thr Asp Ala Glu Ser Arg Arg Thr Arg
 65 70 75 80

Trp Pro Thr Asp Asp Asp Asp Ala Glu Pro Leu Val Asp Glu Ile Arg
 85 90 95

Ala Met Leu Thr Ser Met Ser Asp Gly Asp Ile Ser Val Ser Ala Tyr
 100 105 110

Asp Thr Ala Trp Val Gly Leu Val Pro Arg Leu Asp Gly Gly Glu Gly
 115 120 125

Pro Gln Phe Pro Ala Ala Val Arg Trp Ile Arg Asn Asn Gln Leu Pro
 130 135 140

SeqLst

Asp Gly Ser Trp Gly Asp Ala Ala Leu Phe Ser Ala Tyr Asp Arg Leu
 145 150 155 160
 Ile Asn Thr Leu Ala Cys Val Val Thr Leu Thr Arg Trp Ser Leu Glu
 165 170 175
 Pro Glu Met Arg Gly Arg Gly Leu Ser Phe Leu Gly Arg Asn Met Trp
 180 185 190
 Lys Leu Ala Thr Glu Asp Glu Glu Ser Met Pro Ile Gly Phe Glu Leu
 195 200 205
 Ala Phe Pro Ser Leu Ile Glu Leu Ala Lys Ser Leu Gly Val His Asp
 210 215 220
 Phe Pro Tyr Asp His Gln Ala Leu Gln Gly Ile Tyr Ser Ser Arg Glu
 225 230 235 240
 Ile Lys Met Lys Arg Ile Pro Lys Glu Val Met His Thr Val Pro Thr
 245 250 255
 Ser Ile Leu His Ser Leu Glu Gly Met Pro Gly Leu Asp Trp Ala Lys
 260 265 270
 Leu Leu Lys Leu Gln Ser Ser Asp Gly Ser Phe Leu Phe Ser Pro Ala
 275 280 285
 Ala Thr Ala Tyr Ala Leu Met Asn Thr Gly Asp Asp Arg Cys Phe Ser
 290 295 300
 Tyr Ile Asp Arg Thr Val Lys Lys Phe Asn Gly Gly Val Pro Asn Val
 305 310 315 320
 Tyr Pro Val Asp Leu Phe Glu His Ile Trp Ala Val Asp Arg Leu Glu
 325 330 335
 Arg Leu Gly Ile Ser Arg Tyr Phe Gln Lys Glu Ile Glu Gln Cys Met
 340 345 350
 Asp Tyr Val Asn Arg His Trp Thr Glu Asp Gly Ile Cys Trp Ala Arg
 355 360 365
 Asn Ser Asp Val Lys Glu Val Asp Asp Thr Ala Met Ala Phe Arg Leu
 370 375 380
 Leu Arg Leu His Gly Tyr Ser Val Ser Pro Asp Val Phe Lys Asn Phe
 385 390 395 400

SeqLst

Glu Lys Asp Gly Glu Phe Phe Ala Phe Val Gly Gln Ser Asn Gln Ala
 405 410 415
 Val Thr Gly Met Tyr Asn Leu Asn Arg Ala Ser Gln Ile Ser Phe Pro
 420 425 430
 Gly Glu Asp Val Leu His Arg Ala Gly Ala Phe Ser Tyr Glu Phe Leu
 435 440 445
 Arg Arg Lys Glu Ala Glu Gly Ala Leu Arg Asp Lys Trp Ile Ile Ser
 450 455 460
 Lys Asp Leu Pro Gly Glu Val Val Tyr Thr Leu Asp Phe Pro Trp Tyr
 465 470 475 480
 Gly Asn Leu Pro Arg Val Glu Ala Arg Asp Tyr Leu Glu Gln Tyr Gly
 485 490 495
 Gly Gly Asp Asp Val Trp Ile Gly Lys Thr Leu Tyr Arg Met Pro Leu
 500 505 510
 Val Asn Asn Asp Val Tyr Leu Glu Leu Ala Arg Met Asp Phe Asn His
 515 520 525
 Cys Gln Ala Leu His Gln Leu Glu Trp Gln Gly Leu Lys Arg Trp Tyr
 530 535 540
 Thr Glu Asn Arg Leu Met Asp Phe Gly Val Ala Gln Glu Asp Ala Leu
 545 550 555 560
 Arg Ala Tyr Phe Leu Ala Ala Ala Ser Val Tyr Glu Pro Cys Arg Ala
 565 570 575
 Ala Glu Arg Leu Ala Trp Ala Arg Ala Ala Ile Leu Ala Asn Ala Val
 580 585 590
 Ser Thr His Leu Arg Asn Ser Pro Ser Phe Arg Glu Arg Leu Glu His
 595 600 605
 Ser Leu Arg Cys Arg Pro Ser Glu Glu Thr Asp Gly Ser Trp Phe Asn
 610 615 620
 Ser Ser Ser Gly Ser Asp Ala Val Leu Val Lys Ala Val Leu Arg Leu
 625 630 635 640
 Thr Asp Ser Leu Ala Arg Glu Ala Gln Pro Ile His Gly Gly Asp Pro

SeqLst

645	650	655
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Glu Asp Ile Ile His Lys Leu Leu Arg Ser Ala Trp Ala Glu Trp Val
 660 665 670

Arg Glu Lys Ala Asp Ala Ala Asp Ser Val Cys Asn Gly Ser Ser Ala
 675 680 685

Val Glu Gln Glu Gly Ser Arg Met Val His Asp Lys Gln Thr Cys Leu
 690 695 700

Leu Leu Ala Arg Met Ile Glu Ile Ser Ala Gly Arg Ala Ala Gly Glu
 705 710 715 720

Ala Ala Ser Glu Asp Gly Asp Arg Arg Ile Ile Gln Leu Thr Gly Ser
 725 730 735

Ile Cys Asp Ser Leu Lys Gln Lys Met Leu Val Ser Gln Asp Pro Glu
 740 745 750

Lys Asn Glu Glu Met Met Ser His Val Asp Asp Glu Leu Lys Leu Arg
 755 760 765

Ile Arg Glu Phe Val Gln Tyr Leu Leu Arg Leu Gly Glu Lys Lys Thr
 770 775 780

Gly Ser Ser Glu Thr Arg Gln Thr Phe Leu Ser Ile Val Lys Ser Cys
 785 790 795 800

Tyr Tyr Ala Ala His Cys Pro Pro His Val Val Asp Arg His Ile Ser
 805 810 815

Arg Val Ile Phe Glu Pro Val Ser Ala Ala Lys
 820 825

<210> 82
 <211> 1461
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

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tttcctgcac aatctcacat aaaggcaatg ctaaagttag cacaactatt acaccataag	120
ggattacaga taactttcgt gaataccgac ttcattccata atcaatttct ggaatctagt	180

	SeqLst	
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tcacattccc cagaggcctc catccaata agagagagtt tactgaggtc aatagaaacc		300
aacttttttg atcgtttcat tgacttggtc acaaaacttc cagacccacc aacttgcata		360
atctctgatg gctttctgtc agtgtttact atcgacgctg ccaaaaagtt gggatatcca		420
gttatgatgt actggactct tgctgcatgc ggtttcatgg gtttctatca catccattct		480
cttatcgaaa agggttttgc tccactgaaa gatgcatcat acttaacca cggctacctg		540
gatactgtta ttgactgggt accagggtatg gaagggtataa gacttaaaga ttttcctttg		600
gattgggtcta cagaccttaa tgataaagta ttgatgttta ctacagaagc tccacaaaga		660
tctcataagg tttcacatca tatctttcac acctttgatg aattggaacc atcaatcatc		720
aaaaccttgt ctctaagata caatcatatc tacactattg gtccattaca attacttcta		780
gatcaaattc ctgaagagaa aaagcaaact ggtattacat ctttacacgg ctactcttta		840
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gaaaacgccg tattacctcc agaattggag gaacacatca aaaagagagg tttcattgct		1080
tcctgggtgt ctcaggaaaa ggtattgaaa catccttctg ttggtgggtt cttactcat		1140
tgcggttggg gctctacaat cgaatcacta agtcaggag ttccaatgat ttgttgcca		1200
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gaaatgggaa caaagggtta acgtgatgaa gtgaaaagat tggttcagga gttgatggg		1320
gaagggtggc acaagatgag aaacaaggcc aaagattgga aggaaaaagc cagaattgct		1380
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ttagccagaa actaagtcga c		1461

<210> 83

<211> 1398

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 83

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ggtgtaaaga caaactgggt aaccactatc cacactttga attctactct gaaccactca		180
aatactacta ctacaagtat agaaattcaa gctatatcag acggatgcga tgaggggtggc		240

	SeqLst	
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gccgatctaa tcaaaaagtt acagagtga ggcaccacaa ttgacgccat aatctacgat		360
tctatgacag agtggggttt agacgttgct atcgaatttg gtattgatgg aggttccttt		420
ttcacacaag catgtgttgt gaattctcta tactaccatg tgcataaagg gttaatctct		480
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ccatcaatgt atttggacaa aagacttgat gatgataaag ataatggttt caatttgtac		780
aaggctaadc atcacgaatg tatgaattgg ctggatgaca aaccaaagga atcagttgta		840
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ctgccagaaa acctttctga agtgataaag accggaaaag gtctaatacg tgcttggtgt		1020
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aactctacac tagaagccat ttccttaggc gtacctgtcg ttgcaatgcc tcagttctcc		1140
gatcagacaa ccaacgctaa acttttggac gaaatactag gggtaggtgt cagagttaa		1200
gcagacgaga atggtatcgt cagaagaggg aacctagctt catgtatcaa aatgatcatg		1260
gaagaggaaa gaggagtat cataaggaaa aacgcagtta agtggaagga tcttgcaaag		1320
gttgccgtcc atgaaggcgg ctcttcagat aatgatattg ttgaatttgt gtccgaacta		1380
atcaaagcct aagtcgac		1398

<210> 84
 <211> 1437
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polynucleotide

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gctgaaaaag gacataaagt gtcattcctt tcaacaacta gaaacattca aagattatct	180
tcccacatat caccattgat taacgtcggt caattgacac ttccaagagt acaggaatta	240
ccagaagatg ctgaagctac aacagatgtg catcctgaag atatccctta cttgaaaaag	300
gcatccgatg gattacagcc tgaggctact agattccttg agcaacacag tccagattgg	360

SeqLst						
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agggcacatt	tcagtgtaac	cacaccttgg	gccattgctt	acatgggtcc	atccgctgat	480
gctatgatta	acggcagtga	tggtagaact	accgttgaag	atttgacaac	cccaccaaag	540
tggtttccat	ttccaactaa	agtctgttgg	agaaaacacg	acttagcaag	actggttcca	600
tacaaggcac	caggaatctc	agacggctat	agaatgggtt	tagtccttaa	agggcttgac	660
tgcctattgt	ctaagtgtta	ccatgagttt	gggacacaat	ggctaccact	tttggaaca	720
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gcaaagtccg	attcagttga	attgccagac	ggctttgtcg	agagaactag	agatagaggg	1020
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atcatgttgc	caatctttgg	tgaccagcct	ttgaatgcac	gtctgttaga	agataaacia	1200
gttggaaattg	aaatcccacg	taatgaggaa	gatggatgtt	taaccaagga	gtctgtggcc	1260
agatcattac	gttccgttgt	cgttgaaaag	gaaggcgaaa	tctacaaggc	caatgcccgt	1320
gaactttcaa	agatctacaa	tgacacaaaa	gtagagaagg	aatatgtttc	tcaatttgta	1380
gattacctag	agaaaaacgc	tagagccgta	gctattgatc	atgaatccta	agtcgac	1437

<210> 85

<211> 1392

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 85

actagtaaaa	tggaatacaa	gaccgaaaca	acagtttagac	gtaggcgtag	aatcattctg	60
tttccagtac	cttttcaagg	gcacatcaat	ccaatactac	aactagccaa	cgttttgtac	120
tctaaagggt	tttctattac	aatctttcac	accaattttca	acaaacaaaa	aacatccaat	180
taccacacatt	tcacattcag	attcatactt	gataatgatc	cacaagatga	acgtattttca	240
aacttaccta	cccacgggtcc	tttagctgga	atgagaattc	caatcatcaa	tgaacatggt	300
gccgatgagc	ttagaagaga	attagagtta	cttatgttgg	catccgaaga	ggacgaggaa	360
gtctcttgtc	tgattactga	cgctctatgg	tactttgccc	aatctgtggc	tgatagtttg	420
aatttgagga	gattgggtact	aatgacatcc	agtctgttta	actttcacgc	tcatgttagt	480

	SeqLst	
aaaaagcctc atgtgatctt cattccatth cctgcacaat ctcacataaa ggcaatgcta		240
aagtttagcac aactattaca ccataaggga ttacagataa ctttcgtgaa taccgacttc		300
atccataatc aatttctgga atctagtggc cctcattggt tggacggagc cccaggggtt		360
agattcgaaa caattcctga cgggtgtttca cattccccag aggcctccat cccaataaga		420
gagagtttac tgagggtcaat agaaaccaac tttttggatc gtttcattga cttgggcaca		480
aaacttccag acccaccaac ttgcataatc tctgatggct ttctgtcagt gtttactatc		540
gacgctgcca aaaagttggg tatcccagtt atgatgtact ggactcttgc tgcattgcgg		600
ttcatgggtt tctatcacat ccattctctt atcgaaaagg gttttgctcc actgaaagat		660
gcatcatact taaccaacgg ctacctggat actgttattg actgggtacc aggtatggaa		720
gggtataagac ttaaagattt tcctttggat tgggtctacag acctaatga taaagtattg		780
atgtttacta cagaagctcc acaaagatct cataagggtt cacatcatat ctttcacacc		840
tttgatgaat tggaaccatc aatcatcaaa accttgtctc taagatacaa tcatatctac		900
actattgggtc cattacaatt acttctagat caaatcctg aagagaaaaa gcaaactggt		960
attacatcct tacacggcta ctcttttagtg aaagaggaa cagaatgttt tcaatggcta		1020
caaagtaaag agcctaattc tgtgggtctac gtcaacttcg gaagtacaac agtcatgtcc		1080
ttggaagata tgactgaatt tgggtggggc cttgctaatt caaatcatta ctttctatgg		1140
attatcaggt ccaatttggg aataggggaa aacgccgtat tacctccaga attggaggaa		1200
cacatcaaaa agagagggtt cattgcttcc tgggtgttctc aggaaaagg attgaaacat		1260
ccttctgttg gtggtttcct tactcattgc ggttggggct ctacaatcga atcactaagt		1320
gcaggagtgc caatgatttg ttggccatat tcatgggacc aacttacaaa ttgtaggtat		1380
atctgtaaag agtgggaagt tggattagaa atgggaacaa aggttaaacy tgatgaagt		1440
aaaagattgg ttcaggagtt gatgggggaa ggtggccaca agatgagaaa caaggccaaa		1500
gattggaagg aaaaagccag aattgctatt gctcctaacy ggtcatcctc tctaaacatt		1560
gataagatgg tcaaagagat tacagtctta gccagaaact aa		1602

<210> 88

<211> 533

<212> PRT

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polypeptide

<400> 88

Met	Thr	Ser	Phe	Ala	Glu	Tyr	Trp	Asn	Leu	Leu	Ser	Pro	Thr	Ser	Phe
1				5					10					15	

SeqLst

Ala Glu Tyr Trp Asn Leu Leu Ser Pro Thr Ser Phe Ala Glu Tyr Trp
20 25 30

Asn Leu Phe Ser Pro Thr Ser Phe Ala Glu Tyr Trp Asn Leu Leu Ser
35 40 45

Pro Ala Ser Lys Met Asp Ala Met Ala Thr Thr Glu Lys Lys Pro His
50 55 60

Val Ile Phe Ile Pro Phe Pro Ala Gln Ser His Ile Lys Ala Met Leu
65 70 75 80

Lys Leu Ala Gln Leu Leu His His Lys Gly Leu Gln Ile Thr Phe Val
85 90 95

Asn Thr Asp Phe Ile His Asn Gln Phe Leu Glu Ser Ser Gly Pro His
100 105 110

Cys Leu Asp Gly Ala Pro Gly Phe Arg Phe Glu Thr Ile Pro Asp Gly
115 120 125

Val Ser His Ser Pro Glu Ala Ser Ile Pro Ile Arg Glu Ser Leu Leu
130 135 140

Arg Ser Ile Glu Thr Asn Phe Leu Asp Arg Phe Ile Asp Leu Val Thr
145 150 155 160

Lys Leu Pro Asp Pro Pro Thr Cys Ile Ile Ser Asp Gly Phe Leu Ser
165 170 175

Val Phe Thr Ile Asp Ala Ala Lys Lys Leu Gly Ile Pro Val Met Met
180 185 190

Tyr Trp Thr Leu Ala Ala Cys Gly Phe Met Gly Phe Tyr His Ile His
195 200 205

Ser Leu Ile Glu Lys Gly Phe Ala Pro Leu Lys Asp Ala Ser Tyr Leu
210 215 220

Thr Asn Gly Tyr Leu Asp Thr Val Ile Asp Trp Val Pro Gly Met Glu
225 230 235 240

Gly Ile Arg Leu Lys Asp Phe Pro Leu Asp Trp Ser Thr Asp Leu Asn
245 250 255

Asp Lys Val Leu Met Phe Thr Thr Glu Ala Pro Gln Arg Ser His Lys
260 265 270

SeqLst

Val Ser His His Ile Phe His Thr Phe Asp Glu Leu Glu Pro Ser Ile
 275 280 285
 Ile Lys Thr Leu Ser Leu Arg Tyr Asn His Ile Tyr Thr Ile Gly Pro
 290 295 300
 Leu Gln Leu Leu Leu Asp Gln Ile Pro Glu Glu Lys Lys Gln Thr Gly
 305 310 315 320
 Ile Thr Ser Leu His Gly Tyr Ser Leu Val Lys Glu Glu Pro Glu Cys
 325 330 335
 Phe Gln Trp Leu Gln Ser Lys Glu Pro Asn Ser Val Val Tyr Val Asn
 340 345 350
 Phe Gly Ser Thr Thr Val Met Ser Leu Glu Asp Met Thr Glu Phe Gly
 355 360 365
 Trp Gly Leu Ala Asn Ser Asn His Tyr Phe Leu Trp Ile Ile Arg Ser
 370 375 380
 Asn Leu Val Ile Gly Glu Asn Ala Val Leu Pro Pro Glu Leu Glu Glu
 385 390 395 400
 His Ile Lys Lys Arg Gly Phe Ile Ala Ser Trp Cys Ser Gln Glu Lys
 405 410 415
 Val Leu Lys His Pro Ser Val Gly Gly Phe Leu Thr His Cys Gly Trp
 420 425 430
 Gly Ser Thr Ile Glu Ser Leu Ser Ala Gly Val Pro Met Ile Cys Trp
 435 440 445
 Pro Tyr Ser Trp Asp Gln Leu Thr Asn Cys Arg Tyr Ile Cys Lys Glu
 450 455 460
 Trp Glu Val Gly Leu Glu Met Gly Thr Lys Val Lys Arg Asp Glu Val
 465 470 475 480
 Lys Arg Leu Val Gln Glu Leu Met Gly Glu Gly Gly His Lys Met Arg
 485 490 495
 Asn Lys Ala Lys Asp Trp Lys Glu Lys Ala Arg Ile Ala Ile Ala Pro
 500 505 510
 Asn Gly Ser Ser Ser Leu Asn Ile Asp Lys Met Val Lys Glu Ile Thr
 515 520 525

SeqLst

Val Leu Ala Arg Asn
530

<210> 89
<211> 1893
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence: Synthetic polynucleotide

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<400> 89
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gttggtgcac aaaaagacac ttatactatg aaagaggttc ttttttatct tggccagtat      180
attatgacta aacgattata tgatgagaag caacaacata ttgtatattg ttcaaattgat      240
cttctaggag atttgtttgg cgtgccaaagc ttctctgtga aagagcacag gaaaatatat      300
accatgatct acaggaactt ggtagtagtc aatcagcagg aatcatcgga cttaggtaca      360
tctgtgagtg agaacagggtg tcaccttgaa ggtgggagtg atcaaaaagga ccttgtacaa      420
gagcttcagg aagagaaacc ttcattctca catttggttt ctagaccatc taccggtggt      480
agcggatcct ctggaggcag tgctagtaaa atggcagagc aacaaaagat caaaaagtca      540
cctcacgtct tacttattcc atttcctctg caaggacata tcaaccatt catacaattt      600
gggaaaagat tgattagtaa ggggtgtaaag acaacactgg taaccactat ccacactttg      660
aattctactc tgaaccactc aaatactact actacaagta tagaaattca agctatatca      720
gacggatgcg atgaggggtg ctttatgtct gccggtgaat ctacttgga aacattcaag      780
caagtgggat ccaagtctct ggccgatcta atcaaaaagt tacagagtga aggcaccaca      840
attgacgcca taatctacga ttctatgaca gagtgggttt tagacgttgc tatcgaattt      900
ggtattgatg gaggttcctt tttcacacaa gcatgtgttg tgaattctct atactacat      960
gtgcataaag ggttaatctc ttaccattg ggtgaaactg tttcagttcc aggttttcca     1020
gtgttacaac gttgggaaac cccattgatc ttacaaaatc atgaacaaat acaatcacct     1080
tgggtcccaga tgttgtttgg tcaattcgct aacatcgatc aagcaagatg ggtctttact     1140
aattcattct ataagttaga ggaagaggta attgaatgga ctaggaagat ctggaatttg     1200
aaagtcattg gtccaacatt gccatcaatg tatttggaac aaagacttga tgatgataaa     1260
gataatgggt tcaatttgta caaggcta atcatcgaat gtatgaattg gctggatgac     1320
aaaccaaagg aatcagttgt atatgttgct ttcggctctc ttgttaaaca tgggtccagaa     1380
caagttgagg agattacaag agcacttata gactctgacg taaacttttt gtgggtcatt     1440

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SeqLst

```

aagcacaag agggaggggaa actgccagaa aacctttctg aagtgataaa gaccggaaaa 1500
ggctctaatcg ttgcttggtg taaacaattg gatgttttag ctcatgaatc tgtaggctgt 1560
tttgtaacac attgcggatt caactctaca ctagaagcca tttccttagg cgtacctgtc 1620
gttgcaatgc ctcagttctc cgatcagaca accaacgcta aacttttgga cgaaatacta 1680
ggggtgggtg tcagagttaa agcagacgag aatggtatcg tcagaagagg gaacctagct 1740
tcattgtatca aaatgatcat ggaagaggaa agaggagtta tcataaggaa aaacgcagtt 1800
aagtggaagg atcttgcaaa ggttgccgtc catgaaggcg gctcttcaga taatgatatt 1860
gttgaatttg tgtccgaact aatcaaagcc taa 1893

```

<210> 90

<211> 630

<212> PRT

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polypeptide

<400> 90

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Met Cys Asn Thr Asn Met Ser Val Pro Thr Asp Gly Ala Val Thr Thr
1           5           10           15

```

```

Ser Gln Ile Pro Ala Ser Glu Gln Glu Thr Leu Val Arg Pro Lys Pro
20           25           30

```

```

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

```

```

Thr Met Lys Glu Val Leu Phe Tyr Leu Gly Gln Tyr Ile Met Thr Lys
50           55           60

```

```

Arg Leu Tyr Asp Glu Lys Gln Gln His Ile Val Tyr Cys Ser Asn Asp
65           70           75           80

```

```

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

```

```

Arg Lys Ile Tyr Thr Met Ile Tyr Arg Asn Leu Val Val Val Asn Gln
100          105          110

```

```

Gln Glu Ser Ser Asp Ser Gly Thr Ser Val Ser Glu Asn Arg Cys His
115          120          125

```

```

Leu Glu Gly Gly Ser Asp Gln Lys Asp Leu Val Gln Glu Leu Gln Glu
130          135          140

```

SeqLst

Glu Lys Pro Ser Ser Ser His Leu Val Ser Arg Pro Ser Thr Gly Gly
 145 150 155 160
 Ser Gly Ser Ser Gly Gly Ser Ala Ser Lys Met Ala Glu Gln Gln Lys
 165 170 175
 Ile Lys Lys Ser Pro His Val Leu Leu Ile Pro Phe Pro Leu Gln Gly
 180 185 190
 His Ile Asn Pro Phe Ile Gln Phe Gly Lys Arg Leu Ile Ser Lys Gly
 195 200 205
 Val Lys Thr Thr Leu Val Thr Thr Ile His Thr Leu Asn Ser Thr Leu
 210 215 220
 Asn His Ser Asn Thr Thr Thr Thr Ser Ile Glu Ile Gln Ala Ile Ser
 225 230 235 240
 Asp Gly Cys Asp Glu Gly Gly Phe Met Ser Ala Gly Glu Ser Tyr Leu
 245 250 255
 Glu Thr Phe Lys Gln Val Gly Ser Lys Ser Leu Ala Asp Leu Ile Lys
 260 265 270
 Lys Leu Gln Ser Glu Gly Thr Thr Ile Asp Ala Ile Ile Tyr Asp Ser
 275 280 285
 Met Thr Glu Trp Val Leu Asp Val Ala Ile Glu Phe Gly Ile Asp Gly
 290 295 300
 Gly Ser Phe Phe Thr Gln Ala Cys Val Val Asn Ser Leu Tyr Tyr His
 305 310 315 320
 Val His Lys Gly Leu Ile Ser Leu Pro Leu Gly Glu Thr Val Ser Val
 325 330 335
 Pro Gly Phe Pro Val Leu Gln Arg Trp Glu Thr Pro Leu Ile Leu Gln
 340 345 350
 Asn His Glu Gln Ile Gln Ser Pro Trp Ser Gln Met Leu Phe Gly Gln
 355 360 365
 Phe Ala Asn Ile Asp Gln Ala Arg Trp Val Phe Thr Asn Ser Phe Tyr
 370 375 380
 Lys Leu Glu Glu Glu Val Ile Glu Trp Thr Arg Lys Ile Trp Asn Leu
 385 390 395 400

SeqLst

Lys Val Ile Gly Pro Thr Leu Pro Ser Met Tyr Leu Asp Lys Arg Leu
 405 410 415
 Asp Asp Asp Lys Asp Asn Gly Phe Asn Leu Tyr Lys Ala Asn His His
 420 425 430
 Glu Cys Met Asn Trp Leu Asp Asp Lys Pro Lys Glu Ser Val Val Tyr
 435 440 445
 Val Ala Phe Gly Ser Leu Val Lys His Gly Pro Glu Gln Val Glu Glu
 450 455 460
 Ile Thr Arg Ala Leu Ile Asp Ser Asp Val Asn Phe Leu Trp Val Ile
 465 470 475 480
 Lys His Lys Glu Glu Gly Lys Leu Pro Glu Asn Leu Ser Glu Val Ile
 485 490 495
 Lys Thr Gly Lys Gly Leu Ile Val Ala Trp Cys Lys Gln Leu Asp Val
 500 505 510
 Leu Ala His Glu Ser Val Gly Cys Phe Val Thr His Cys Gly Phe Asn
 515 520 525
 Ser Thr Leu Glu Ala Ile Ser Leu Gly Val Pro Val Val Ala Met Pro
 530 535 540
 Gln Phe Ser Asp Gln Thr Thr Asn Ala Lys Leu Leu Asp Glu Ile Leu
 545 550 555 560
 Gly Val Gly Val Arg Val Lys Ala Asp Glu Asn Gly Ile Val Arg Arg
 565 570 575
 Gly Asn Leu Ala Ser Cys Ile Lys Met Ile Met Glu Glu Glu Arg Gly
 580 585 590
 Val Ile Ile Arg Lys Asn Ala Val Lys Trp Lys Asp Leu Ala Lys Val
 595 600 605
 Ala Val His Glu Gly Gly Ser Ser Asp Asn Asp Ile Val Glu Phe Val
 610 615 620
 Ser Glu Leu Ile Lys Ala
 625 630

<210> 91

SeqLst

<211> 1932

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 91

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gttggtgcac aaaaagacac ttatactatg aaagagggtc ttttttatct tggccagtat	180
attatgacta aacgattata tgatgagaag caacaacata ttgtatattg ttcaaagtat	240
cttctaggag atttggttg cgtagcaagc ttctctgtga aagagcacag gaaaatatat	300
accatgatct acaggaactt ggtagtagtc aatcagcagg aatcatcgga cttaggtaca	360
tctgtgagtg agaacagggtg tcaccttgaa ggtgggagtg atcaaaagga ccttgtacaa	420
gagcttcagg aagagaaacc ttcattctca catttggttt ctagaccatc taccggtggt	480
agcggatcct ctggaggcag tgctagtaaa atggctacat ctgattctat tgttgatgac	540
aggaagcagt tgcattgtgg tactttccct tggcttgctt tcggtcatat actgccttac	600
ctacaactat caaaactgat agctgaaaaa ggacataaag tgcattcct ttcaacaact	660
agaaacattc aaagattatc ttcccacata tcaccattga ttaacgtcgt tcaattgaca	720
cttccaagag tacaggaatt accagaagat gctgaagcta caacagatgt gcatcctgaa	780
gatatccctt acttgaaaaa ggcattccgat ggattacagc ctgaggtcac tagattcctt	840
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gcagcatcac taggcatttc tagggcacat ttcagtgtaa ccacaccttg ggccattgct	960
tacatgggtc catccgctga tgctatgatt aacggcagtg atggtagaac taccgttgaa	1020
gatttgacaa cccacacaaa gtggtttcca ttccaacta aagtctgttg gagaaaacac	1080
gacttagcaa gactgggtcc atacaaggca ccaggaatct cagacggcta tagaatgggt	1140
ttagtcctta aagggtctga ctgcctattg tctaagtgtt accatgagtt tgggacacaa	1200
tggctaccac ttttggaaac attacaccaa gttcctgtcg taccagttgg tctattacct	1260
ccagaaatcc ctggtgatga gaaggacgag acttgggttt caatcaaaaa gtgggttagac	1320
gggaagcaaa aaggctcagt ggtatatgtg gcaactgggt ccgaagtgtt agtatctcaa	1380
acagaagtgt tggaaacttg cttagggttg gaactatctg gattgccatt tgtctgggcc	1440
tacagaaaac caaaaggccc tgcaaagtcc gattcagttg aattgccaga cggctttgtc	1500
gagagaacta gagatagagg gttggtatgg acttcatggg ctccacaatt gagaatcctg	1560
agtcacgaat ctgtgtgcgg tttcctaaca cattgtgggt ctggttctat agttgaagga	1620

SeqLst

```

ctgatgtttg gtcatccact tatcatgttg ccaatctttg gtgaccagcc tttgaatgca      1680
cgtctgttag aagataaaca agttggaatt gaaatccac gtaatgagga agatggatgt      1740
ttaaccaagg agtctgtggc cagatcatta cgttccgttg tcgttgaaaa ggaaggcgaa      1800
atctacaagg ccaatgcccg tgaactttca aagatctaca atgacacaaa agtagagaag      1860
gaatatgttt ctcaatttgt agattaccta gagaaaaacg ctagagccgt agctattgat      1920
catgaatcct aa                                                              1932

```

<210> 92
 <211> 643
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Description of Artificial Sequence: Synthetic polypeptide

<400> 92
 Met Cys Asn Thr Asn Met Ser Val Pro Thr Asp Gly Ala Val Thr Thr
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 Ser Gln Ile Pro Ala Ser Glu Gln Glu Thr Leu Val Arg Pro Lys Pro
 20 25 30

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

 Thr Met Lys Glu Val Leu Phe Tyr Leu Gly Gln Tyr Ile Met Thr Lys
 50 55 60

 Arg Leu Tyr Asp Glu Lys Gln Gln His Ile Val Tyr Cys Ser Asn Asp
 65 70 75 80

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

 Arg Lys Ile Tyr Thr Met Ile Tyr Arg Asn Leu Val Val Val Asn Gln
 100 105 110

 Gln Glu Ser Ser Asp Ser Gly Thr Ser Val Ser Glu Asn Arg Cys His
 115 120 125

 Leu Glu Gly Gly Ser Asp Gln Lys Asp Leu Val Gln Glu Leu Gln Glu
 130 135 140

 Glu Lys Pro Ser Ser Ser His Leu Val Ser Arg Pro Ser Thr Gly Gly
 145 150 155 160

SeqLst

Ser Gly Ser Ser Gly Gly Ser Ala Ser Lys Met Ala Thr Ser Asp Ser
165 170 175

Ile Val Asp Asp Arg Lys Gln Leu His Val Ala Thr Phe Pro Trp Leu
180 185 190

Ala Phe Gly His Ile Leu Pro Tyr Leu Gln Leu Ser Lys Leu Ile Ala
195 200 205

Glu Lys Gly His Lys Val Ser Phe Leu Ser Thr Thr Arg Asn Ile Gln
210 215 220

Arg Leu Ser Ser His Ile Ser Pro Leu Ile Asn Val Val Gln Leu Thr
225 230 235 240

Leu Pro Arg Val Gln Glu Leu Pro Glu Asp Ala Glu Ala Thr Thr Asp
245 250 255

Val His Pro Glu Asp Ile Pro Tyr Leu Lys Lys Ala Ser Asp Gly Leu
260 265 270

Gln Pro Glu Val Thr Arg Phe Leu Glu Gln His Ser Pro Asp Trp Ile
275 280 285

Ile Tyr Asp Tyr Thr His Tyr Trp Leu Pro Ser Ile Ala Ala Ser Leu
290 295 300

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

Tyr Met Gly Pro Ser Ala Asp Ala Met Ile Asn Gly Ser Asp Gly Arg
325 330 335

Thr Thr Val Glu Asp Leu Thr Thr Pro Pro Lys Trp Phe Pro Phe Pro
340 345 350

Thr Lys Val Cys Trp Arg Lys His Asp Leu Ala Arg Leu Val Pro Tyr
355 360 365

Lys Ala Pro Gly Ile Ser Asp Gly Tyr Arg Met Gly Leu Val Leu Lys
370 375 380

Gly Ser Asp Cys Leu Leu Ser Lys Cys Tyr His Glu Phe Gly Thr Gln
385 390 395 400

Trp Leu Pro Leu Leu Glu Thr Leu His Gln Val Pro Val Val Pro Val
405 410 415

SeqLst

Gly Leu Leu Pro Pro Glu Ile Pro Gly Asp Glu Lys Asp Glu Thr Trp
 420 425 430

Val Ser Ile Lys Lys Trp Leu Asp Gly Lys Gln Lys Gly Ser Val Val
 435 440 445

Tyr Val Ala Leu Gly Ser Glu Val Leu Val Ser Gln Thr Glu Val Val
 450 455 460

Glu Leu Ala Leu Gly Leu Glu Leu Ser Gly Leu Pro Phe Val Trp Ala
 465 470 475 480

Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser Asp Ser Val Glu Leu Pro
 485 490 495

Asp Gly Phe Val Glu Arg Thr Arg Asp Arg Gly Leu Val Trp Thr Ser
 500 505 510

Trp Ala Pro Gln Leu Arg Ile Leu Ser His Glu Ser Val Cys Gly Phe
 515 520 525

Leu Thr His Cys Gly Ser Gly Ser Ile Val Glu Gly Leu Met Phe Gly
 530 535 540

His Pro Leu Ile Met Leu Pro Ile Phe Gly Asp Gln Pro Leu Asn Ala
 545 550 555 560

Arg Leu Leu Glu Asp Lys Gln Val Gly Ile Glu Ile Pro Arg Asn Glu
 565 570 575

Glu Asp Gly Cys Leu Thr Lys Glu Ser Val Ala Arg Ser Leu Arg Ser
 580 585 590

Val Val Val Glu Lys Glu Gly Glu Ile Tyr Lys Ala Asn Ala Arg Glu
 595 600 605

Leu Ser Lys Ile Tyr Asn Asp Thr Lys Val Glu Lys Glu Tyr Val Ser
 610 615 620

Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala Arg Ala Val Ala Ile Asp
 625 630 635 640

His Glu Ser

<210> 93
 <211> 1887

SeqLst

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 93

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gttggtgcac aaaaagacac ttatactatg aaagagggtc ttttttatct tggccagtat	180
attatgacta aacgattata tgatgagaag caacaacata ttgtatattg ttcaaattgat	240
cttctaggag atttgtttgg cgtgccaaagc ttctctgtga aagagcacag gaaaatatat	300
accatgatct acaggaactt ggtagtagtc aatcagcagg aatcatcgga cttaggtaca	360
tctgtgagtg agaacagggtg tcaccttgaa ggtgggagtg atcaaaagga ccttgtacaa	420
gagcttcagg aagagaaacc ttcattcttca catttggttt ctagaccatc taccggtggt	480
agcggatcct ctggaggcag tgctagtaaa atggaaaaca agaccgaaac aacagttaga	540
cgtaggcgta gaatcattct gtttccagta ctttttcaag ggcacatcaa tccaatacta	600
caactagcca acgttttgta ctctaaaggc ttttctatta caatctttca caccaatttc	660
aacaaaccaa aaacatccaa ttaccacatc ttcacattca gattcatact tgataatgat	720
ccacaagatg aacgtatttc aaacttacct acccacggtc ctttagctgg aatgagaatt	780
ccaatcatca atgaacatgg tgccgatgag cttagaagag aattagagtt acttatgttg	840
gcatccgaag aggacgagga agtctcttgt ctgattactg acgctctatg gtactttgcc	900
caatctgtgg ctgatagttt gaatttgagg agattggtac taatgacatc cagtctgttt	960
aactttcacg ctcatgttag ttaccacaa tttagacgaat tgggatactt ggaccctgat	1020
gacaagacta ggtagagga acaggcctct ggttttccta tgttgaaagt caaagatatc	1080
aagtctgcct attctaattg gcaaattctg aaagagatct taggaaagat gatcaaacag	1140
acaaaggctt catctggagt gatttggaa agtttcaaag agttagaaga gtctgaattg	1200
gagactgtaa tcagagaaat tccagcacct tcattcctga taccattacc aaaacatttg	1260
actgcttcct cttcctcttt gttggatcat gacagaacag tttttcaatg gttggaccaa	1320
caaccaccta gttctgtttt gtacgtgtca tttggtagta cttctgaagt cgatgaaaag	1380
gacttccttg aaatcgcaag aggcttagtc gatagtaagc agtcattcct ttgggtcgtg	1440
cgtccagggt tcgtgaaagg ctcaacatgg gtcgaaccac ttccagatgg ttttctaggc	1500
gaaagaggta gaatagtcaa atgggttcct caacaggaag ttttagctca tggcgctatt	1560
ggggcattct ggactcattc cggatggaat tcaactttag aatcagtatg cgaaggggta	1620
cctatgatct tttcagattt tggctttgat caaccactga acgcaagata catgtctgat	1680

SeqLst

gttttgaaag tgggtgtata tctagaaaat ggctgggaaa ggggtgaaat agctaatagca 1740
 ataagacgtg ttatggttga tgaagagggg gagtatatca gacaaaacgc aagagtgtctg 1800
 aagcaaaagg ccgacgtttc tctaatagaag ggaggctctt catacgaatc cttagaatct 1860
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<210> 94

<211> 628

<212> PRT

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polypeptide

<400> 94

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Ser Gln Ile Pro Ala Ser Glu Gln Glu Thr Leu Val Arg Pro Lys Pro
 20 25 30

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

Thr Met Lys Glu Val Leu Phe Tyr Leu Gly Gln Tyr Ile Met Thr Lys
 50 55 60

Arg Leu Tyr Asp Glu Lys Gln Gln His Ile Val Tyr Cys Ser Asn Asp
 65 70 75 80

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

Arg Lys Ile Tyr Thr Met Ile Tyr Arg Asn Leu Val Val Val Asn Gln
 100 105 110

Gln Glu Ser Ser Asp Ser Gly Thr Ser Val Ser Glu Asn Arg Cys His
 115 120 125

Leu Glu Gly Gly Ser Asp Gln Lys Asp Leu Val Gln Glu Leu Gln Glu
 130 135 140

Glu Lys Pro Ser Ser Ser His Leu Val Ser Arg Pro Ser Thr Gly Gly
 145 150 155 160

Ser Gly Ser Ser Gly Gly Ser Ala Ser Lys Met Glu Asn Lys Thr Glu
 165 170 175

SeqLst

Thr Thr Val Arg Arg Arg Arg Arg Ile Ile Leu Phe Pro Val Pro Phe
 180 185 190
 Gln Gly His Ile Asn Pro Ile Leu Gln Leu Ala Asn Val Leu Tyr Ser
 195 200 205
 Lys Gly Phe Ser Ile Thr Ile Phe His Thr Asn Phe Asn Lys Pro Lys
 210 215 220
 Thr Ser Asn Tyr Pro His Phe Thr Phe Arg Phe Ile Leu Asp Asn Asp
 225 230 235 240
 Pro Gln Asp Glu Arg Ile Ser Asn Leu Pro Thr His Gly Pro Leu Ala
 245 250 255
 Gly Met Arg Ile Pro Ile Ile Asn Glu His Gly Ala Asp Glu Leu Arg
 260 265 270
 Arg Glu Leu Glu Leu Leu Met Leu Ala Ser Glu Glu Asp Glu Glu Val
 275 280 285
 Ser Cys Leu Ile Thr Asp Ala Leu Trp Tyr Phe Ala Gln Ser Val Ala
 290 295 300
 Asp Ser Leu Asn Leu Arg Arg Leu Val Leu Met Thr Ser Ser Leu Phe
 305 310 315 320
 Asn Phe His Ala His Val Ser Leu Pro Gln Phe Asp Glu Leu Gly Tyr
 325 330 335
 Leu Asp Pro Asp Asp Lys Thr Arg Leu Glu Glu Gln Ala Ser Gly Phe
 340 345 350
 Pro Met Leu Lys Val Lys Asp Ile Lys Ser Ala Tyr Ser Asn Trp Gln
 355 360 365
 Ile Leu Lys Glu Ile Leu Gly Lys Met Ile Lys Gln Thr Lys Ala Ser
 370 375 380
 Ser Gly Val Ile Trp Asn Ser Phe Lys Glu Leu Glu Glu Ser Glu Leu
 385 390 395 400
 Glu Thr Val Ile Arg Glu Ile Pro Ala Pro Ser Phe Leu Ile Pro Leu
 405 410 415
 Pro Lys His Leu Thr Ala Ser Ser Ser Ser Leu Leu Asp His Asp Arg
 420 425 430

SeqLst

Thr Val Phe Gln Trp Leu Asp Gln Gln Pro Pro Ser Ser Val Leu Tyr
 435 440 445

Val Ser Phe Gly Ser Thr Ser Glu Val Asp Glu Lys Asp Phe Leu Glu
 450 455 460

Ile Ala Arg Gly Leu Val Asp Ser Lys Gln Ser Phe Leu Trp Val Val
 465 470 475 480

Arg Pro Gly Phe Val Lys Gly Ser Thr Trp Val Glu Pro Leu Pro Asp
 485 490 495

Gly Phe Leu Gly Glu Arg Gly Arg Ile Val Lys Trp Val Pro Gln Gln
 500 505 510

Glu Val Leu Ala His Gly Ala Ile Gly Ala Phe Trp Thr His Ser Gly
 515 520 525

Trp Asn Ser Thr Leu Glu Ser Val Cys Glu Gly Val Pro Met Ile Phe
 530 535 540

Ser Asp Phe Gly Leu Asp Gln Pro Leu Asn Ala Arg Tyr Met Ser Asp
 545 550 555 560

Val Leu Lys Val Gly Val Tyr Leu Glu Asn Gly Trp Glu Arg Gly Glu
 565 570 575

Ile Ala Asn Ala Ile Arg Arg Val Met Val Asp Glu Glu Gly Glu Tyr
 580 585 590

Ile Arg Gln Asn Ala Arg Val Leu Lys Gln Lys Ala Asp Val Ser Leu
 595 600 605

Met Lys Gly Gly Ser Ser Tyr Glu Ser Leu Glu Ser Leu Val Ser Tyr
 610 615 620

Ile Ser Ser Leu
 625

<210> 95

<211> 473

<212> PRT

<213> Stevia rebaudiana

<400> 95

Met Ala Thr Ser Asp Ser Ile Val Asp Asp Arg Lys Gln Leu His Val
 1 5 10 15

SeqLst

Ala Thr Phe Pro Trp Leu Ala Phe Gly His Ile Leu Pro Tyr Leu Gln
 20 25 30
 Leu Ser Lys Leu Ile Ala Glu Lys Gly His Lys Val Ser Phe Leu Ser
 35 40 45
 Thr Thr Arg Asn Ile Gln Arg Leu Ser Ser His Ile Ser Pro Leu Ile
 50 55 60
 Asn Val Val Gln Leu Thr Leu Pro Arg Val Gln Glu Leu Pro Glu Asp
 65 70 75 80
 Ala Glu Ala Thr Thr Asp Val His Pro Glu Asp Ile Pro Tyr Leu Lys
 85 90 95
 Lys Ala Ser Asp Gly Leu Gln Pro Glu Val Thr Arg Phe Leu Glu Gln
 100 105 110
 His Ser Pro Asp Trp Ile Ile Tyr Asp Tyr Thr His Tyr Trp Leu Pro
 115 120 125
 Ser Ile Ala Ala Ser Leu Gly Ile Ser Arg Ala His Phe Ser Val Thr
 130 135 140
 Thr Pro Trp Ala Ile Ala Tyr Met Gly Pro Ser Ala Asp Ala Met Ile
 145 150 155 160
 Asn Gly Ser Asp Gly Arg Thr Thr Val Glu Asp Leu Thr Thr Pro Pro
 165 170 175
 Lys Trp Phe Pro Phe Pro Thr Lys Val Cys Trp Arg Lys His Asp Leu
 180 185 190
 Ala Arg Leu Val Pro Tyr Lys Ala Pro Gly Ile Ser Asp Arg Cys Arg
 195 200 205
 Met Gly Leu Val Leu Lys Gly Ser Asp Cys Leu Leu Ser Lys Cys Tyr
 210 215 220
 His Glu Phe Gly Thr Gln Trp Leu Pro Leu Leu Glu Thr Leu His Gln
 225 230 235 240
 Val Pro Val Val Pro Val Gly Leu Leu Pro Pro Glu Ile Pro Gly Asp
 245 250 255
 Glu Lys Asp Glu Thr Trp Val Ser Ile Lys Lys Trp Leu Asp Gly Lys
 260 265 270

SeqLst

Gln Lys Gly Ser Val Val Tyr Val Ala Leu Gly Ser Glu Val Leu Val
 275 280 285

Ser Gln Thr Glu Val Val Glu Leu Ala Leu Gly Leu Glu Leu Ser Gly
 290 295 300

Leu Pro Phe Val Trp Ala Tyr Arg Lys Pro Lys Gly Pro Ala Lys Ser
 305 310 315 320

Asp Ser Val Glu Leu Pro Asp Gly Phe Val Glu Arg Thr Arg Asp Arg
 325 330 335

Gly Leu Val Trp Thr Ser Arg Ala Pro Gln Leu Arg Ile Leu Ser His
 340 345 350

Glu Ser Val Cys Gly Phe Leu Thr His Cys Gly Ser Gly Ser Ile Val
 355 360 365

Glu Gly Leu Met Phe Gly His Pro Leu Ile Met Leu Pro Ile Phe Gly
 370 375 380

Asp Gln Pro Leu Asn Ala Arg Leu Leu Glu Asp Lys Gln Val Gly Ile
 385 390 395 400

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

Ala Arg Ser Leu Arg Ser Val Val Val Glu Lys Glu Gly Glu Ile Tyr
 420 425 430

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

Glu Lys Glu Tyr Val Ser Gln Phe Val Asp Tyr Leu Glu Lys Asn Ala
 450 455 460

Arg Ala Val Ala Ile Asp His Glu Ser
 465 470

<210> 96

<211> 1422

<212> DNA

<213> Stevia rebaudiana

<400> 96

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tggcttgctt tcggtcacat cctcccttac cttcagcttt cgaaattgat agctgaaaag 120

SeqLst

ggtcacaaag tctcgtttct ttctaccacc agaaacattc aacgtctctc ttctcatatc	180
tcgccactca taaatgttgt tcaactcaca cttccacgtg tccaagagct gccggaggat	240
gcagaggcga cactgacgt ccaccctgaa gatattccat atctcaagaa ggcttctgat	300
ggctttcaac cggagggtcac ccggtttcta gaacaacact ctccggactg gattatttat	360
gattatactc actactgggt gccatccatc gcggctagcc tcggtatctc acgagcccac	420
ttctccgtca cactccatg ggccattgct tatatgggac cctcagctga cgccatgata	480
aatggttcag atggtcgaac cacggttgag gatctcacga caccgcccac gtggtttccc	540
tttccgacca aagtatgctg gcggaagcat gatcttgccc gactgggtgcc ttacaaagct	600
ccggggatat ctgatcgatg ccgtatgggg ctggttctta agggatctga ttgtttgctc	660
tccaaagtgt accatgagtt tggaactcaa tggtactctc ttttgagac actacaccaa	720
gtaccgggtg ttccgggtgg attactgcca ccggaatac ccggagacga gaaagatgaa	780
acatgggtgt caatcaagaa atggctcgat ggtaaacaaa aaggcagtggt ggtgtacgtt	840
gcattaggaa gcgaggtttt ggtgagccaa accgaggttg ttgagttagc attgggtctc	900
gagctttctg ggttgccatt tgtttgggct tatagaaaac caaaagggtcc cgcaagtca	960
gactcgggtg agttgccaga cgggttcgtg gaacgaactc gtgaccgtgg gttggtctgg	1020
acgagtcggg cacctcagtt acgaatactg agccatgagt cggtttgtgg gttcttgacg	1080
cattgtgggt ctggatcaat tgtggaagg ctaatgtttg gtcaccctct aatcatgcta	1140
ccgatttttg gggaccaacc tctgaatgct cgattactgg aggacaaaca ggtgggaatc	1200
gagataccaa gaaatgagga agatggttgc ttgaccaagg agtcggttgc tagatcactg	1260
aggtccgttg ttgtggaaaa agaaggggag atctacaagg cgaacgcgag ggagctgagt	1320
aaaatctata acgacactaa ggttgaaaaa gaatatgtaa gccaatcgt agactatttg	1380
gaaagaatg cgctgctggg tgccatcgat catgagagtt aa	1422

<210> 97

<211> 1380

<212> DNA

<213> Stevia rebaudiana

<400> 97

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ttcagtatca catctttca caccaacttc aacaaacca aaacatctaa ttaccctcac	180
ttcactttca gattcatcct cgacaacgac ccacaagacg aacgcatttc caatctaccg	240
actcatgggtc cgctcgctgg tatgcggatt ccgattatca acgaacacgg agctgacgaa	300
ttacgacgcg aactggaact gttgatgtta gcttctgaag aagatgaaga ggtatcgtgt	360

SeqLst

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ttaatcacgg atgctctttg gtacttcgcg caatctgttg ctgacagtct taacctccga      420
cggcttgttt tgatgacaag cagcttgttt aattttcatg cacatgtttc acttcctcag      480
tttgatgagc ttggttacct cgatcctgat gacaaaaccc gtttggaaga acaagcgagt      540
gggtttccta tgctaaaagt gaaagacatc aagtctgctg attcgaactg gcaaatactc      600
aaagagatat tagggaagat gataaaacaa acaaaagcat cttcaggagt catctggaac      660
tcatttaagg aactcgaaga gtctgagctc gaaactgtta tccgtgagat cccggctcca      720
agtttcttga taccactccc caagcatttg acagcctctt ccagcagctt actagaccac      780
gatcgaaccg tttttccatg gttagaccaa caaccgtcac gttcgggtact gtatgttagt      840
tttggttagtg gtactgaagt actggatgag aaagatttct tggaaatagc tcgtggggtg      900
gttgatagca agcagtcggt tttatgggtg gttcgacctg ggtttgtcaa gggttcgacg      960
tgggtcgaac cgttgccaga tgggttcttg ggtgaaagag gacgtattgt gaaatggggt      1020
ccacagcaag aagtgctagc tcatggagca ataggcgcat tctggactca tagcggatgg      1080
aactctacgt tggaagcgt ttgtgaaggt gttcctatga ttttctcgga ttttgggctc      1140
gatcaaccgt tgaatgctag atacatgagt gatgttttga aggtaggggt gtatttgga      1200
aatgggtggg aaagaggaga gatagcaaat gcaataagaa gagttatggg ggatgaagaa      1260
ggagaataca ttagacagaa tgcaagagtt ttgaaacaaa aggcagatgt ttctttgatg      1320
aagggtgggt cgtcttacga atcattagag tctctagttt cttacatttc atcgttgtaa      1380

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<210> 98

<211> 459

<212> PRT

<213> Stevia rebaudiana

<400> 98

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

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

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```

Asn Phe Asn Lys Pro Lys Thr Ser Asn Tyr Pro His Phe Thr Phe Arg
          50          55          60

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

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Thr His Gly Pro Leu Ala Gly Met Arg Ile Pro Ile Ile Asn Glu His

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SeqLst															
85							90							95	
Gly	Ala	Asp	Glu 100	Leu	Arg	Arg	Glu	Leu 105	Glu	Leu	Leu	Met	Leu 110	Ala	Ser
Glu	Glu	Asp 115	Glu	Glu	Val	Ser	Cys 120	Leu	Ile	Thr	Asp	Ala 125	Leu	Trp	Tyr
Phe	Ala 130	Gln	Ser	Val	Ala	Asp 135	Ser	Leu	Asn	Leu	Arg 140	Arg	Leu	Val	Leu
Met 145	Thr	Ser	Ser	Leu	Phe 150	Asn	Phe	His	Ala	His 155	Val	Ser	Leu	Pro	Gln 160
Phe	Asp	Glu	Leu	Gly 165	Tyr	Leu	Asp	Pro	Asp 170	Asp	Lys	Thr	Arg	Leu 175	Glu
Glu	Gln	Ala	Ser 180	Gly	Phe	Pro	Met	Leu 185	Lys	Val	Lys	Asp	Ile 190	Lys	Ser
Ala	Tyr	Ser 195	Asn	Trp	Gln	Ile	Leu 200	Lys	Glu	Ile	Leu	Gly 205	Lys	Met	Ile
Lys	Gln 210	Thr	Lys	Ala	Ser	Ser 215	Gly	Val	Ile	Trp	Asn 220	Ser	Phe	Lys	Glu
Leu 225	Glu	Glu	Ser	Glu	Leu 230	Glu	Thr	Val	Ile	Arg 235	Glu	Ile	Pro	Ala	Pro 240
Ser	Phe	Leu	Ile	Pro 245	Leu	Pro	Lys	His	Leu 250	Thr	Ala	Ser	Ser	Ser 255	Ser
Leu	Leu	Asp	His 260	Asp	Arg	Thr	Val	Phe 265	Pro	Trp	Leu	Asp	Gln 270	Gln	Pro
Ser	Arg	Ser 275	Val	Leu	Tyr	Val	Ser 280	Phe	Gly	Ser	Gly	Thr 285	Glu	Val	Leu
Asp	Glu 290	Lys	Asp	Phe	Leu	Glu 295	Ile	Ala	Arg	Gly	Leu 300	Val	Asp	Ser	Lys
Gln 305	Ser	Phe	Leu	Trp	Val 310	Val	Arg	Pro	Gly	Phe 315	Val	Lys	Gly	Ser	Thr 320
Trp	Val	Glu	Pro	Leu 325	Pro	Asp	Gly	Phe	Leu 330	Gly	Glu	Arg	Gly	Arg 335	Ile

SeqLst

Val Lys Trp Val Pro Gln Gln Glu Val Leu Ala His Gly Ala Ile Gly
340 345 350

Ala Phe Trp Thr His Ser Gly Trp Asn Ser Thr Leu Glu Ser Val Cys
355 360 365

Glu Gly Val Pro Met Ile Phe Ser Asp Phe Gly Leu Asp Gln Pro Leu
370 375 380

Asn Ala Arg Tyr Met Ser Asp Val Leu Lys Val Gly Val Tyr Leu Glu
385 390 395 400

Asn Gly Trp Glu Arg Gly Glu Ile Ala Asn Ala Ile Arg Arg Val Met
405 410 415

Val Asp Glu Glu Gly Glu Tyr Ile Arg Gln Asn Ala Arg Val Leu Lys
420 425 430

Gln Lys Ala Asp Val Ser Leu Met Lys Gly Gly Ser Ser Tyr Glu Ser
435 440 445

Leu Glu Ser Leu Val Ser Tyr Ile Ser Ser Leu
450 455

<210> 99
<211> 1380
<212> DNA
<213> Stevia rebaudiana

<220>
<221> modified_base
<222> (861)..(863)
<223> a, c, t, g, unknown or other

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ttcagtatca ccatctttca caccaacttc aacaaaccca aaacatctaa ttaccctcac 180
ttcactttca gattcatcct cgacaacgac ccacaagacg aacgcatttc caatctaccg 240
actcatggtc cgctcgctgg tatgcggatt ccgattatca acgaacacgg agctgacgaa 300
ttacgacgcg aactggaact gttgatgtta gtttctgaag aagatgaaga ggtatcgtgt 360
ttaatcacgg atgctctttg gtacttcgcg caatctgttg ctgacagtct taacctccga 420
cggcttgttt tgatgacaag cagcttgttt aattttcatg cacatgtttc acttcctcag 480
tttgatgagc ttggttacct cgatcctgat gacaaaaccc gtttggaaga acaagcgagt 540
gggtttccta tgctaaaagt gaaagacatc aagtctgcgt attcgaactg gcaaatactc 600

SeqLst

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aaagagatat tagggaagat gataaaacaa acaaaagcat cttcaggagt catctggaac      660
tcatttaagg aactcgaaga gtctgagctc gaaactgtta tccgtgagat cccggctcca      720
agtttcttga taccactccc caagcatttg acagcctctt ccagcagctt actagaccac      780
gatcgaaccg tttttcaatg gttagaccaa caaccgcaa gttcgggtact gtatgttagt      840
tttggtagta ctagtgaagt nnnngatgag aaagatttct tggaaatagc tcgtggggtg      900
gttgatagca agcagtcgtt tttatgggtg gttcgacctg ggtttgtcaa gggttcgacg      960
tgggtcgaac cgttgccaga tgggttcgtg gccgaaagag ggcgtattgt gaaatggggt      1020
ccgcaacagg aagtgatagc tcatggagca atcgggtgcat tctggactca tagcggatgg      1080
aactctacat tggaaagcgt ttgtgaagggt gttcctatga ttttctcgga ttttgggctc      1140
gatcaaccgt tgaatgctag atacatgagt gatgttttga aggtaggggt gtatttggaa      1200
aatgggtggg aaagaggaga gatagcaaat gcaatacgaa gagttatggg ggatgaagaa      1260
ggagaataca ttagacagaa tgcaagagtt ttgaaacaaa aggcagatgt ttctttgatg      1320
aagggtgggt catcttacga atcattagag tctctagttt cttacatttc atcgttgtaa      1380

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<210> 100
<211> 459
<212> PRT
<213> Stevia rebaudiana

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<220>
<221> MOD_RES
<222> (288)..(288)
<223> Any amino acid

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<400> 100
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1          5          10          15

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Leu Phe Pro Val Pro Phe Gln Gly His Ile Asn Pro Ile Leu Gln Leu
20          25          30

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

```

```

Asn Phe Asn Lys Pro Lys Thr Ser Asn Tyr Pro His Phe Thr Phe Arg
50          55          60

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

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Thr His Gly Pro Leu Ala Gly Met Arg Ile Pro Ile Ile Asn Glu His
85          90          95

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SeqLst

Gly Ala Asp Glu₁₀₀ Leu Arg Arg Glu₁₀₅ Leu Glu Leu Leu Met₁₁₀ Leu Ala Ser
 Glu Glu Asp₁₁₅ Glu Glu Val Ser Cys₁₂₀ Leu Ile Thr Asp₁₂₅ Ala Leu Trp Tyr
 Phe Ala₁₃₀ Gln Ser Val Ala Asp₁₃₅ Ser Leu Asn Leu Arg₁₄₀ Arg Leu Val Leu
 Met₁₄₅ Thr Ser Ser Leu Phe₁₅₀ Asn Phe His Ala₁₅₅ His Val Ser Leu Pro Gln₁₆₀
 Phe Asp Glu Leu Gly₁₆₅ Tyr Leu Asp Pro Asp₁₇₀ Asp Lys Thr Arg Leu₁₇₅ Glu
 Glu Gln Ala Ser₁₈₀ Gly Phe Pro Met₁₈₅ Leu Lys Val Lys Asp Ile₁₉₀ Lys Ser
 Ala Tyr Ser₁₉₅ Asn Trp Gln Ile Leu₂₀₀ Lys Glu Ile Leu Gly₂₀₅ Lys Met Ile
 Lys Gln Thr Lys Ala Ser Ser₂₁₅ Gly Val Ile Trp Asn₂₂₀ Ser Phe Lys Glu
 Leu₂₂₅ Glu Glu Ser Glu Leu₂₃₀ Glu Thr Val Ile Arg₂₃₅ Glu Ile Pro Ala Pro₂₄₀
 Ser Phe Leu Ile Pro₂₄₅ Leu Pro Lys His Leu₂₅₀ Thr Ala Ser Ser Ser₂₅₅ Ser
 Leu Leu Asp His₂₆₀ Asp Arg Thr Val Phe₂₆₅ Gln Trp Leu Asp Gln₂₇₀ Gln Pro
 Pro Ser Ser₂₇₅ Val Leu Tyr Val Ser₂₈₀ Phe Gly Ser Thr Ser₂₈₅ Glu Val Xaa
 Asp Glu₂₉₀ Lys Asp Phe Leu Glu₂₉₅ Ile Ala Arg Gly Leu₃₀₀ Val Asp Ser Lys
 Gln₃₀₅ Ser Phe Leu Trp Val₃₁₀ Val Arg Pro Gly Phe₃₁₅ Val Lys Gly Ser Thr₃₂₀
 Trp Val Glu Pro Leu₃₂₅ Pro Asp Gly Phe Val₃₃₀ Ala Glu Arg Gly Arg₃₃₅ Ile
 Val Lys Trp Val₃₄₀ Pro Gln Gln Glu Val₃₄₅ Ile Ala His Gly Ala₃₅₀ Ile Gly

SeqLst

Ala Phe Trp Thr His Ser Gly Trp Asn Ser Thr Leu Glu Ser Val Cys
 355 360 365

Glu Gly Val Pro Met Ile Phe Ser Asp Phe Gly Leu Asp Gln Pro Leu
 370 375 380

Asn Ala Arg Tyr Met Ser Asp Val Leu Lys Val Gly Val Tyr Leu Glu
 385 390 395 400

Asn Gly Trp Glu Arg Gly Glu Ile Ala Asn Ala Ile Arg Arg Val Met
 405 410 415

Val Asp Glu Glu Gly Glu Tyr Ile Arg Gln Asn Ala Arg Val Leu Lys
 420 425 430

Gln Lys Ala Asp Val Ser Leu Met Lys Gly Gly Ser Ser Tyr Glu Ser
 435 440 445

Leu Glu Ser Leu Val Ser Tyr Ile Ser Ser Leu
 450 455

<210> 101
 <211> 1380
 <212> DNA
 <213> Stevia rebaudiana

<220>
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 <222> (861)..(863)
 <223> a, c, t, g, unknown or other

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 ttcagtatca ccatctttca caccaacttc aacaaacca aaacatctaa ttaccctcac 180
 ttcactttca gattcatcct cgacaacgac ccacaagacg aacgcatttc caatctaccg 240
 actcatgggc cgctcgctgg tatgcggatt ccgattatca acgaacacgg agctgacgaa 300
 ttacgacgcg aactggaact gttgatgtta gcttctgaag aagatgaaga ggtatcgtgt 360
 ttaatcacgg atgctctttg gtacttcgcg caatctgttg ctgacagtct taacctccga 420
 cggcttgttt tgatgacaag cagcttgttt aattttcatg cacatgtttc acttcctcag 480
 tttgatgagc ttggttacct cgatcctgat gacaaaaccc gtttggaaga acaagcgagt 540
 gggtttccta tgctaaaagt gaaagacatc aagtctgcgt attcgaactg gcaaatactc 600
 aaagagatat tagggaagat gataaaacaa acaaaagcat cttcaggagt catctggaac 660

SeqLst

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tcatttaagg aactcgaaga gtctgagctc gaaactgtta tccgtgagat cccggctcca      720
agtttcttga taccactccc caagcatttg acagcctctt ccagcagctt actagaccac      780
gatcgaaccg tttttcaatg gttagaccaa caaccgcaa gttcgggtact gtatgttagt      840
tttggtagta ctagtgaagt nnnnggatgag aaagatttct tggaaatagc tcgtggggtg      900
gttgatagca agcagtcggt tttatgggtg gttcgacctg ggtttgtcaa gggttcgacg      960
tgggtcgaac cgttgccaga tgggttcttg ggtgaaagag gacgtattgt gaaatgggtt     1020
ccacagcaag aagtgctagc tcatggagca ataggcgcat tctggactca tagcggatgg     1080
aactctacgt tggaaagcgt ttgtgaaggt gttcctatga ttttctcgga ttttgggctc     1140
gatcaaccgt tgaatgctag atacatgagt gatgttttga aggtaggggt gtatttggaa     1200
aatgggtggg aaagaggaga gatagcaaat gcaataagaa gagttatggt ggatgaagaa     1260
ggagaataca ttagacagaa tgcaagagtt ttgaaacaaa aggcatgtgt ttctttgatg     1320
aagggtgggt cgtcttacga atcattagag tctctagttt cttacatttc atcgttgtaa     1380

```

```

<210> 102
<211> 459
<212> PRT
<213> Stevia rebaudiana

```

```

<220>
<221> MOD_RES
<222> (288)..(288)
<223> Any amino acid

```

```

<400> 102
Met Glu Asn Lys Thr Glu Thr Thr Val Arg Arg Arg Arg Arg Ile Ile
1          5          10          15

```

```

Leu Phe Pro Val Pro Phe Gln Gly His Ile Asn Pro Ile Leu Gln Leu
20          25          30

```

```

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

```

```

Asn Phe Asn Lys Pro Lys Thr Ser Asn Tyr Pro His Phe Thr Phe Arg
50          55          60

```

```

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

```

```

Thr His Gly Pro Leu Ala Gly Met Arg Ile Pro Ile Ile Asn Glu His
85          90          95

```

```

Gly Ala Asp Glu Leu Arg Arg Glu Leu Glu Leu Leu Met Leu Ala Ser

```

															SeqLst															
100					105					110																				
Glu	Glu	Asp	Glu	Glu	Val	Ser	Cys	Leu	Ile	Thr	Asp	Ala	Leu	Trp	Tyr															
		115					120					125																		
Phe	Ala	Gln	Ser	Val	Ala	Asp	Ser	Leu	Asn	Leu	Arg	Arg	Leu	Val	Leu															
	130					135					140																			
Met	Thr	Ser	Ser	Leu	Phe	Asn	Phe	His	Ala	His	Val	Ser	Leu	Pro	Gln															
145					150					155					160															
Phe	Asp	Glu	Leu	Gly	Tyr	Leu	Asp	Pro	Asp	Asp	Lys	Thr	Arg	Leu	Glu															
				165					170					175																
Glu	Gln	Ala	Ser	Gly	Phe	Pro	Met	Leu	Lys	Val	Lys	Asp	Ile	Lys	Ser															
			180					185					190																	
Ala	Tyr	Ser	Asn	Trp	Gln	Ile	Leu	Lys	Glu	Ile	Leu	Gly	Lys	Met	Ile															
		195					200					205																		
Lys	Gln	Thr	Lys	Ala	Ser	Ser	Gly	Val	Ile	Trp	Asn	Ser	Phe	Lys	Glu															
	210					215					220																			
Leu	Glu	Glu	Ser	Glu	Leu	Glu	Thr	Val	Ile	Arg	Glu	Ile	Pro	Ala	Pro															
225					230					235					240															
Ser	Phe	Leu	Ile	Pro	Leu	Pro	Lys	His	Leu	Thr	Ala	Ser	Ser	Ser	Ser															
				245					250					255																
Leu	Leu	Asp	His	Asp	Arg	Thr	Val	Phe	Gln	Trp	Leu	Asp	Gln	Gln	Pro															
			260					265					270																	
Pro	Ser	Ser	Val	Leu	Tyr	Val	Ser	Phe	Gly	Ser	Thr	Ser	Glu	Val	Xaa															
		275					280					285																		
Asp	Glu	Lys	Asp	Phe	Leu	Glu	Ile	Ala	Arg	Gly	Leu	Val	Asp	Ser	Lys															
	290					295					300																			
Gln	Ser	Phe	Leu	Trp	Val	Val	Arg	Pro	Gly	Phe	Val	Lys	Gly	Ser	Thr															
305					310					315				320																
Trp	Val	Glu	Pro	Leu	Pro	Asp	Gly	Phe	Leu	Gly	Glu	Arg	Gly	Arg	Ile															
				325					330					335																
Val	Lys	Trp	Val	Pro	Gln	Gln	Glu	Val	Leu	Ala	His	Gly	Ala	Ile	Gly															
			340				345						350																	

SeqLst

Ala Phe Trp Thr His Ser Gly Trp Asn Ser Thr Leu Glu Ser Val Cys
355 360 365

Glu Gly Val Pro Met Ile Phe Ser Asp Phe Gly Leu Asp Gln Pro Leu
370 375 380

Asn Ala Arg Tyr Met Ser Asp Val Leu Lys Val Gly Val Tyr Leu Glu
385 390 395 400

Asn Gly Trp Glu Arg Gly Glu Ile Ala Asn Ala Ile Arg Arg Val Met
405 410 415

Val Asp Glu Glu Gly Glu Tyr Ile Arg Gln Asn Ala Arg Val Leu Lys
420 425 430

Gln Lys Ala Asp Val Ser Leu Met Lys Gly Gly Ser Ser Tyr Glu Ser
435 440 445

Leu Glu Ser Leu Val Ser Tyr Ile Ser Ser Leu
450 455

<210> 103
<211> 1323
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 103
atgcattcta ccagacatat cttaagacaa agggccgtcc tagttacagg cgctagaaca 60
ccattcgtga aatcatttgg ggctcttatg aaagcagata ccttggaatt ggcatcagca 120
tcagtcgctg ggttgctgaa caagacctca ctggacccta gagatatcga tcatatcggt 180
tggggtaatg ttgtacttca aggatcagct cataactgcg ccagagaaat agttatcgac 240
cttaacatgc ctaaaaagat catcggtaat ttgacatcta tggcctgtgc ttcaggctta 300
tcttctttgt cacaagcctg tatgctaata gaggggtggtc atgccgatgt cgtcattgct 360
ggcggttctg attcagtctc caacactgaa gtgcctttgc caagatccgt cacttacggt 420
ctaattgatgg cccaaaggaa ggggtgttatg ggcttcttta aggaagcagg atacaacca 480
ttcaaattgg ttccaggcgg tattgcttta accgaacgta gtacaggaaa aactatgggt 540
tggcatggag acttaattgc tgagttaaac tctatatcta gagatgacca ggaagccctg 600
gctgtggctt ctcatgcaaa tgctgctaga gcagaaaaag ctgggtactt taaggaggaa 660
attgtacctg tgacaatcga caaaaagggc aaaaagactg aagtaacatg tgatgatgtt 720
atgcaaagag atacagaaaa gatgaaggcc aagatgccat cattgaagcc tgttttcaga 780

SeqLst

```

aaagaggggag gtacaataac agcagccact tccagtactc tgactgatgg tggctctgca      840
atgttggtta tgtcagagga aaaggccaaa aagttggggt atccaactga tgtctgcgtg      900
aagtcttggg atttcagtgg tatcgatcct tacccacaac ttttgttagc accagttcta      960
ggttgggggtc cagctttgaa aaaggccgga ttaaccccta aagatatcga tttgtacgaa     1020
attcacgaag catttgctgc acaagttcta gccacaatta agtgtttgaa gtctcaggaa     1080
ttcttcgata ggtacgctaa cggtgcaaag ccagtattaa ctgaggatat tgatctttct     1140
aaactaaatg ttaatggcgg ttccttagca cttggccacc cattcgccgc tacaggaggt     1200
agaatcgtaa tctctctagc aaatgagttg agaagatccg gaaagagaca cgggctggtc     1260
agtatttgtg cagctggagg gttaggcgga gtagctatac ttgagcatac agcaagtaag     1320
taa                                                                    1323

```

```

<210> 104
<211> 440
<212> PRT
<213> Leishmania infantum

```

```

<400> 104
Met His Ser Thr Arg His Ile Leu Arg Gln Arg Ala Val Leu Val Thr
1          5          10          15

Gly Ala Arg Thr Pro Phe Val Lys Ser Phe Gly Ala Leu Met Lys Ala
          20          25          30

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

Thr Ser Leu Asp Pro Arg Asp Ile Asp His Ile Val Trp Gly Asn Val
          50          55          60

Val Leu Gln Gly Ser Ala His Asn Cys Ala Arg Glu Ile Val Ile Asp
65          70          75          80

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

Ala Ser Gly Leu Ser Ser Leu Ser Gln Ala Cys Met Leu Ile Glu Gly
          100          105          110

Gly His Ala Asp Val Val Ile Ala Gly Gly Ser Asp Ser Val Ser Asn
          115          120          125

Thr Glu Val Pro Leu Pro Arg Ser Val Thr Tyr Gly Leu Met Met Ala
          130          135          140

```

SeqLst

Gln Arg Lys Gly Val Met Gly Phe Phe Lys Glu Ala Gly Tyr Asn Pro
 145 150 155 160
 Phe Lys Trp Phe Pro Gly Gly Ile Ala Leu Thr Glu Arg Ser Thr Gly
 165 170 175
 Lys Thr Met Gly Trp His Gly Asp Leu Ile Ala Glu Leu Asn Ser Ile
 180 185 190
 Ser Arg Asp Asp Gln Glu Ala Leu Ala Val Ala Ser His Ala Asn Ala
 195 200 205
 Ala Arg Ala Glu Lys Ala Gly Tyr Phe Lys Glu Glu Ile Val Pro Val
 210 215 220
 Thr Ile Asp Lys Lys Gly Lys Lys Thr Glu Val Thr Cys Asp Asp Val
 225 230 235 240
 Met Gln Arg Asp Thr Glu Lys Met Lys Ala Lys Met Pro Ser Leu Lys
 245 250 255
 Pro Val Phe Arg Lys Glu Gly Gly Thr Ile Thr Ala Ala Thr Ser Ser
 260 265 270
 Thr Leu Thr Asp Gly Gly Ser Ala Met Leu Val Met Ser Glu Glu Lys
 275 280 285
 Ala Lys Lys Leu Gly Tyr Pro Thr Asp Val Cys Val Lys Ser Trp Tyr
 290 295 300
 Phe Ser Gly Ile Asp Pro Tyr Pro Gln Leu Leu Leu Ala Pro Val Leu
 305 310 315 320
 Gly Trp Gly Pro Ala Leu Lys Lys Ala Gly Leu Thr Pro Lys Asp Ile
 325 330 335
 Asp Leu Tyr Glu Ile His Glu Ala Phe Ala Ala Gln Val Leu Ala Thr
 340 345 350
 Ile Lys Cys Leu Lys Ser Gln Glu Phe Phe Asp Arg Tyr Ala Asn Gly
 355 360 365
 Ala Lys Pro Val Leu Thr Glu Asp Ile Asp Leu Ser Lys Leu Asn Val
 370 375 380
 Asn Gly Gly Ser Leu Ala Leu Gly His Pro Phe Ala Ala Thr Gly Gly
 385 390 395 400

SeqLst

Arg Ile Val Ile Ser Leu Ala Asn Glu Leu Arg Arg Ser Gly Lys Arg
 405 410 415

His Gly Leu Val Ser Ile Cys Ala Ala Gly Gly Leu Gly Gly Val Ala
 420 425 430

Ile Leu Glu His Thr Ala Ser Lys
 435 440

<210> 105

<211> 1584

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 105

atggcagctg accaattggt gaaaactgaa gtcaccaaga agtctttttac tgctcctgta	60
caaaaggctt ctacaccagt tttaaccaat aaaacagtca tttctggatc gaaagtcaaa	120
agtttatcat ctgcgcaatc gagctcatca ggaccttcat catctagtga ggaagatgat	180
tcccgcgata ttgaaagctt ggataagaaa atacgtcctt tagaagaatt agaagcatta	240
ttaagtagtg gaaatacaaa acaattgaag aacaaagagg tcgctgcctt ggttattcac	300
ggtaagttac ctttgtacgc tttggagaaa aaattagggtg atactacgag agcggttgcg	360
gtacgtagga aggctctttc aattttggca gaagctcctg tattagcatc tgatcgttta	420
ccatataaaa attatgacta cgaccgcgta tttggcgctt gttgtgaaaa tgttataggt	480
tacatgcctt tgcccgttgg tgttataggc cccttgggta tcgatgggtac atcttatcat	540
ataccaatgg caactacaga gggttgtttg gtagcttctg ccatgcgtgg ctgtaaggca	600
atcaatgctg gcggtggtgc aacaactgtt ttaactaagg atgggtatgac aagaggccca	660
gtagtccgtt tcccaacttt gaaaagatct ggtgcctgta agatatgggt agactcagaa	720
gagggacaaa acgcaattaa aaaagctttt aactctacat caagatttgc acgtctgcaa	780
catattcaaa cttgtctagc aggagattta ctcttcatga gatttagaac aactactggt	840
gacgcaatgg gtatgaatat gatttctaaa ggtgtcgaat actcattaaa gcaaattggt	900
gaagagtatg gctgggaaga tatggagggt gtctccgttt ctggtaacta ctgtaccgac	960
aaaaaaccag ctgccatcaa ctggatcgaa ggtcgtggta agagtgtcgt cgcagaagct	1020
actattcctg gtgatgttgt cagaaaagtg ttaaaaagtg atgtttccgc attggttgag	1080
ttgaacattg ctaagaattt gggttgatct gcaatggctg ggtctgttgg tggatttaac	1140
gcacatgcag ctaatttagt gacagctggt ttcttggcat taggacaaga tcctgcacaa	1200

SeqLst

```

aatgttgaaa gttccaactg tataacattg atgaaagaag tggacggtga tttgagaatt 1260
tccgtatcca tgccatccat cgaagtaggt accatcgggtg gtggtactgt tctagaacca 1320
caaggtgcca tgttggactt attaggtgta agaggcccg c atgctaccgc tcctggtacc 1380
aacgcacgtc aattagcaag aatagttgcc tgtgccgtct tggcaggtga attatcctta 1440
tgtgctgccc tagcagccgg ccatttgggtt caaagtcata tgaccacaaa caggaaacct 1500
gctgaaccaa caaaacctaa caatttggac gccactgata taaatcgttt gaaagatggg 1560
tccgtcacct gcattaaatc ctaa 1584

```

<210> 106

<211> 527

<212> PRT

<213> *Saccharomyces cerevisiae*

<400> 106

```

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

```

```

Thr Ala Pro Val Gln Lys Ala Ser Thr Pro Val Leu Thr Asn Lys Thr
          20          25          30

```

```

Val Ile Ser Gly Ser Lys Val Lys Ser Leu Ser Ser Ala Gln Ser Ser
          35          40          45

```

```

Ser Ser Gly Pro Ser Ser Ser Ser Glu Glu Asp Asp Ser Arg Asp Ile
          50          55          60

```

```

Glu Ser Leu Asp Lys Lys Ile Arg Pro Leu Glu Glu Leu Glu Ala Leu
65          70          75          80

```

```

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

```

```

Leu Val Ile His Gly Lys Leu Pro Leu Tyr Ala Leu Glu Lys Lys Leu
          100          105          110

```

```

Gly Asp Thr Thr Arg Ala Val Ala Val Arg Arg Lys Ala Leu Ser Ile
          115          120          125

```

```

Leu Ala Glu Ala Pro Val Leu Ala Ser Asp Arg Leu Pro Tyr Lys Asn
          130          135          140

```

```

Tyr Asp Tyr Asp Arg Val Phe Gly Ala Cys Cys Glu Asn Val Ile Gly
145          150          155          160

```

```

Tyr Met Pro Leu Pro Val Gly Val Ile Gly Pro Leu Val Ile Asp Gly

```

SeqLst															
165								170				175			
Thr	Ser	Tyr	His 180	Ile	Pro	Met	Ala	Thr 185	Thr	Glu	Gly	Cys	Leu 190	Val	Ala
Ser	Ala	Met 195	Arg	Gly	Cys	Lys	Ala 200	Ile	Asn	Ala	Gly	Gly 205	Gly	Ala	Thr
Thr	Val 210	Leu	Thr	Lys	Asp	Gly 215	Met	Thr	Arg	Gly	Pro 220	Val	Val	Arg	Phe
Pro 225	Thr	Leu	Lys	Arg	Ser 230	Gly	Ala	Cys	Lys	Ile 235	Trp	Leu	Asp	Ser	Glu 240
Glu	Gly	Gln	Asn	Ala 245	Ile	Lys	Lys	Ala	Phe 250	Asn	Ser	Thr	Ser	Arg 255	Phe
Ala	Arg	Leu	Gln 260	His	Ile	Gln	Thr	Cys 265	Leu	Ala	Gly	Asp	Leu 270	Leu	Phe
Met	Arg	Phe 275	Arg	Thr	Thr	Thr	Gly 280	Asp	Ala	Met	Gly	Met 285	Asn	Met	Ile
Ser	Lys 290	Gly	Val	Glu	Tyr	Ser 295	Leu	Lys	Gln	Met	Val 300	Glu	Glu	Tyr	Gly
Trp 305	Glu	Asp	Met	Glu	Val 310	Val	Ser	Val	Ser	Gly 315	Asn	Tyr	Cys	Thr	Asp 320
Lys	Lys	Pro	Ala	Ala 325	Ile	Asn	Trp	Ile	Glu 330	Gly	Arg	Gly	Lys	Ser 335	Val
Val	Ala	Glu	Ala 340	Thr	Ile	Pro	Gly	Asp 345	Val	Val	Arg	Lys	Val 350	Leu	Lys
Ser	Asp	Val 355	Ser	Ala	Leu	Val	Glu 360	Leu	Asn	Ile	Ala	Lys 365	Asn	Leu	Val
Gly	Ser 370	Ala	Met	Ala	Gly	Ser 375	Val	Gly	Gly	Phe	Asn 380	Ala	His	Ala	Ala
Asn 385	Leu	Val	Thr	Ala	Val 390	Phe	Leu	Ala	Leu	Gly 395	Gln	Asp	Pro	Ala	Gln 400
Asn	Val	Glu	Ser	Ser 405	Asn	Cys	Ile	Thr	Leu 410	Met	Lys	Glu	Val	Asp 415	Gly

SeqLst

Asp Leu Arg Ile Ser Val Ser Met Pro Ser Ile Glu Val Gly Thr Ile
420 425 430

Gly Gly Gly Thr Val Leu Glu Pro Gln Gly Ala Met Leu Asp Leu Leu
435 440 445

Gly Val Arg Gly Pro His Ala Thr Ala Pro Gly Thr Asn Ala Arg Gln
450 455 460

Leu Ala Arg Ile Val Ala Cys Ala Val Leu Ala Gly Glu Leu Ser Leu
465 470 475 480

Cys Ala Ala Leu Ala Ala Gly His Leu Val Gln Ser His Met Thr His
485 490 495

Asn Arg Lys Pro Ala Glu Pro Thr Lys Pro Asn Asn Leu Asp Ala Thr
500 505 510

Asp Ile Asn Arg Leu Lys Asp Gly Ser Val Thr Cys Ile Lys Ser
515 520 525

<210> 107
<211> 3681
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 107
atgagagctg tccttagatt gttatcaaca catactgttt tctctcctat tgaacaatt 60
gtatctgttt tcgtgtagc tacattagct tacttccaca tcttgccgg aatcaagcac 120
tcaagtttct ttgcatcttc tcatcctcct gctatcagac ctgcttttgc acatctgacc 180
aacggggaat ggggtgccgt ctcccaacat gattggactg aagcatggaa gcacccctggc 240
ggttcacttg atgcattaga acttcaacaa gtagttttca ctttagatga caagactcaa 300
ccatctgctg tgctagatgc atccgcaatt agtcagcact tagtttccaa tggtcctgca 360
ttatctggaa aagcctactc ttcatgtgc caccatccaa atgtatcagg cacctcctgt 420
tttacatcag tttctggtcc aggagcttca ccaatcttga cactgagttt taagcctgga 480
actagagacg attgggttagg atcattaagg aaggagaaaa ctatcacact agatgggggtt 540
aagtacgacg ttggagccgg aaaaagacaa gagtcaatcg gcgatatgga atcatctaag 600
tgggttgctt atgcattatc agctttggta cttagatttt gggaattaac aaaggcagat 660
tccttagata tactagtggg tctaactggg tacatcctaa tgcacgtaac attcatgaga 720
ttgttcttgg catccagagc acttggcagt aacttttggg tatcagctgg catattctcc 780

SeqLst

tccgcaacaa	tttctttcct	attcacttta	ccaatgtgta	gatctatgga	tattccactt	840
gatccaattg	ccttgacaga	agccctgcca	ttcttggtgt	gtaccgtagg	ttttgacaaa	900
ccacttagat	tggcaagagc	tgtgatggct	catcctaata	tccttaaacc	tcaagatgat	960
ggtaggatga	aagctgccgg	agatgtcatt	cttgaggcac	tggacagagt	tggtaacatg	1020
atattgagag	attacgcttt	agagatcgca	gttctattcg	ttggcggtta	ctccagagtt	1080
ggcggcttta	aggaattttg	tgctgtagct	gcagcattac	ttgctatgga	cagattaatg	1140
acattcacac	tttatacagc	agtgttaacc	atcatggttg	aggtaaggcg	tatcaaaaag	1200
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gagacaacta	aaaacctaa	acaaagagcc	actgattcag	ccatcggtgt	taagggttca	1380
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ccaattccta	gagttgacat	tactacccca	gccatagcca	atatcttgct	tcatctagct	1620
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gtcgtgctc	cagtctacgt	ccatgctcta	ccattggccc	ctgctttaag	agcttcaaac	1740
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ccagttgtta	gtaagtggat	cgtagcattg	ctagctgtct	ctgttgcat	gaatggatac	1860
ttgttaaagg	gtatagccgc	aggttccggg	ttggctgcca	tgagagctgt	tagatctcaa	1920
ggtgttcggt	tcagatctag	agctagaagt	atcgtaaaga	tatctgatga	acctgagcca	1980
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ccattgacta	ttttctcaag	accactgaac	ttagaaacag	tggacaaaaa	gttacaagat	2160
gctctgccaa	taagatcccc	accacctggt	gaaccaatca	ctccagaatc	tagagaagtg	2220
gaaccaaccc	aagtagaagt	aagatctcta	gctgaatgtg	tggatgtggt	cgagaatggg	2280
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gtacgtgtca	gaagagcact	tattagtaga	gcttcacgta	caaaaacttt	agaaaactca	2460
ctggttccta	tgaaagatta	tgattacgcc	agagtcatgg	gtgcctgttg	tgaaaacggt	2520
atcggataca	tgccattacc	actagggatt	gcagggtccat	tgaagattga	tggcttgatg	2580
tatcctatac	caatggcaac	cgcagaagg	accttggttg	catctacttc	taggggctgt	2640

SeqLst

aaggccttaa atgctggtgg aggggtcaca actgtcttga cagcagatgg catgacaaga	2700
gggccagcta tagactttcc ttccatcgtc agagctgcag aggctaaggc cttcattgaa	2760
tcagaagatg gatacgctac aatcagggag gctttcgagt ctacttctag atttgccaag	2820
ttgcaaaaga tcaagtgtgc actagctggt cgtactcttt ttgtcagatt tgctactaga	2880
acaggagatg ccatgggtat gaacatgatt tctaaggcta ccgaaaaggc acttgatgtc	2940
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aaaaagcctg cagctatttc atggatcgaa ggtaggggaa aatctattgt agcagaagca	3060
gttattcctg gtaaggctgt taagtcagtc ctgaaaacaa cagtcgagtc tctttgcaat	3120
gtcaacacta agaaaaacct gattggttca gccatggcag gttctgttgg tggtttcaac	3180
gctcatgccg ccaacatcct aacagctgtg ttcctagcca caggtcagga tcctgctcaa	3240
aatgtcgaat cttctaattg catgacttta atggaaccaa caaacggcgg tgaggatttg	3300
ctaattgacaa tttcaatgcc atgtatagag gtaggaaccg ttggtggagg gacaattctg	3360
gaaccacaag gtgcagtttt ggatttgttg ggcgtagag gggctcacc tactaatcct	3420
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tctttgataa gtgccttagc cgcaggcat ttggtagag ctcattctgc ccacaatcgt	3540
tctcaattga atacaccaat gccatccaga ccacatactc ctggccctga ggatgtctca	3600
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tacgttgctg aagcaaaata a	3681

<210> 108
 <211> 1226
 <212> PRT
 <213> Ganoderma lucidum

<400> 108
 Met Arg Ala Val Leu Arg Leu Leu Ser Thr His Thr Val Phe Ser Pro
 1 5 10 15

 Ile Glu Thr Ile Val Ser Val Phe Val Leu Ala Thr Leu Ala Tyr Phe
 20 25 30

 His Ile Leu Ser Gly Ile Lys His Ser Ser Phe Phe Ala Ser Ser His
 35 40 45

 Pro Pro Ala Ile Arg Pro Ala Phe Ala His Leu Thr Asn Gly Glu Trp
 50 55 60

 Val Ala Val Ser Gln His Asp Trp Thr Glu Ala Trp Lys His Pro Gly
 65 70 75 80

SeqLst

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

Asp Lys Thr Gln Pro Ser Ala Val Leu Asp Ala Ser Ala Ile Ser Gln
100 105 110

His Leu Val Ser Asn Val Pro Ala Leu Ser Gly Lys Ala Tyr Ser Ser
115 120 125

Leu Cys His His Pro Asn Val Ser Gly Thr Ser Cys Phe Thr Ser Val
130 135 140

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

Thr Arg Asp Asp Trp Leu Gly Ser Leu Arg Lys Glu Lys Thr Ile Thr
165 170 175

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

Ile Gly Asp Met Glu Ser Ser Lys Trp Val Ala Tyr Ala Leu Ser Ala
195 200 205

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

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

Leu Phe Leu Ala Ser Arg Ala Leu Gly Ser Asn Phe Trp Leu Ser Ala
245 250 255

Gly Ile Phe Ser Ser Ala Thr Ile Ser Phe Leu Phe Thr Leu Pro Met
260 265 270

Cys Arg Ser Met Asp Ile Pro Leu Asp Pro Ile Ala Leu Thr Glu Ala
275 280 285

Leu Pro Phe Leu Val Cys Thr Val Gly Phe Asp Lys Pro Leu Arg Leu
290 295 300

Ala Arg Ala Val Met Ala His Pro Asn Ile Leu Lys Pro Gln Asp Asp
305 310 315 320

Gly Arg Met Lys Ala Ala Gly Asp Val Ile Leu Glu Ala Leu Asp Arg
325 330 335

SeqLst

Val Gly Asn Met Ile Leu Arg Asp Tyr Ala Leu Glu Ile Ala Val Leu
 340 345 350
 Phe Val Gly Val Asn Ser Arg Val Gly Gly Leu Lys Glu Phe Cys Ala
 355 360 365
 Val Ala Ala Ala Leu Leu Ala Met Asp Arg Leu Met Thr Phe Thr Leu
 370 375 380
 Tyr Thr Ala Val Leu Thr Ile Met Val Glu Val Arg Arg Ile Lys Lys
 385 390 395 400
 Val Arg Asp Met Thr Lys Ala Arg Ser Arg Ser Ser Ser Ile Thr Ala
 405 410 415
 Val Thr Ala Asn Gly Thr Ala Ile Arg Gly Val Leu Ser Arg Lys Ser
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 Ser Lys Gln Ser Val Thr Glu Pro Glu Thr Thr Lys Asn Leu Arg Gln
 435 440 445
 Arg Ala Thr Asp Ser Ala Ile Gly Val Lys Gly Ser Leu Leu Lys Asp
 450 455 460
 Gly Gly Arg Leu Gln Glu Ala Glu Glu Asn Pro Met Ala Arg Leu Lys
 465 470 475 480
 Leu Leu Leu Ile Ala Ser Phe Leu Thr Leu His Ile Leu Asn Phe Cys
 485 490 495
 Thr Thr Leu Thr Ser Ala Thr Ala Asn Ala Arg His Gln Arg His Pro
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 Phe Arg Thr Val Gln Glu Val Val Pro Ile Pro Arg Val Asp Ile Thr
 515 520 525
 Thr Pro Ala Ile Ala Asn Ile Leu Ser His Leu Ala Val Ala Gln Glu
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 Pro Met Phe Thr Val Val Gly Ser Glu Pro Ile Glu Leu Leu Val Lys
 545 550 555 560
 Val Ala Ala Pro Val Tyr Val His Ala Leu Pro Leu Ala Pro Ala Leu
 565 570 575
 Arg Ala Ser Asn Thr Asn Thr Gly Glu Ala Ile Glu Asn Phe Met Ser
 580 585 590

SeqLst

Ser Trp Ser Ser Leu Val Gly Asp Pro Val Val Ser Lys Trp Ile Val
 595 600 605
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 610 615 620
 Ile Ala Ala Gly Ser Gly Leu Ala Ala Met Arg Ala Val Arg Ser Gln
 625 630 635 640
 Gly Val Arg Phe Arg Ser Arg Ala Arg Ser Ile Val Lys Ile Ser Asp
 645 650 655
 Glu Pro Glu Pro Glu Pro Glu His Ser Ile Asp Pro Ala Pro Val Val
 660 665 670
 Phe Phe Ala Ser Ala Ala Pro Ala Val Glu Ala Pro Ala Pro Ala Pro
 675 680 685
 Ala Pro Glu Pro Glu Pro Pro Val Asn Arg Pro Pro Pro Leu Thr Ile
 690 695 700
 Phe Ser Arg Pro Leu Asn Leu Glu Thr Val Asp Lys Lys Leu Gln Asp
 705 710 715 720
 Ala Leu Pro Ile Arg Ser Pro Pro Pro Val Glu Pro Ile Thr Pro Glu
 725 730 735
 Ser Arg Glu Val Glu Pro Thr Gln Val Glu Val Arg Ser Leu Ala Glu
 740 745 750
 Cys Val Asp Val Phe Glu Asn Gly Pro Arg Pro Val Ser Val Ala Leu
 755 760 765
 Lys Thr Leu Asn Asp Glu Glu Val Ile Leu Leu Cys Gln Thr Gly Lys
 770 775 780
 Ile Ala Pro Tyr Ala Leu Val Lys Met Leu Ala Asp Phe Asp Arg Ala
 785 790 795 800
 Val Arg Val Arg Arg Ala Leu Ile Ser Arg Ala Ser Arg Thr Lys Thr
 805 810 815
 Leu Glu Asn Ser Leu Val Pro Met Lys Asp Tyr Asp Tyr Ala Arg Val
 820 825 830
 Met Gly Ala Cys Cys Glu Asn Val Ile Gly Tyr Met Pro Leu Pro Leu

SeqLst															
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Gly	Ile	Ala	Gly	Pro	Leu	Lys	Ile	Asp	Gly	Leu	Met	Tyr	Pro	Ile	Pro
850						855					860				
Met	Ala	Thr	Ala	Glu	Gly	Thr	Leu	Val	Ala	Ser	Thr	Ser	Arg	Gly	Cys
865					870					875					880
Lys	Ala	Leu	Asn	Ala	Gly	Gly	Gly	Val	Thr	Thr	Val	Leu	Thr	Ala	Asp
				885					890					895	
Gly	Met	Thr	Arg	Gly	Pro	Ala	Ile	Asp	Phe	Pro	Ser	Ile	Val	Arg	Ala
			900					905					910		
Ala	Glu	Ala	Lys	Ala	Phe	Ile	Glu	Ser	Glu	Asp	Gly	Tyr	Ala	Thr	Ile
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Arg	Glu	Ala	Phe	Glu	Ser	Thr	Ser	Arg	Phe	Ala	Lys	Leu	Gln	Lys	Ile
	930					935					940				
Lys	Cys	Ala	Leu	Ala	Gly	Arg	Thr	Leu	Phe	Val	Arg	Phe	Ala	Thr	Arg
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Thr	Gly	Asp	Ala	Met	Gly	Met	Asn	Met	Ile	Ser	Lys	Ala	Thr	Glu	Lys
				965					970					975	
Ala	Leu	Asp	Val	Leu	Ser	His	Glu	Phe	Pro	Glu	Met	Val	Val	Leu	Ala
			980					985					990		
Leu	Ser	Gly	Asn	Tyr	Cys	Thr	Asp	Lys	Lys	Pro	Ala	Ala	Ile	Ser	Trp
		995					1000					1005			
Ile	Glu	Gly	Arg	Gly	Lys	Ser	Ile	Val	Ala	Glu	Ala	Val	Ile	Pro	
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Gly	Lys	Val	Val	Lys	Ser	Val	Leu	Lys	Thr	Thr	Val	Glu	Ser	Leu	
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Cys	Asn	Val	Asn	Thr	Lys	Lys	Asn	Leu	Ile	Gly	Ser	Ala	Met	Ala	
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Ala	Val	Phe	Leu	Ala	Thr	Gly	Gln	Asp	Pro	Ala	Gln	Asn	Val	Glu	
	1070					1075					1080				

SeqLst

Ser Ser Asn Cys Met Thr Leu Met Glu Pro Thr Asn Gly Gly Glu
1085 1090 1095

Asp Leu Leu Met Thr Ile Ser Met Pro Cys Ile Glu Val Gly Thr
1100 1105 1110

Val Gly Gly Gly Thr Ile Leu Glu Pro Gln Gly Ala Val Leu Asp
1115 1120 1125

Leu Leu Gly Val Arg Gly Ala His Pro Thr Asn Pro Gly Gln Asn
1130 1135 1140

Ala Gln Gln Leu Ala Arg Ile Ile Ala Ser Ala Val Met Ala Gly
1145 1150 1155

Glu Leu Ser Leu Ile Ser Ala Leu Ala Ala Gly His Leu Val Arg
1160 1165 1170

Ala His Leu Ala His Asn Arg Ser Gln Leu Asn Thr Pro Met Pro
1175 1180 1185

Ser Arg Pro His Thr Pro Gly Pro Glu Asp Val Ser His Val Gln
1190 1195 1200

Gln Leu Pro Thr Pro Ser Ala Ser Asp Asp Lys Gly Val Thr Ala
1205 1210 1215

Gln Gly Tyr Val Val Glu Ala Lys
1220 1225

<210> 109
<211> 2667
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence: Synthetic polynucleotide

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aacaagattt gtggttgga ttatgagtgt cctaagctgg aagaggatgt gttgagttca 180
gacatcatca tacttactat aacaagatgc attgcaatat tgtatatcta cttccaattt 240
caaaacctta gacaattggg tagtaaatac atcctaggca tcgccggatt gttcactatt 300
ttctctagtt ttgttttctc aaccgtcggt attcactttt tggacaaaga gttaactggt 360
ttgaacgaag ctctaccatt cttcttgctg ctggtagatt tgtccagagc ttccgcttta 420

SeqLst

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gtgttagaag	aggaggaaaa	caaaccta	cctgtcacac	agagagtga	aatgatcatg	780
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gaacaagtga	taacgttgtc	tttggcttta	ttgttagccg	ttaagtacat	tttctttgag	1020
caagccgaaa	cggaatctac	attatcactg	aaaaacccaa	ttacatcccc	agtcggtacc	1080
cagaaaaaga	taactgatga	ttgctgtaga	agagatccag	tgttgggtcag	gaatgatcaa	1140
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gaaccaagac	caaatgagga	atgtttgcaa	atactagaga	acgctgaaaa	gggagccaag	1380
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gcctttgatt	ccacatcaag	ggtggccaga	ttacaaaaac	tacacatgtc	tgctgctggg	1920
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tcaaaagggg	cagaaaaggc	tttgtcaaag	ctgcaggagt	atttcccaga	gatgcaaatc	2040
ttggccgtat	ctggcaacta	ttgcacagac	aaaaagcctg	ccgccatcaa	ctggattgaa	2100
ggaagaggca	aatctgtggt	ttgtgaagct	gtaattccag	ccaaagtgtg	tagagaagtg	2160
ttaaagacca	caacagaagc	tatgattgaa	gtaaacataa	acaaaaactt	agtaggggtct	2220
gccatggctg	gttcaattgg	aggatacaac	gctcatgctg	ccaatattgt	aaccgctatc	2280

SeqLst

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gaaatagggga ctgtggggagg aggaactaac	ttactttccac agcaagcctg cttacaaatg	2460
ctgggtgtac aaggagcctg tagagataat	ccagggggaga acgctagaca acttgccaga	2520
attgtttgtg ggacagttat ggctggtgaa	cttagtctaa tggcagcttt ggctgctggg	2580
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 <211> 888
 <212> PRT
 <213> Bos taurus

<400> 110
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Ser Met Asn Met Phe Thr Gly Asn Asn Lys Ile Cys Gly Trp Asn Tyr
 35 40 45

Glu Cys Pro Lys Leu Glu Glu Asp Val Leu Ser Ser Asp Ile Ile Ile
 50 55 60

Leu Thr Ile Thr Arg Cys Ile Ala Ile Leu Tyr Ile Tyr Phe Gln Phe
 65 70 75 80

Gln Asn Leu Arg Gln Leu Gly Ser Lys Tyr Ile Leu Gly Ile Ala Gly
 85 90 95

Leu Phe Thr Ile Phe Ser Ser Phe Val Phe Ser Thr Val Val Ile His
 100 105 110

Phe Leu Asp Lys Glu Leu Thr Gly Leu Asn Glu Ala Leu Pro Phe Phe
 115 120 125

Leu Leu Leu Val Asp Leu Ser Arg Ala Ser Ala Leu Ala Lys Phe Ala
 130 135 140

Leu Ser Ser Asn Ser Gln Asp Glu Val Arg Glu Asn Ile Ala Arg Gly
 145 150 155 160

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

SeqLst

Leu Val Ile Gly Val Gly Thr Met Ser Gly Val Arg Gln Leu Glu Ile
 180 185 190
 Met Cys Cys Phe Gly Cys Met Ser Val Leu Ala Asn Tyr Phe Val Phe
 195 200 205
 Met Thr Phe Phe Pro Ala Cys Val Ser Leu Val Leu Glu Leu Ser Arg
 210 215 220
 Glu Ser Arg Glu Gly Arg Pro Ile Trp Gln Leu Ser His Phe Ala Arg
 225 230 235 240
 Val Leu Glu Glu Glu Glu Asn Lys Pro Asn Pro Val Thr Gln Arg Val
 245 250 255
 Lys Met Ile Met Ser Leu Gly Leu Val Leu Val His Ala His Ser Arg
 260 265 270
 Trp Ile Ala Asp Pro Ser Pro Gln Asn Ser Thr Ala Asp Asn Ser Lys
 275 280 285
 Val Ser Leu Gly Leu Asp Glu Asn Val Ser Lys Arg Ile Glu Pro Ser
 290 295 300
 Val Ser Leu Trp Gln Phe Tyr Leu Ser Lys Met Ile Ser Met Asp Ile
 305 310 315 320
 Glu Gln Val Ile Thr Leu Ser Leu Ala Leu Leu Leu Ala Val Lys Tyr
 325 330 335
 Ile Phe Phe Glu Gln Ala Glu Thr Glu Ser Thr Leu Ser Leu Lys Asn
 340 345 350
 Pro Ile Thr Ser Pro Val Val Thr Gln Lys Lys Ile Thr Asp Asp Cys
 355 360 365
 Cys Arg Arg Asp Pro Val Leu Val Arg Asn Asp Gln Lys Phe His Ala
 370 375 380
 Met Glu Glu Glu Thr Arg Lys Asn Arg Glu Arg Lys Val Glu Val Ile
 385 390 395 400
 Lys Pro Leu Leu Ala Glu Asn Asp Thr Ser His Arg Ala Thr Phe Val
 405 410 415
 Val Gly Asn Ser Ser Leu Leu Gly Thr Ser Leu Glu Leu Glu Thr Gln

															SeqLst															
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Leu	Gln	Ile	Leu	Glu	Asn	Ala	Glu	Lys	Gly	Ala	Lys	Phe	Leu	Ser	Asp															
	450					455					460																			
Ala	Glu	Ile	Ile	Gln	Leu	Val	Asn	Ala	Lys	His	Ile	Pro	Ala	Tyr	Lys															
465					470					475					480															
Leu	Glu	Thr	Leu	Met	Glu	Thr	His	Glu	Arg	Gly	Val	Ser	Ile	Arg	Arg															
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Gln	Leu	Leu	Ser	Lys	Lys	Leu	Pro	Glu	Pro	Ser	Ser	Leu	Gln	Tyr	Leu															
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Pro	Tyr	Arg	Asp	Tyr	Asn	Tyr	Ser	Leu	Val	Met	Gly	Ala	Cys	Cys	Glu															
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Asn	Val	Ile	Gly	Tyr	Met	Pro	Ile	Pro	Val	Gly	Val	Ala	Gly	Pro	Leu															
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Cys	Leu	Asp	Gly	Lys	Glu	Phe	Gln	Val	Pro	Met	Ala	Thr	Thr	Glu	Gly															
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Cys	Leu	Val	Ala	Ser	Thr	Asn	Arg	Gly	Cys	Arg	Ala	Ile	Gly	Leu	Gly															
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Gly	Gly	Ala	Ser	Ser	Arg	Val	Leu	Ala	Asp	Gly	Met	Thr	Arg	Gly	Pro															
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Val	Val	Arg	Phe	Pro	Arg	Ala	Cys	Asp	Ser	Ala	Glu	Val	Lys	Ala	Trp															
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Leu	Glu	Thr	Pro	Glu	Gly	Phe	Thr	Val	Ile	Lys	Glu	Ala	Phe	Asp	Ser															
	610					615					620																			
Thr	Ser	Arg	Val	Ala	Arg	Leu	Gln	Lys	Leu	His	Met	Ser	Val	Ala	Gly															
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Arg	Asn	Leu	Tyr	Ile	Arg	Phe	Gln	Ser	Arg	Ser	Gly	Asp	Ala	Met	Gly															
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Met	Asn	Met	Ile	Ser	Lys	Gly	Thr	Glu	Lys	Ala	Leu	Ser	Lys	Leu	Gln															
			660					665					670																	

SeqLst

Glu Tyr Phe Pro Glu Met Gln Ile Leu Ala Val Ser Gly Asn Tyr Cys
675 680 685

Thr Asp Lys Lys Pro Ala Ala Ile Asn Trp Ile Glu Gly Arg Gly Lys
690 695 700

Ser Val Val Cys Glu Ala Val Ile Pro Ala Lys Val Val Arg Glu Val
705 710 715 720

Leu Lys Thr Thr Thr Glu Ala Met Ile Glu Val Asn Ile Asn Lys Asn
725 730 735

Leu Val Gly Ser Ala Met Ala Gly Ser Ile Gly Gly Tyr Asn Ala His
740 745 750

Ala Ala Asn Ile Val Thr Ala Ile Tyr Ile Ala Cys Gly Gln Asp Ala
755 760 765

Ala Gln Asn Val Gly Ser Ser Asn Cys Ile Thr Leu Met Glu Ala Ser
770 775 780

Gly Pro Thr Asn Glu Asp Leu Tyr Ile Ser Cys Thr Met Pro Ser Ile
785 790 795 800

Glu Ile Gly Thr Val Gly Gly Gly Thr Asn Leu Leu Pro Gln Gln Ala
805 810 815

Cys Leu Gln Met Leu Gly Val Gln Gly Ala Cys Arg Asp Asn Pro Gly
820 825 830

Glu Asn Ala Arg Gln Leu Ala Arg Ile Val Cys Gly Thr Val Met Ala
835 840 845

Gly Glu Leu Ser Leu Met Ala Ala Leu Ala Ala Gly His Leu Val Arg
850 855 860

Ser His Met Ile His Asn Arg Ser Lys Ile Asn Leu Gln Asp Leu Gln
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Gly Thr Cys Thr Lys Lys Ala Ala
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<210> 111
<211> 1704
<212> DNA
<213> Artificial sequence

<220>
<223> Description of Artificial sequence: Synthetic

SeqLst

polynucleotide

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<210> 112

SeqLst

<211> 567

<212> PRT

<213> Artemisia annua

<400> 112

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Ala Ser Asp Ala Leu Pro Leu Pro Leu Tyr Leu Thr Asn Thr Phe Phe
 35 40 45

Phe Thr Leu Phe Phe Ser Val Ala Tyr Tyr Leu Leu His Arg Trp Arg
 50 55 60

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

Leu Ser Ala Ile Val Leu Leu Ile Ala Ser Phe Ile Tyr Leu Leu Gly
 85 90 95

Phe Phe Gly Ile Asp Phe Val Gln Ser Phe Thr Ser Arg Glu Asn Glu
 100 105 110

Gln Leu Asn Asn Asp Asp His Asn Val Val Ser Thr Asn Asn Val Leu
 115 120 125

Ser Asp Arg Arg Leu Val Tyr Asp Tyr Gly Phe Asp Val Thr Gly Asp
 130 135 140

Asn Asp Asn Asp Asn Asp Asp Val Ile Val Lys Ser Val Val Ser
 145 150 155 160

Gly Glu Val Asn Ser Tyr Ser Leu Glu Ala Ser Leu Gly Asp Cys Tyr
 165 170 175

Arg Ala Ala Lys Ile Arg Lys Arg Ala Val Glu Arg Ile Val Gly Arg
 180 185 190

Glu Val Leu Gly Leu Gly Phe Glu Gly Phe Asp Tyr Glu Ser Ile Leu
 195 200 205

Gly Gln Cys Cys Glu Met Pro Ile Gly Tyr Val Gln Val Pro Val Gly
 210 215 220

Val Ala Gly Pro Leu Leu Leu Asn Gly Gly Glu Phe Met Val Pro Met
 225 230 235 240

SeqLst

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

SeqLst

				485					490						495
Ser	Gln	Ser	Ala 500	Cys	Leu	Asn	Leu	Leu 505	Gly	Val	Lys	Gly	Ala 510	Cys	Ile
Glu	Ser	Pro 515	Gly	Ser	Asn	Ala	Gln 520	Leu	Leu	Ala	Arg	Ile 525	Val	Ala	Gly
Ser	Val 530	Leu	Ala	Gly	Glu	Leu 535	Ser	Leu	Met	Ser	Ala 540	Ile	Ser	Ala	Gly
Gln 545	Leu	Val	Lys	Ser	His 550	Met	Lys	Tyr	Asn	Arg 555	Ser	Ser	Arg	Asp	Met 560
Ser	Ala	Ile	Ala	Ser 565	Lys	Val									

SeqLst

```

cttgttgggt cagctatggc tggttctggt ggaggtttta acgcccaggc tgcaaacgct      960
gtggcagcca ttttcattgc aaccggtcaa gatcctgctc aagtggtaga aagttcaatg      1020
tgtatcacta caatgtccaa ggtaggtaac gatctattga tctctgtgac catgccttct      1080
atcgaggtcg gggtcgtggg aggagggact ggtcttgctg cccaaagagg atgcttagag      1140
ttaatagggg gcggaggccc atctaaggag tctcctggta ctaatgccc acttctaagt      1200
agagttgttg cagctggcgt tttatcagcc gaactttcct tgatgtccgg actggcagca      1260
ggtcacatctat tgtcagcaca tatgagattg aacagaaaga agaaataa      1308

```

<210> 114
 <211> 435
 <212> PRT
 <213> Trypanosoma cruzi

<400> 114
 Met Phe Arg Arg Ala Ile Leu Leu Gly Cys Ser Ala Ala Lys Thr Pro
 1 5 10 15

Trp Ser Glu Cys Ser Asn Ala Gln Leu Val Asp Ala Val Lys Ser Arg
 20 25 30

Lys Ile Ser Phe Tyr Gly Leu Glu Gln Ala Leu Glu Pro Asp Tyr Arg
 35 40 45

Arg Ala Ile Glu Val Arg Arg Glu Val Val Ser Glu Ile Ala Ser Gln
 50 55 60

Gln Pro Glu Ala Lys Lys Lys Gln Ser Ala Leu His Thr Ile Pro Phe
 65 70 75 80

Glu Asn Tyr Asp Trp Asn Lys Val Val Gly Gln Asn Cys Glu Asn Ile
 85 90 95

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

Asp Gly Lys Glu Tyr Pro Ile Pro Met Ala Thr Thr Glu Gly Ala Leu
 115 120 125

Val Ala Ser Thr His Arg Gly Ala Arg Ala Ile Thr Arg Ser Gly Gly
 130 135 140

Cys Lys Thr Leu Leu Leu Gly Glu Gly Met Thr Arg Ala Pro Val Val
 145 150 155 160

Glu Leu Pro Ser Leu Glu Glu Ala Gly Arg Leu His Lys Tyr Cys Asn
 165 170 175

SeqLst

Glu Asn Phe Leu Ser Leu Lys Glu Ala Phe Glu Ser Thr Thr Gln Tyr
 180 185 190
 Gly Lys Leu Asn Ser Leu Lys Cys Val Leu Ala Gly Arg Lys Ala Tyr
 195 200 205
 Leu Arg Phe Arg Ala Thr Thr Gly Asp Ala Met Gly Met Asn Met Ile
 210 215 220
 Thr Lys Gly Val Asp Lys Ala Leu Ser Val Leu Gln Gln His Phe Pro
 225 230 235 240
 Ser Met Glu Ile Leu Ala Leu Ser Gly Asn Tyr Cys Thr Asp Lys Lys
 245 250 255
 Pro Ser Ala Val Asn Trp Ile Asp Gly Arg Gly Lys Ser Val Val Ala
 260 265 270
 Glu Ala Thr Leu Leu Ala Asp Val Val Glu Asp Thr Leu Lys Cys Thr
 275 280 285
 Val Asp Ser Leu Val Ser Leu Asn Ile Asp Lys Asn Leu Val Gly Ser
 290 295 300
 Ala Met Ala Gly Ser Val Gly Gly Phe Asn Ala Gln Ala Ala Asn Ala
 305 310 315 320
 Val Ala Ala Ile Phe Ile Ala Thr Gly Gln Asp Pro Ala Gln Val Val
 325 330 335
 Glu Ser Ser Met Cys Ile Thr Thr Met Ser Lys Val Gly Asn Asp Leu
 340 345 350
 Leu Ile Ser Val Thr Met Pro Ser Ile Glu Val Gly Val Val Gly Gly
 355 360 365
 Gly Thr Gly Leu Ala Ala Gln Arg Gly Cys Leu Glu Leu Ile Gly Cys
 370 375 380
 Gly Gly Pro Ser Lys Glu Ser Pro Gly Thr Asn Ala Gln Leu Leu Ser
 385 390 395 400
 Arg Val Val Ala Ala Gly Val Leu Ser Ala Glu Leu Ser Leu Met Ser
 405 410 415
 Gly Leu Ala Ala Gly His Leu Leu Ser Ala His Met Arg Leu Asn Arg

Lys Lys Lys
435

<210> 115
<211> 1281
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence: Synthetic polynucleotide

```
<400> 115
atgcaatccc tggacaaaaa ctttagacac ttatcaagac aacagaagtt acaacagcta      60
gttgataaac aatggctatc agaggaacaa ttcaatattc tacttaacca cccacttatt      120
gatgaagagg tagcaaactc attgatagaa aatgtcatcg cacagggcgc actgcctggt      180
ggtttactac caaatatcat cgttgatgac aaagcatacg tcgtgcctat gatggtggaa      240
gagccatctg ttgttgccgc tgcttcatac ggcgctaaat tggngaacca aacagggtgg      300
ttcaaaaccg tgtcctcaga acgtatcatg ataggtcaaa tagtatttga tggagtcgat      360
gataccgaga aactgtctgc agatatcaag gctcttgaaa aacaaatcca tcagattgca      420
gatgaggctt acccttctat taaggccaga ggtggaggct atcaaaggat cgccatcgat      480
acattcccag aacaacagtt gctttcattg aagggttttcg ttgatactaa ggatgctatg      540
ggcgctaata tgtaaacac aatcctagaa gcaatcacag cttttttgaa aaacgaattc      600
ccacaatctg atatcttgat gtctatcctt tccaaccacg caacagccag tgttgtcaag      660
gtccaggggtg aaatagacgt taaggatttg gcaagaggag aacgtactgg agaagagggtc      720
gctaagagaa tggaaagagc atctgtgtta gctcaagtgg acattcatag agcagcaaca      780
cacaataagg gtgttatgaa tggcattcat gctgtagtct tggctacagg taatgatact      840
agagggtgcag aagcctctgc tcacgcttac gcttccaaag acggtcaata tagagggata      900
gctacatgga gatacgatca agagagacaa aggttaatag gaactataga agttccaatg      960
actctggcca ttgttggtgg cggtaccaag gtactgccta ttgctaaggc ctcttttagaa     1020
ctgttaaacc tagaaagtgc ccaagagttg ggacatgttg tcgctgccgt tggactagct     1080
caaaacttcg ctgcatgtag agctttgggt tccgaaggta ttcaacaagg gcatatgtct     1140
ttgcaataca agtcttttagc catcgtagtc ggggctaagg gcgatgaaat tgctcaggta     1200
gccgaagcac taaagcaaga gccaaagagc aacactcaag ttgcagagag aattttgcaa     1260
gatttgagaa gtcaacaata a                                     1281
```

<210> 116

SeqLst

<211> 426

<212> PRT

<213> Staphylococcus aureus

<400> 116

Met Gln Ser Leu Asp Lys Asn Phe Arg His Leu Ser Arg Gln Gln Lys
 1 5 10 15

Leu Gln Gln Leu Val Asp Lys Gln Trp Leu Ser Glu Glu Gln Phe Asn
 20 25 30

Ile Leu Leu Asn His Pro Leu Ile Asp Glu Glu Val Ala Asn Ser Leu
 35 40 45

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

Asn Ile Ile Val Asp Asp Lys Ala Tyr Val Val Pro Met Met Val Glu
 65 70 75 80

Glu Pro Ser Val Val Ala Ala Ala Ser Tyr Gly Ala Lys Leu Val Asn
 85 90 95

Gln Thr Gly Gly Phe Lys Thr Val Ser Ser Glu Arg Ile Met Ile Gly
 100 105 110

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

Ile Lys Ala Leu Glu Lys Gln Ile His Gln Ile Ala Asp Glu Ala Tyr
 130 135 140

Pro Ser Ile Lys Ala Arg Gly Gly Gly Tyr Gln Arg Ile Ala Ile Asp
 145 150 155 160

Thr Phe Pro Glu Gln Gln Leu Leu Ser Leu Lys Val Phe Val Asp Thr
 165 170 175

Lys Asp Ala Met Gly Ala Asn Met Leu Asn Thr Ile Leu Glu Ala Ile
 180 185 190

Thr Ala Phe Leu Lys Asn Glu Phe Pro Gln Ser Asp Ile Leu Met Ser
 195 200 205

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

Ile Asp Val Lys Asp Leu Ala Arg Gly Glu Arg Thr Gly Glu Glu Val
 225 230 235 240

SeqLst

Ala Lys Arg Met Glu Arg Ala Ser Val Leu Ala Gln Val Asp Ile His
 245 250 255

Arg Ala Ala Thr His Asn Lys Gly Val Met Asn Gly Ile His Ala Val
 260 265 270

Val Leu Ala Thr Gly Asn Asp Thr Arg Gly Ala Glu Ala Ser Ala His
 275 280 285

Ala Tyr Ala Ser Lys Asp Gly Gln Tyr Arg Gly Ile Ala Thr Trp Arg
 290 295 300

Tyr Asp Gln Glu Arg Gln Arg Leu Ile Gly Thr Ile Glu Val Pro Met
 305 310 315 320

Thr Leu Ala Ile Val Gly Gly Gly Thr Lys Val Leu Pro Ile Ala Lys
 325 330 335

Ala Ser Leu Glu Leu Leu Asn Val Glu Ser Ala Gln Glu Leu Gly His
 340 345 350

Val Val Ala Ala Val Gly Leu Ala Gln Asn Phe Ala Ala Cys Arg Ala
 355 360 365

Leu Val Ser Glu Gly Ile Gln Gln Gly His Met Ser Leu Gln Tyr Lys
 370 375 380

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

Ala Glu Ala Leu Lys Gln Glu Pro Arg Ala Asn Thr Gln Val Ala Glu
 405 410 415

Arg Ile Leu Gln Asp Leu Arg Ser Gln Gln
 420 425

<210> 117

<211> 1311

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 117

atgcaggctt taagattgga taggagacat tacaaaagtg gcaagattag aagagcaatg 60

agttctagaa ttcttggttt ctacaaattg tcagtcgagg aaagactgaa aaaggttgct 120

SeqLst

```

gaatttgcag ggttatctga tgaggaagtg aaagctgttt tgtcacaagg tttacctttg      180
gacgtagctg atagaatgat cgaaaatgtg atcgggtacat ttgaattacc acttggtata      240
gcaaccaatt tccttattga tggcaaggat tatctaattcc ctatggctat agaggaacca      300
tcagtagttg cagctgcttc taacgcagct agaatggcca gagagtctgg cggggtttaca      360
actgattaca caggggtccct gatgattggg caaattcaag tcacaaaact gttgaatcca      420
aatgcagcta agttcgaagt tctacgtcaa aaagacgaaa tcatagaaag agcaaattgag      480
tgtgatccaa tgttggtgaa tttgggcggg ggatgtaaag atatagaagc aaggggtgatc      540
gatacaatca tgggtaagat gctaattggt catctgatcg ttgatgttaa agacgctatg      600
ggtgcaaatt ctgtcaacac tatgtgtgaa aaagttgctc ctttcacgga acgtattact      660
gggggaaagg tctatcttag aatcatttcc aacttggtcg catatagact tgctagagca      720
aaggccgttt ttgacaaaga cgttattggc ggagaggagg ttgtagaagg gatcatgctt      780
gcatacgctt tcgctgccgc tgacccattt cgttgcgcca cccacaataa gggatatcatg      840
aatggcatat cagccttaat gatcgctaca ggaaacgact ttagagccat tgaagcagga      900
gctcattcct atgctgcaat aggtggatag aaaccactaa ctacctacga agttgataga      960
aaaggtaatc tagtaggcac aattgaaata cctatggcag taggcgtgat tgggtggtgca     1020
accaaagtca acccactagc caagatctct cttagatagc taggagtga cactgctgaa     1080
gagttagcca gagtcgcagc cgctctaggt ttggctcaaa actttgctgc cttagagacc     1140
ttggccacag aaggtatcca aagaggtcac atggaattac atgccaggaa cttagcaatc     1200
atggctggag ctactggaga tgaggttgac agagttgtag agattatggg gagagatggc     1260
aaaatcagat tggactacgc taaggaagta ttggagagac tgcgttccta a              1311

```

<210> 118

<211> 436

<212> PRT

<213> Archaeoglobus fulgidus

<400> 118

```

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

```

```

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

```

```

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

```

```

Glu Val Lys Ala Val Leu Ser Gln Gly Leu Pro Leu Asp Val Ala Asp
          50          55          60

```

SeqLst

Arg Met Ile Glu Asn Val Ile Gly Thr Phe Glu Leu Pro Leu Gly Ile
 65 70 75 80
 Ala Thr Asn Phe Leu Ile Asp Gly Lys Asp Tyr Leu Ile Pro Met Ala
 85 90 95
 Ile Glu Glu Pro Ser Val Val Ala Ala Ala Ser Asn Ala Ala Arg Met
 100 105 110
 Ala Arg Glu Ser Gly Gly Phe Thr Thr Asp Tyr Thr Gly Ser Leu Met
 115 120 125
 Ile Gly Gln Ile Gln Val Thr Lys Leu Leu Asn Pro Asn Ala Ala Lys
 130 135 140
 Phe Glu Val Leu Arg Gln Lys Asp Glu Ile Ile Glu Arg Ala Asn Glu
 145 150 155 160
 Cys Asp Pro Met Leu Val Asn Leu Gly Gly Gly Cys Lys Asp Ile Glu
 165 170 175
 Ala Arg Val Ile Asp Thr Ile Met Gly Lys Met Leu Ile Val His Leu
 180 185 190
 Ile Val Asp Val Lys Asp Ala Met Gly Ala Asn Ala Val Asn Thr Met
 195 200 205
 Cys Glu Lys Val Ala Pro Phe Ile Glu Arg Ile Thr Gly Gly Lys Val
 210 215 220
 Tyr Leu Arg Ile Ile Ser Asn Leu Ala Ala Tyr Arg Leu Ala Arg Ala
 225 230 235 240
 Lys Ala Val Phe Asp Lys Asp Val Ile Gly Gly Glu Glu Val Val Glu
 245 250 255
 Gly Ile Met Leu Ala Tyr Ala Phe Ala Ala Ala Asp Pro Phe Arg Cys
 260 265 270
 Ala Thr His Asn Lys Gly Ile Met Asn Gly Ile Ser Ala Leu Met Ile
 275 280 285
 Ala Thr Gly Asn Asp Phe Arg Ala Ile Glu Ala Gly Ala His Ser Tyr
 290 295 300
 Ala Ala Ile Gly Gly Tyr Lys Pro Leu Thr Thr Tyr Glu Val Asp Arg
 305 310 315 320

SeqLst

Lys Gly Asn Leu Val Gly Thr Ile Glu Ile Pro Met Ala Val Gly Val
325 330 335

Ile Gly Gly Ala Thr Lys Val Asn Pro Leu Ala Lys Ile Ser Leu Lys
340 345 350

Ile Leu Gly Val Asn Thr Ala Glu Glu Leu Ala Arg Val Ala Ala Ala
355 360 365

Leu Gly Leu Ala Gln Asn Phe Ala Ala Leu Arg Ala Leu Ala Thr Glu
370 375 380

Gly Ile Gln Arg Gly His Met Glu Leu His Ala Arg Asn Leu Ala Ile
385 390 395 400

Met Ala Gly Ala Thr Gly Asp Glu Val Asp Arg Val Val Glu Ile Met
405 410 415

Val Arg Asp Gly Lys Ile Arg Leu Asp Tyr Ala Lys Glu Val Leu Glu
420 425 430

Arg Leu Arg Ser
435

<210> 119

<211> 1287

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence: Synthetic polynucleotide

<400> 119

atgtccttag attcaagact gccagctttc agaaatctgt ctccagctgc aagactagat	60
cacattggcc aacttttggg actaagtcac gacgacgttt cctttttagc aaacgccggt	120
gctttaccaa tggatatcgc taatggtatg attgaaaatg taatcgggac ctttgaactg	180
ccatatgcag tggccagtaa ctttcagatc aatggccgtg acgtcttagt accattagtt	240
gtggaggaac ctagtatcgt tgctgcagcc tcttacatgg caaagtttagc tagagccaat	300
gggtgggttca ctacatcttc atctgctcca ctaatgcatg cacaagtaca aattgtcggc	360
attcaggatc cactaaacgc aagattgtct ttactgcgta gaaaggatga gatcatagaa	420
ttagccaata ggaaggacca acttctgaat tcattgggcg gtggttgtag agacatagag	480
gtgcatacat ttgccgatac tccaagagga ccaatgcttg tagcacacct tattgtcgat	540
gtgcgtgatg ccatgggagc taatactggt aacactatgg ctgaagcagt agcacctctg	600

SeqLst

```

atggaagcca taacaggtgg ccaggtaaga ttgagaatcc tttccaattt ggctgatctt      660
agattggcca gagcccaagt gagaatcact cctcagcaat tggaaactgc cgaattctca      720
ggtgaggcag taattgaggg tatcttggac gcatatgctt ttgccgctgt ggacccttac      780
agagccgcta cccacaacaa aggcataatg aacggtatcg atcctttgat cgtcgctaca      840
ggaaatgatt ggagagctgt tgaggcagga gctcatgcat acgctttag atccggacat      900
tacggttcat taacaacatg ggaaaaagat aacaatggac acttggtcgg gacattggaa      960
atgcctatgc cagttgggtt agttgggggt gctacaaaaa cccatcctct tgctcaattg     1020
tctttgagga tacttggtgt caaaactgct caagcactag ccgaaattgc cgttgctggt     1080
ggtttggcac aaaacttggg tgcaatgcgt gctttagcta cagaaggcat ccaaagagga     1140
catatggctc tacacgctag aaacattgca gttgttgtag gagccagagg tgatgagggt     1200
gattgggtgg ctagacaact tgtcgaatat catgatgtca gagcagacag ggctgtggca     1260
ttactgaaac agaagagagg tcaataa                                     1287

```

<210> 120

<211> 428

<212> PRT

<213> Pseudomonas mevalonii

<400> 120

```

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

```

```

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

```

```

Val Ser Leu Leu Ala Asn Ala Gly Ala Leu Pro Met Asp Ile Ala Asn
          35           40           45

```

```

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

```

```

Ala Ser Asn Phe Gln Ile Asn Gly Arg Asp Val Leu Val Pro Leu Val
65           70           75           80

```

```

Val Glu Glu Pro Ser Ile Val Ala Ala Ala Ser Tyr Met Ala Lys Leu
          85           90           95

```

```

Ala Arg Ala Asn Gly Gly Phe Thr Thr Ser Ser Ser Ala Pro Leu Met
100           105           110

```

```

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

```

SeqLst

Leu Ser Leu Leu Arg Arg Lys Asp Glu Ile Ile Glu Leu Ala Asn Arg
 130 135 140
 Lys Asp Gln Leu Leu Asn Ser Leu Gly Gly Gly Cys Arg Asp Ile Glu
 145 150 155 160
 Val His Thr Phe Ala Asp Thr Pro Arg Gly Pro Met Leu Val Ala His
 165 170 175
 Leu Ile Val Asp Val Arg Asp Ala Met Gly Ala Asn Thr Val Asn Thr
 180 185 190
 Met Ala Glu Ala Val Ala Pro Leu Met Glu Ala Ile Thr Gly Gly Gln
 195 200 205
 Val Arg Leu Arg Ile Leu Ser Asn Leu Ala Asp Leu Arg Leu Ala Arg
 210 215 220
 Ala Gln Val Arg Ile Thr Pro Gln Gln Leu Glu Thr Ala Glu Phe Ser
 225 230 235 240
 Gly Glu Ala Val Ile Glu Gly Ile Leu Asp Ala Tyr Ala Phe Ala Ala
 245 250 255
 Val Asp Pro Tyr Arg Ala Ala Thr His Asn Lys Gly Ile Met Asn Gly
 260 265 270
 Ile Asp Pro Leu Ile Val Ala Thr Gly Asn Asp Trp Arg Ala Val Glu
 275 280 285
 Ala Gly Ala His Ala Tyr Ala Cys Arg Ser Gly His Tyr Gly Ser Leu
 290 295 300
 Thr Thr Trp Glu Lys Asp Asn Asn Gly His Leu Val Gly Thr Leu Glu
 305 310 315 320
 Met Pro Met Pro Val Gly Leu Val Gly Gly Ala Thr Lys Thr His Pro
 325 330 335
 Leu Ala Gln Leu Ser Leu Arg Ile Leu Gly Val Lys Thr Ala Gln Ala
 340 345 350
 Leu Ala Glu Ile Ala Val Ala Val Gly Leu Ala Gln Asn Leu Gly Ala
 355 360 365
 Met Arg Ala Leu Ala Thr Glu Gly Ile Gln Arg Gly His Met Ala Leu
 370 375 380

SeqLst

His Ala Arg Asn Ile Ala Val Val Ala Gly Ala Arg Gly Asp Glu Val
 385 390 395 400

Asp Trp Val Ala Arg Gln Leu Val Glu Tyr His Asp Val Arg Ala Asp
 405 410 415

Arg Ala Val Ala Leu Leu Lys Gln Lys Arg Gly Gln
 420 425

<210> 121

<211> 361

<212> PRT

<213> Stevia rebaudiana

<400> 121

Met Ala Leu Val Asn Pro Thr Ala Leu Phe Tyr Gly Thr Ser Ile Arg
 1 5 10 15

Thr Arg Pro Thr Asn Leu Leu Asn Pro Thr Gln Lys Leu Arg Pro Val
 20 25 30

Ser Ser Ser Ser Leu Pro Ser Phe Ser Ser Val Ser Ala Ile Leu Thr
 35 40 45

Glu Lys His Gln Ser Asn Pro Ser Glu Asn Asn Asn Leu Gln Thr His
 50 55 60

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

Met Val Asn Glu Ala Leu Asp Ala Ser Val Pro Leu Lys Asp Pro Ile
 85 90 95

Lys Ile His Glu Ser Met Arg Tyr Ser Leu Leu Ala Gly Gly Lys Arg
 100 105 110

Ile Arg Pro Met Met Cys Ile Ala Ala Cys Glu Ile Val Gly Gly Asn
 115 120 125

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

Met Ser Leu Val His Asp Asp Leu Pro Cys Met Asp Asn Asp Asp Phe
 145 150 155 160

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

SeqLst

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

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

Glu Leu Ala Arg Ser Val Gly Ser Glu Gly Leu Val Ala Gly Gln Val
210 215 220

Val Asp Ile Leu Ser Glu Gly Ala Asp Val Gly Leu Asp His Leu Glu
225 230 235 240

Tyr Ile His Ile His Lys Thr Ala Met Leu Leu Glu Ser Ser Val Val
245 250 255

Ile Gly Ala Ile Met Gly Gly Gly Ser Asp Gln Gln Ile Glu Lys Leu
260 265 270

Arg Lys Phe Ala Arg Ser Ile Gly Leu Leu Phe Gln Val Val Asp Asp
275 280 285

Ile Leu Asp Val Thr Lys Ser Thr Glu Glu Leu Gly Lys Thr Ala Gly
290 295 300

Lys Asp Leu Leu Thr Asp Lys Thr Thr Tyr Pro Lys Leu Leu Gly Ile
305 310 315 320

Glu Lys Ser Arg Glu Phe Ala Glu Lys Leu Asn Lys Glu Ala Gln Glu
325 330 335

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

Ala Asn Tyr Asn Ala Tyr Arg Gln Asn
355 360

<210> 122

<211> 342

<212> PRT

<213> Gibberella fujikuroi

<400> 122

Met Ala Glu Gln Gln Ile Ser Asn Leu Leu Ser Met Phe Asp Ala Ser
1 5 10 15

His Ala Ser Gln Lys Leu Glu Ile Thr Val Gln Met Met Asp Thr Tyr
20 25 30

SeqLst

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

Leu Ser Arg Tyr Asp Glu Arg Arg Val Ser Leu Pro Leu Ser His Asn
50 55 60

Ala Ala Ser Pro Asp Ile Val Ser Gln Leu Cys Phe Ser Thr Ala Met
65 70 75 80

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

Asp Ser Pro Tyr Asn Tyr Ile Leu Thr Leu Pro Ser Lys Gly Ile Arg
100 105 110

Gly Ala Phe Ile Asp Ser Leu Asn Val Trp Leu Glu Val Pro Glu Asp
115 120 125

Glu Thr Ser Val Ile Lys Glu Val Ile Gly Met Leu His Asn Ser Ser
130 135 140

Leu Ile Ile Asp Asp Phe Gln Asp Asn Ser Pro Leu Arg Arg Gly Lys
145 150 155 160

Pro Ser Thr His Thr Val Phe Gly Pro Ala Gln Ala Ile Asn Thr Ala
165 170 175

Thr Tyr Val Ile Val Lys Ala Ile Glu Lys Ile Gln Asp Ile Val Gly
180 185 190

His Asp Ala Leu Ala Asp Val Thr Gly Thr Ile Thr Thr Ile Phe Gln
195 200 205

Gly Gln Ala Met Asp Leu Trp Trp Thr Ala Asn Ala Ile Val Pro Ser
210 215 220

Ile Gln Glu Tyr Leu Leu Met Val Asn Asp Lys Thr Gly Ala Leu Phe
225 230 235 240

Arg Leu Ser Leu Glu Leu Leu Ala Leu Asn Ser Glu Ala Ser Ile Ser
245 250 255

Asp Ser Ala Leu Glu Ser Leu Ser Ser Ala Val Ser Leu Leu Gly Gln
260 265 270

Tyr Phe Gln Ile Arg Asp Asp Tyr Met Asn Leu Ile Asp Asn Lys Tyr
275 280 285

SeqLst

Thr Asp Gln Lys Gly Phe Cys Glu Asp Leu Asp Glu Gly Lys Tyr Ser
 290 295 300

Leu Thr Leu Ile His Ala Leu Gln Thr Asp Ser Ser Asp Leu Leu Thr
 305 310 315 320

Asn Ile Leu Ser Met Arg Arg Val Gln Gly Lys Leu Thr Ala Gln Lys
 325 330 335

Arg Cys Trp Phe Trp Lys
 340

<210> 123

<211> 300

<212> PRT

<213> Mus musculus

<400> 123

Met Glu Lys Thr Lys Glu Lys Ala Glu Arg Ile Leu Leu Glu Pro Tyr
 1 5 10 15

Arg Tyr Leu Leu Gln Leu Pro Gly Lys Gln Val Arg Ser Lys Leu Ser
 20 25 30

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

Ile Ile Glu Val Thr Glu Met Leu His Asn Ala Ser Leu Leu Ile Asp
 50 55 60

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

Ser Ile Tyr Gly Val Pro Ser Val Ile Asn Ser Ala Asn Tyr Val Tyr
 85 90 95

Phe Leu Gly Leu Glu Lys Val Leu Thr Leu Asp His Pro Asp Ala Val
 100 105 110

Lys Leu Phe Thr Arg Gln Leu Leu Glu Leu His Gln Gly Gln Gly Leu
 115 120 125

Asp Ile Tyr Trp Arg Asp Thr Tyr Thr Cys Pro Thr Glu Glu Glu Tyr
 130 135 140

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

SeqLst

Gly Leu Met Gln Leu Phe Ser Asp Tyr Lys Glu Asp Leu Lys Pro Leu
165 170 175

Leu Asp Thr Leu Gly Leu Phe Phe Gln Ile Arg Asp Asp Tyr Ala Asn
180 185 190

Leu His Ser Lys Glu Tyr Ser Glu Asn Lys Ser Phe Cys Glu Asp Leu
195 200 205

Thr Glu Gly Lys Phe Ser Phe Pro Thr Ile His Ala Ile Trp Ser Arg
210 215 220

Pro Glu Ser Thr Gln Val Gln Asn Ile Leu Arg Gln Arg Thr Glu Asn
225 230 235 240

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

Phe Ala Tyr Thr Arg His Thr Leu Arg Glu Leu Glu Ala Lys Ala Tyr
260 265 270

Lys Gln Ile Glu Ala Cys Gly Gly Asn Pro Ser Leu Val Ala Leu Val
275 280 285

Lys His Leu Ser Lys Met Phe Thr Glu Glu Asn Lys
290 295 300

<210> 124
<211> 339
<212> PRT
<213> Thalassiosira pseudonana

<400> 124
Met Ala Arg Phe Tyr Phe Leu Asn Ala Leu Leu Met Val Ile Ser Leu
1 5 10 15

Gln Ser Thr Thr Ala Phe Thr Pro Ala Lys Leu Ala Tyr Pro Thr Thr
20 25 30

Thr Thr Ala Leu Asn Val Ala Ser Ala Glu Thr Ser Phe Ser Leu Asp
35 40 45

Glu Tyr Leu Ala Ser Lys Ile Gly Pro Ile Glu Ser Ala Leu Glu Ala
50 55 60

Ser Val Lys Ser Arg Ile Pro Gln Thr Asp Lys Ile Cys Glu Ser Met
65 70 75 80

Ala Tyr Ser Leu Met Ala Gly Gly Lys Arg Ile Arg Pro Val Leu Cys

SeqLst

Arg Lys Asn

<210> 125

<211> 355

<212> PRT

<213> Streptomyces clavuligerus

<400> 125

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

Asp Arg Val Pro Glu Arg Gln Gly Ala Leu Gly Arg Arg Arg Gly Ala
 20 25 30

Gly Ser Thr Gly Cys Ala Arg Ala Ala Ala Gly Val His Arg Arg Arg
 35 40 45

Gly Gly Gly Glu Ala Asp Pro Ser Ala Ala Val His Arg Gly Trp Gln
 50 55 60

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

Ala Leu Glu Met Phe His Ala Phe Ala Leu Ile His Asp Asp Ile Met
 85 90 95

Asp Asp Ser Ala Thr Arg Arg Gly Ser Pro Thr Val His Arg Ala Leu
 100 105 110

Ala Asp Arg Leu Gly Ala Ala Leu Asp Pro Asp Gln Ala Gly Gln Leu
 115 120 125

Gly Val Ser Thr Ala Ile Leu Val Gly Asp Leu Ala Leu Thr Trp Ser
 130 135 140

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

Leu Pro Leu Val Thr Ala Met Arg Ala Glu Thr Val His Gly Gln Tyr
 165 170 175

Leu Asp Ile Thr Ser Ala Arg Arg Pro Gly Thr Asp Thr Ser Leu Ala
 180 185 190

Leu Arg Ile Ala Arg Tyr Lys Thr Ala Ala Tyr Thr Met Glu Arg Pro
 195 200 205

Leu His Ile Gly Ala Ala Leu Ala Gly Ala Arg Pro Glu Leu Leu Ala

															SeqLst	
210					215					220						
Gly	Leu	Ser	Ala	Tyr	Ala	Leu	Pro	Ala	Gly	Glu	Ala	Phe	Gln	Leu	Ala	
225					230					235					240	
Asp	Asp	Leu	Leu	Gly	Val	Phe	Gly	Asp	Pro	Arg	Arg	Thr	Gly	Lys	Pro	
				245					250					255		
Asp	Leu	Asp	Asp	Leu	Arg	Gly	Gly	Lys	His	Thr	Val	Leu	Val	Ala	Leu	
			260					265					270			
Ala	Arg	Glu	His	Ala	Thr	Pro	Glu	Gln	Arg	His	Thr	Leu	Asp	Thr	Leu	
		275					280					285				
Leu	Gly	Thr	Pro	Gly	Leu	Asp	Arg	Gln	Gly	Ala	Ser	Arg	Leu	Arg	Cys	
	290					295					300					
Val	Leu	Val	Ala	Thr	Gly	Ala	Arg	Ala	Glu	Ala	Glu	Arg	Leu	Ile	Thr	
305					310					315					320	
Glu	Arg	Arg	Asp	Gln	Ala	Leu	Thr	Ala	Leu	Asn	Ala	Leu	Thr	Leu	Pro	
				325					330					335		
Pro	Pro	Leu	Ala	Glu	Ala	Leu	Ala	Arg	Leu	Thr	Leu	Gly	Ser	Thr	Ala	
			340					345					350			
His	Pro	Ala														
		355														

<210> 126
 <211> 330
 <212> PRT
 <213> Sulfolobus acidicaldarius

<400> 126																
Met	Ser	Tyr	Phe	Asp	Asn	Tyr	Phe	Asn	Glu	Ile	Val	Asn	Ser	Val	Asn	
1				5					10					15		
Asp	Ile	Ile	Lys	Ser	Tyr	Ile	Ser	Gly	Asp	Val	Pro	Lys	Leu	Tyr	Glu	
			20					25					30			
Ala	Ser	Tyr	His	Leu	Phe	Thr	Ser	Gly	Gly	Lys	Arg	Leu	Arg	Pro	Leu	
		35					40					45				
Ile	Leu	Thr	Ile	Ser	Ser	Asp	Leu	Phe	Gly	Gly	Gln	Arg	Glu	Arg	Ala	
	50					55					60					
Tyr	Tyr	Ala	Gly	Ala	Ala	Ile	Glu	Val	Leu	His	Thr	Phe	Thr	Leu	Val	
65					70					75					80	

SeqLst

His Asp Asp Ile Met Asp Gln Asp Asn Ile Arg Arg Gly Leu Pro Thr
 85 90 95
 Val His Val Lys Tyr Gly Leu Pro Leu Ala Ile Leu Ala Gly Asp Leu
 100 105 110
 Leu His Ala Lys Ala Phe Gln Leu Leu Thr Gln Ala Leu Arg Gly Leu
 115 120 125
 Pro Ser Glu Thr Ile Ile Lys Ala Phe Asp Ile Phe Thr Arg Ser Ile
 130 135 140
 Ile Ile Ile Ser Glu Gly Gln Ala Val Asp Met Glu Phe Glu Asp Arg
 145 150 155 160
 Ile Asp Ile Lys Glu Gln Glu Tyr Leu Asp Met Ile Ser Arg Lys Thr
 165 170 175
 Ala Ala Leu Phe Ser Ala Ser Ser Ser Ile Gly Ala Leu Ile Ala Gly
 180 185 190
 Ala Asn Asp Asn Asp Val Arg Leu Met Ser Asp Phe Gly Thr Asn Leu
 195 200 205
 Gly Ile Ala Phe Gln Ile Val Asp Asp Ile Leu Gly Leu Thr Ala Asp
 210 215 220
 Glu Lys Glu Leu Gly Lys Pro Val Phe Ser Asp Ile Arg Glu Gly Lys
 225 230 235 240
 Lys Thr Ile Leu Val Ile Lys Thr Leu Glu Leu Cys Lys Glu Asp Glu
 245 250 255
 Lys Lys Ile Val Leu Lys Ala Leu Gly Asn Lys Ser Ala Ser Lys Glu
 260 265 270
 Glu Leu Met Ser Ser Ala Asp Ile Ile Lys Lys Tyr Ser Leu Asp Tyr
 275 280 285
 Ala Tyr Asn Leu Ala Glu Lys Tyr Tyr Lys Asn Ala Ile Asp Ser Leu
 290 295 300
 Asn Gln Val Ser Ser Lys Ser Asp Ile Pro Gly Lys Ala Leu Lys Tyr
 305 310 315 320
 Leu Ala Glu Phe Thr Ile Arg Arg Arg Lys

325

SeqLst
330

<210> 127

<211> 297

<212> PRT

<213> Synechococcus sp.

<400> 127

Met Val Ala Gln Thr Phe Asn Leu Asp Thr Tyr Leu Ser Gln Arg Gln
1 5 10 15Gln Gln Val Glu Glu Ala Leu Ser Ala Ala Leu Val Pro Ala Tyr Pro
20 25 30Glu Arg Ile Tyr Glu Ala Met Arg Tyr Ser Leu Leu Ala Gly Gly Lys
35 40 45Arg Leu Arg Pro Ile Leu Cys Leu Ala Ala Cys Glu Leu Ala Gly Gly
50 55 60Ser Val Glu Gln Ala Met Pro Thr Ala Cys Ala Leu Glu Met Ile His
65 70 75 80Thr Met Ser Leu Ile His Asp Asp Leu Pro Ala Met Asp Asn Asp Asp
85 90 95Phe Arg Arg Gly Lys Pro Thr Asn His Lys Val Phe Gly Glu Asp Ile
100 105 110Ala Ile Leu Ala Gly Asp Ala Leu Leu Ala Tyr Ala Phe Glu His Ile
115 120 125Ala Ser Gln Thr Arg Gly Val Pro Pro Gln Leu Val Leu Gln Val Ile
130 135 140Ala Arg Ile Gly His Ala Val Ala Ala Thr Gly Leu Val Gly Gly Gln
145 150 155 160Val Val Asp Leu Glu Ser Glu Gly Lys Ala Ile Ser Leu Glu Thr Leu
165 170 175Glu Tyr Ile His Ser His Lys Thr Gly Ala Leu Leu Glu Ala Ser Val
180 185 190Val Ser Gly Gly Ile Leu Ala Gly Ala Asp Glu Glu Leu Leu Ala Arg
195 200 205Leu Ser His Tyr Ala Arg Asp Ile Gly Leu Ala Phe Gln Ile Val Asp
210 215 220

SeqLst

Asp Ile Leu Asp Val Thr Ala Thr Ser Glu Gln Leu Gly Lys Thr Ala
225 230 235 240

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

Leu Glu Ala Ser Arg Gln Lys Ala Glu Glu Leu Ile Gln Ser Ala Lys
260 265 270

Glu Ala Leu Arg Pro Tyr Gly Ser Gln Ala Glu Pro Leu Leu Ala Leu
275 280 285

Ala Asp Phe Ile Thr Arg Arg Gln His
290 295

<210> 128

<211> 371

<212> PRT

<213> Arabidopsis thaliana

<400> 128

Met Ala Ser Val Thr Leu Gly Ser Trp Ile Val Val His His His Asn
1 5 10 15

His His His Pro Ser Ser Ile Leu Thr Lys Ser Arg Ser Arg Ser Cys
20 25 30

Pro Ile Thr Leu Thr Lys Pro Ile Ser Phe Arg Ser Lys Arg Thr Val
35 40 45

Ser Ser Ser Ser Ser Ile Val Ser Ser Ser Val Val Thr Lys Glu Asp
50 55 60

Asn Leu Arg Gln Ser Glu Pro Ser Ser Phe Asp Phe Met Ser Tyr Ile
65 70 75 80

Ile Thr Lys Ala Glu Leu Val Asn Lys Ala Leu Asp Ser Ala Val Pro
85 90 95

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

Ala Gly Gly Lys Arg Val Arg Pro Val Leu Cys Ile Ala Ala Cys Glu
115 120 125

Leu Val Gly Gly Glu Glu Ser Thr Ala Met Pro Ala Ala Cys Ala Val
130 135 140

SeqLst

Glu Met Ile His Thr Met Ser Leu Ile His Asp Asp Leu Pro Cys Met
 145 150 155 160

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

Gly Glu Asp Val Ala Val Leu Ala Gly Asp Ala Leu Leu Ser Phe Ala
 180 185 190

Phe Glu His Leu Ala Ser Ala Thr Ser Ser Asp Val Val Ser Pro Val
 195 200 205

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

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

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

Thr Ala Ala Leu Leu Glu Ala Ser Ala Val Leu Gly Ala Ile Val Gly
 260 265 270

Gly Gly Ser Asp Asp Glu Ile Glu Arg Leu Arg Lys Phe Ala Arg Cys
 275 280 285

Ile Gly Leu Leu Phe Gln Val Val Asp Asp Ile Leu Asp Val Thr Lys
 290 295 300

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

Lys Leu Thr Tyr Pro Lys Ile Met Gly Leu Glu Lys Ser Arg Glu Phe
 325 330 335

Ala Glu Lys Leu Asn Arg Glu Ala Arg Asp Gln Leu Leu Gly Phe Asp
 340 345 350

Ser Asp Lys Val Ala Pro Leu Leu Ala Leu Ala Asn Tyr Ile Ala Tyr
 355 360 365

Arg Gln Asn
 370

<210> 129
 <211> 787

SeqLst

<212> PRT

<213> Stevia rebaudiana

<400> 129

Met Lys Thr Gly Phe Ile Ser Pro Ala Thr Val Phe His His Arg Ile
 1 5 10 15

Ser Pro Ala Thr Thr Phe Arg His His Leu Ser Pro Ala Thr Thr Asn
 20 25 30

Ser Thr Gly Ile Val Ala Leu Arg Asp Ile Asn Phe Arg Cys Lys Ala
 35 40 45

Val Ser Lys Glu Tyr Ser Asp Leu Leu Gln Lys Asp Glu Ala Ser Phe
 50 55 60

Thr Lys Trp Asp Asp Asp Lys Val Lys Asp His Leu Asp Thr Asn Lys
 65 70 75 80

Asn Leu Tyr Pro Asn Asp Glu Ile Lys Glu Phe Val Glu Ser Val Lys
 85 90 95

Ala Met Phe Gly Ser Met Asn Asp Gly Glu Ile Asn Val Ser Ala Tyr
 100 105 110

Asp Thr Ala Trp Val Ala Leu Val Gln Asp Val Asp Gly Ser Gly Ser
 115 120 125

Pro Gln Phe Pro Ser Ser Leu Glu Trp Ile Ala Asn Asn Gln Leu Ser
 130 135 140

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

Ile Asn Thr Leu Ala Cys Val Ile Ala Leu Thr Ser Trp Asn Val His
 165 170 175

Pro Ser Lys Cys Glu Lys Gly Leu Asn Phe Leu Arg Glu Asn Ile Cys
 180 185 190

Lys Leu Glu Asp Glu Asn Ala Glu His Met Pro Ile Gly Phe Glu Val
 195 200 205

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

Pro Glu Asp Thr Pro Ala Leu Lys Glu Ile Tyr Ala Arg Arg Asp Ile
 225 230 235 240

SeqLst

Lys Leu Thr Lys Ile Pro Met Glu Val Leu His Lys Val Pro Thr Thr
 245 250 255
 Leu Leu His Ser Leu Glu Gly Met Pro Asp Leu Glu Trp Glu Lys Leu
 260 265 270
 Leu Lys Leu Gln Cys Lys Asp Gly Ser Phe Leu Phe Ser Pro Ser Ser
 275 280 285
 Thr Ala Phe Ala Leu Met Gln Thr Lys Asp Glu Lys Cys Leu Gln Tyr
 290 295 300
 Leu Thr Asn Ile Val Thr Lys Phe Asn Gly Gly Val Pro Asn Val Tyr
 305 310 315 320
 Pro Val Asp Leu Phe Glu His Ile Trp Val Val Asp Arg Leu Gln Arg
 325 330 335
 Leu Gly Ile Ala Arg Tyr Phe Lys Ser Glu Ile Lys Asp Cys Val Glu
 340 345 350
 Tyr Ile Asn Lys Tyr Trp Thr Lys Asn Gly Ile Cys Trp Ala Arg Asn
 355 360 365
 Thr His Val Gln Asp Ile Asp Asp Thr Ala Met Gly Phe Arg Val Leu
 370 375 380
 Arg Ala His Gly Tyr Asp Val Thr Pro Asp Val Phe Arg Gln Phe Glu
 385 390 395 400
 Lys Asp Gly Lys Phe Val Cys Phe Ala Gly Gln Ser Thr Gln Ala Val
 405 410 415
 Thr Gly Met Phe Asn Val Tyr Arg Ala Ser Gln Met Leu Phe Pro Gly
 420 425 430
 Glu Arg Ile Leu Glu Asp Ala Lys Lys Phe Ser Tyr Asn Tyr Leu Lys
 435 440 445
 Glu Lys Gln Ser Thr Asn Glu Leu Leu Asp Lys Trp Ile Ile Ala Lys
 450 455 460
 Asp Leu Pro Gly Glu Val Gly Tyr Ala Leu Asp Ile Pro Trp Tyr Ala
 465 470 475 480
 Ser Leu Pro Arg Leu Glu Thr Arg Tyr Tyr Leu Glu Gln Tyr Gly Gly
 485 490 495

SeqLst

Glu Asp Asp Val Trp Ile Gly Lys Thr Leu Tyr Arg Met Gly Tyr Val
 500 505 510
 Ser Asn Asn Thr Tyr Leu Glu Met Ala Lys Leu Asp Tyr Asn Asn Tyr
 515 520 525
 Val Ala Val Leu Gln Leu Glu Trp Tyr Thr Ile Gln Gln Trp Tyr Val
 530 535 540
 Asp Ile Gly Ile Glu Lys Phe Glu Ser Asp Asn Ile Lys Ser Val Leu
 545 550 555 560
 Val Ser Tyr Tyr Leu Ala Ala Ala Ser Ile Phe Glu Pro Glu Arg Ser
 565 570 575
 Lys Glu Arg Ile Ala Trp Ala Lys Thr Thr Ile Leu Val Asp Lys Ile
 580 585 590
 Thr Ser Ile Phe Asp Ser Ser Gln Ser Ser Lys Glu Asp Ile Thr Ala
 595 600 605
 Phe Ile Asp Lys Phe Arg Asn Lys Ser Ser Ser Lys Lys His Ser Ile
 610 615 620
 Asn Gly Glu Pro Trp His Glu Val Met Val Ala Leu Lys Lys Thr Leu
 625 630 635 640
 His Gly Phe Ala Leu Asp Ala Leu Met Thr His Ser Gln Asp Ile His
 645 650 655
 Pro Gln Leu His Gln Ala Trp Glu Met Trp Leu Thr Lys Leu Gln Asp
 660 665 670
 Gly Val Asp Val Thr Ala Glu Leu Met Val Gln Met Ile Asn Met Thr
 675 680 685
 Ala Gly Arg Trp Val Ser Lys Glu Leu Leu Thr His Pro Gln Tyr Gln
 690 695 700
 Arg Leu Ser Thr Val Thr Asn Ser Val Cys His Asp Ile Thr Lys Leu
 705 710 715 720
 His Asn Phe Lys Glu Asn Ser Thr Thr Val Asp Ser Lys Val Gln Glu
 725 730 735
 Leu Val Gln Leu Val Phe Ser Asp Thr Pro Asp Asp Leu Asp Gln Asp

														SeqLst																
740							745							750																
Met	Lys	Gln	Thr	Phe	Leu	Thr	Val	Met	Lys	Thr	Phe	Tyr	Tyr	Lys	Ala															
		755					760					765																		
Trp	Cys	Asp	Pro	Asn	Thr	Ile	Asn	Asp	His	Ile	Ser	Lys	Val	Phe	Glu															
	770					775					780																			
Ile	Val	Ile																												
785																														
<210> 130																														
<211> 527																														
<212> PRT																														
<213> Streptomyces clavuligerus																														
<400> 130																														
Met	Pro	Asp	Ala	His	Asp	Ala	Pro	Pro	Pro	Gln	Ile	Arg	Gln	Arg	Thr															
1				5					10					15																
Leu	Val	Asp	Glu	Ala	Thr	Gln	Leu	Leu	Thr	Glu	Ser	Ala	Glu	Asp	Ala															
		20					25						30																	
Trp	Gly	Glu	Val	Ser	Val	Ser	Glu	Tyr	Glu	Thr	Ala	Arg	Leu	Val	Ala															
		35					40					45																		
His	Ala	Thr	Trp	Leu	Gly	Gly	His	Ala	Thr	Arg	Val	Ala	Phe	Leu	Leu															
	50				55						60																			
Glu	Arg	Gln	His	Glu	Asp	Gly	Ser	Trp	Gly	Pro	Pro	Gly	Gly	Tyr	Arg															
65					70				75					80																
Leu	Val	Pro	Thr	Leu	Ser	Ala	Val	His	Ala	Leu	Leu	Thr	Cys	Leu	Ala															
				85				90					95																	
Ser	Pro	Ala	Gln	Asp	His	Gly	Val	Pro	His	Asp	Arg	Leu	Leu	Arg	Ala															
		100					105					110																		
Val	Asp	Ala	Gly	Leu	Thr	Ala	Leu	Arg	Arg	Leu	Gly	Thr	Ser	Asp	Ser															
		115					120					125																		
Pro	Pro	Asp	Thr	Ile	Ala	Val	Glu	Leu	Val	Ile	Pro	Ser	Leu	Leu	Glu															
	130					135					140																			
Gly	Ile	Gln	His	Leu	Leu	Asp	Pro	Ala	His	Pro	His	Ser	Arg	Pro	Ala															
145					150					155				160																
Phe	Ser	Gln	His	Arg	Gly	Ser	Leu	Val	Cys	Pro	Gly	Gly	Leu	Asp	Gly															
				165				170					175																	

SeqLst

Arg Thr Leu Gly Ala Leu Arg Ser His Ala Ala Ala Gly Thr Pro Val
 180 185 190
 Pro Gly Lys Val Trp His Ala Ser Glu Thr Leu Gly Leu Ser Thr Glu
 195 200 205
 Ala Ala Ser His Leu Gln Pro Ala Gln Gly Ile Ile Gly Gly Ser Ala
 210 215 220
 Ala Ala Thr Ala Thr Trp Leu Thr Arg Val Ala Pro Ser Gln Gln Ser
 225 230 235 240
 Asp Ser Ala Arg Arg Tyr Leu Glu Glu Leu Gln His Arg Tyr Ser Gly
 245 250 255
 Pro Val Pro Ser Ile Thr Pro Ile Thr Tyr Phe Glu Arg Ala Trp Leu
 260 265 270
 Leu Asn Asn Phe Ala Ala Ala Gly Val Pro Cys Glu Ala Pro Ala Ala
 275 280 285
 Leu Leu Asp Ser Leu Glu Ala Ala Leu Thr Pro Gln Gly Ala Pro Ala
 290 295 300
 Gly Ala Gly Leu Pro Pro Asp Ala Asp Asp Thr Ala Ala Val Leu Leu
 305 310 315 320
 Ala Leu Ala Thr His Gly Arg Gly Arg Arg Pro Glu Val Leu Met Asp
 325 330 335
 Tyr Arg Thr Asp Gly Tyr Phe Gln Cys Phe Ile Gly Glu Arg Thr Pro
 340 345 350
 Ser Ile Ser Thr Asn Ala His Val Leu Glu Thr Leu Gly His His Val
 355 360 365
 Ala Gln His Pro Gln Asp Arg Ala Arg Tyr Gly Ser Ala Met Asp Thr
 370 375 380
 Ala Ser Ala Trp Leu Leu Ala Ala Gln Lys Gln Asp Gly Ser Trp Leu
 385 390 395 400
 Asp Lys Trp His Ala Ser Pro Tyr Tyr Ala Thr Val Cys Cys Thr Gln
 405 410 415
 Ala Leu Ala Ala His Ala Ser Pro Ala Thr Ala Pro Ala Arg Gln Arg

SeqLst

420

425

430

Ala Val Arg Trp Val Leu Ala Thr Gln Arg Ser Asp Gly Gly Trp Gly
 435 440 445

Leu Trp His Ser Thr Val Glu Glu Thr Ala Tyr Ala Leu Gln Ile Leu
 450 455 460

Ala Pro Pro Ser Gly Gly Glu Asn Ile Pro Val Gln Gln Ala Leu Thr
 465 470 475 480

Arg Gly Arg Ala Arg Leu Cys Gly Ala Leu Pro Leu Thr Pro Leu Trp
 485 490 495

His Asp Lys Asp Leu Tyr Thr Pro Val Arg Val Val Arg Ala Ala Arg
 500 505 510

Ala Ala Ala Leu Tyr Thr Thr Arg Asp Leu Leu Leu Pro Pro Leu
 515 520 525

<210> 131

<211> 516

<212> PRT

<213> Bradyrhizobium japonicum

<400> 131

Met Asn Ala Leu Ser Glu His Ile Leu Ser Glu Leu Arg Arg Leu Leu
 1 5 10 15

Ser Glu Met Ser Asp Gly Gly Ser Val Gly Pro Ser Val Tyr Asp Thr
 20 25 30

Ala Gln Ala Leu Arg Phe His Gly Asn Val Thr Gly Arg Gln Asp Ala
 35 40 45

Tyr Ala Trp Leu Ile Ala Gln Gln Gln Ala Asp Gly Gly Trp Gly Ser
 50 55 60

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

Ala Leu Gln Arg Ala Asp Pro Leu Pro Gly Ala Ala Asp Ala Val Gln
 85 90 95

Thr Ala Thr Arg Phe Leu Gln Arg Gln Pro Asp Pro Tyr Ala His Ala
 100 105 110

Val Pro Glu Asp Ala Pro Ile Gly Ala Glu Leu Ile Leu Pro Gln Phe
 115 120 125

SeqLst

Cys Gly Glu Ala Ala Trp Leu Leu Gly Gly Val Ala Phe Pro Arg His
 130 135 140
 Pro Ala Leu Leu Pro Leu Arg Gln Ala Cys Leu Val Lys Leu Gly Ala
 145 150 155 160
 Val Ala Met Leu Pro Ser Gly His Pro Leu Leu His Ser Trp Glu Ala
 165 170 175
 Trp Gly Thr Ser Pro Thr Thr Ala Cys Pro Asp Asp Asp Gly Ser Ile
 180 185 190
 Gly Ile Ser Pro Ala Ala Thr Ala Ala Trp Arg Ala Gln Ala Val Thr
 195 200 205
 Arg Gly Ser Thr Pro Gln Val Gly Arg Ala Asp Ala Tyr Leu Gln Met
 210 215 220
 Ala Ser Arg Ala Thr Arg Ser Gly Ile Glu Gly Val Phe Pro Asn Val
 225 230 235 240
 Trp Pro Ile Asn Val Phe Glu Pro Cys Trp Ser Leu Tyr Thr Leu His
 245 250 255
 Leu Ala Gly Leu Phe Ala His Pro Ala Leu Ala Glu Ala Val Arg Val
 260 265 270
 Ile Val Ala Gln Leu Glu Ala Arg Leu Gly Val His Gly Leu Gly Pro
 275 280 285
 Ala Leu His Phe Ala Ala Asp Ala Asp Asp Thr Ala Val Ala Leu Cys
 290 295 300
 Val Leu His Leu Ala Gly Arg Asp Pro Ala Val Asp Ala Leu Arg His
 305 310 315 320
 Phe Glu Ile Gly Glu Leu Phe Val Thr Phe Pro Gly Glu Arg Asn Ala
 325 330 335
 Ser Val Ser Thr Asn Ile His Ala Leu His Ala Leu Arg Leu Leu Gly
 340 345 350
 Lys Pro Ala Ala Gly Ala Ser Ala Tyr Val Glu Ala Asn Arg Asn Pro
 355 360 365
 His Gly Leu Trp Asp Asn Glu Lys Trp His Val Ser Trp Leu Tyr Pro

SeqLst

370		375		380
Thr 385	Ala 390	His 395	Ala 400	Val 405
Ala 410	Leu 415	Ala 420	Leu 425	Val 430
Ala 435	Leu 440	Ala 445	Leu 450	Val 455
Ala 460	Leu 465	Ala 470	Leu 475	Val 480
Ala 485	Leu 490	Ala 495	Leu 500	Val 505
Ala 510	Leu 515	Ala 520	Leu 525	Val 530
Ala 535	Leu 540	Ala 545	Leu 550	Val 555
Ala 560	Leu 565	Ala 570	Leu 575	Val 580
Ala 585	Leu 590	Ala 595	Leu 600	Val 605
Ala 610	Leu 615	Ala 620	Leu 625	Val 630
Ala 635	Leu 640	Ala 645	Leu 650	Val 655
Ala 660	Leu 665	Ala 670	Leu 675	Val 680
Ala 685	Leu 690	Ala 695	Leu 700	Val 705
Ala 710	Leu 715	Ala 720	Leu 725	Val 730
Ala 735	Leu 740	Ala 745	Leu 750	Val 755
Ala 760	Leu 765	Ala 770	Leu 775	Val 780
Ala 785	Leu 790	Ala 795	Leu 800	Val 805
Ala 810	Leu 815	Ala 820	Leu 825	Val 830
Ala 835	Leu 840	Ala 845	Leu 850	Val 855
Ala 860	Leu 865	Ala 870	Leu 875	Val 880
Ala 885	Leu 890	Ala 895	Leu 900	Val 905
Ala 910	Leu 915	Ala 920	Leu 925	Val 930
Ala 935	Leu 940	Ala 945	Leu 950	Val 955
Ala 960	Leu 965	Ala 970	Leu 975	Val 980
Ala 985	Leu 990	Ala 995	Leu 1000	Val 1005

<210> 132
 <211> 784
 <212> PRT
 <213> Stevia rebaudiana

<400> 132
 Met 1 Asn 5 Leu 10 Ser 15 Cys 20 Ile 25 Ala 30 Ser 35 Pro 40 Leu 45 Leu 50 Thr 55 Lys 60 Ser 65 Asn 70

Arg 75 Pro 80 Ala 85 Ala 90 Leu 95 Ser 100 Ala 105 Ile 110 His 115 Thr 120 Ala 125 Ser 130 Thr 135 Ser 140 His 145 Gly 150

Gly 155 Gln 160 Thr 165 Asn 170 Pro 175 Thr 180 Asn 185 Leu 190 Ile 195 Ile 200 Asp 205 Thr 210 Thr 215 Lys 220 Glu 225 Arg 230

Ile 235 Gln 240 Lys 245 Gln 250 Phe 255 Lys 260 Asn 265 Val 270 Glu 275 Ile 280 Ser 285 Val 290 Ser 295 Ser 300 Tyr 305 Asp 310

Thr 315 Ala 320 Trp 325 Val 330 Ala 335 Met 340 Val 345 Pro 350 Ser 355 Pro 360 Asn 365 Ser 370 Pro 375 Lys 380 Ser 385 Pro 390

SeqLst

Cys Phe Pro Glu Cys Leu Asn Trp Leu Ile Asn Asn Gln Leu Asn Asp
 85 90 95
 Gly Ser Trp Gly Leu Val Asn His Thr His Asn His Asn His Pro Leu
 100 105 110
 Leu Lys Asp Ser Leu Ser Ser Thr Leu Ala Cys Ile Val Ala Leu Lys
 115 120 125
 Arg Trp Asn Val Gly Glu Asp Gln Ile Asn Lys Gly Leu Ser Phe Ile
 130 135 140
 Glu Ser Asn Leu Ala Ser Ala Thr Glu Lys Ser Gln Pro Ser Pro Ile
 145 150 155 160
 Gly Phe Asp Ile Ile Phe Pro Gly Leu Leu Glu Tyr Ala Lys Asn Leu
 165 170 175
 Asp Ile Asn Leu Leu Ser Lys Gln Thr Asp Phe Ser Leu Met Leu His
 180 185 190
 Lys Arg Glu Leu Glu Gln Lys Arg Cys His Ser Asn Glu Met Asp Gly
 195 200 205
 Tyr Leu Ala Tyr Ile Ser Glu Gly Leu Gly Asn Leu Tyr Asp Trp Asn
 210 215 220
 Met Val Lys Lys Tyr Gln Met Lys Asn Gly Ser Val Phe Asn Ser Pro
 225 230 235 240
 Ser Ala Thr Ala Ala Ala Phe Ile Asn His Gln Asn Pro Gly Cys Leu
 245 250 255
 Asn Tyr Leu Asn Ser Leu Leu Asp Lys Phe Gly Asn Ala Val Pro Thr
 260 265 270
 Val Tyr Pro His Asp Leu Phe Ile Arg Leu Ser Met Val Asp Thr Ile
 275 280 285
 Glu Arg Leu Gly Ile Ser His His Phe Arg Val Glu Ile Lys Asn Val
 290 295 300
 Leu Asp Glu Thr Tyr Arg Cys Trp Val Glu Arg Asp Glu Gln Ile Phe
 305 310 315 320
 Met Asp Val Val Thr Cys Ala Leu Ala Phe Arg Leu Leu Arg Ile Asn

															SeqLst															
325										330					335															
Gly	Tyr	Glu	Val	Ser	Pro	Asp	Pro	Leu	Ala	Glu	Ile	Thr	Asn	Glu	Leu															
			340					345					350																	
Ala	Leu	Lys	Asp	Glu	Tyr	Ala	Ala	Leu	Glu	Thr	Tyr	His	Ala	Ser	His															
		355					360					365																		
Ile	Leu	Tyr	Gln	Glu	Asp	Leu	Ser	Ser	Gly	Lys	Gln	Ile	Leu	Lys	Ser															
	370					375					380																			
Ala	Asp	Phe	Leu	Lys	Glu	Ile	Ile	Ser	Thr	Asp	Ser	Asn	Arg	Leu	Ser															
385					390					395				400																
Lys	Leu	Ile	His	Lys	Glu	Val	Glu	Asn	Ala	Leu	Lys	Phe	Pro	Ile	Asn															
				405					410					415																
Thr	Gly	Leu	Glu	Arg	Ile	Asn	Thr	Arg	Arg	Asn	Ile	Gln	Leu	Tyr	Asn															
			420					425					430																	
Val	Asp	Asn	Thr	Arg	Ile	Leu	Lys	Thr	Thr	Tyr	His	Ser	Ser	Asn	Ile															
		435					440					445																		
Ser	Asn	Thr	Asp	Tyr	Leu	Arg	Leu	Ala	Val	Glu	Asp	Phe	Tyr	Thr	Cys															
	450					455					460																			
Gln	Ser	Ile	Tyr	Arg	Glu	Glu	Leu	Lys	Gly	Leu	Glu	Arg	Trp	Val	Val															
465					470					475				480																
Glu	Asn	Lys	Leu	Asp	Gln	Leu	Lys	Phe	Ala	Arg	Gln	Lys	Thr	Ala	Tyr															
				485					490					495																
Cys	Tyr	Phe	Ser	Val	Ala	Ala	Thr	Leu	Ser	Ser	Pro	Glu	Leu	Ser	Asp															
			500					505					510																	
Ala	Arg	Ile	Ser	Trp	Ala	Lys	Asn	Gly	Ile	Leu	Thr	Thr	Val	Val	Asp															
		515					520					525																		
Asp	Phe	Phe	Asp	Ile	Gly	Gly	Thr	Ile	Asp	Glu	Leu	Thr	Asn	Leu	Ile															
	530					535					540																			
Gln	Cys	Val	Glu	Lys	Trp	Asn	Val	Asp	Val	Asp	Lys	Asp	Cys	Cys	Ser															
545					550					555				560																
Glu	His	Val	Arg	Ile	Leu	Phe	Leu	Ala	Leu	Lys	Asp	Ala	Ile	Cys	Trp															
				565					570					575																

SeqLst

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

Val Ile Gln Thr Trp Leu Glu Leu Met Asn Ser Met Leu Arg Glu Ala
595 600 605

Ile Trp Thr Arg Asp Ala Tyr Val Pro Thr Leu Asn Glu Tyr Met Glu
610 615 620

Asn Ala Tyr Val Ser Phe Ala Leu Gly Pro Ile Val Lys Pro Ala Ile
625 630 635 640

Tyr Phe Val Gly Pro Lys Leu Ser Glu Glu Ile Val Glu Ser Ser Glu
645 650 655

Tyr His Asn Leu Phe Lys Leu Met Ser Thr Gln Gly Arg Leu Leu Asn
660 665 670

Asp Ile His Ser Phe Lys Arg Glu Phe Lys Glu Gly Lys Leu Asn Ala
675 680 685

Val Ala Leu His Leu Ser Asn Gly Glu Ser Gly Lys Val Glu Glu Glu
690 695 700

Val Val Glu Glu Met Met Met Met Ile Lys Asn Lys Arg Lys Glu Leu
705 710 715 720

Met Lys Leu Ile Phe Glu Glu Asn Gly Ser Ile Val Pro Arg Ala Cys
725 730 735

Lys Asp Ala Phe Trp Asn Met Cys His Val Leu Asn Phe Phe Tyr Ala
740 745 750

Asn Asp Asp Gly Phe Thr Gly Asn Thr Ile Leu Asp Thr Val Lys Asp
755 760 765

Ile Ile Tyr Asn Pro Leu Val Leu Val Asn Glu Asn Glu Glu Gln Arg
770 775 780

<210> 133
<211> 784
<212> PRT
<213> Stevia rebaudiana

<400> 133
Met Asn Leu Ser Leu Cys Ile Ala Ser Pro Leu Leu Thr Lys Ser Ser
1 5 10 15

Arg Pro Thr Ala Leu Ser Ala Ile His Thr Ala Ser Thr Ser His Gly

															SeqLst														
20										25					30														
Gly	Gln	Thr	Asn	Pro	Thr	Asn	Leu	Ile	Ile	Asp	Thr	Thr	Lys	Glu	Arg														
		35					40					45																	
Ile	Gln	Lys	Leu	Phe	Lys	Asn	Val	Glu	Ile	Ser	Val	Ser	Ser	Tyr	Asp														
	50					55					60																		
Thr	Ala	Trp	Val	Ala	Met	Val	Pro	Ser	Pro	Asn	Ser	Pro	Lys	Ser	Pro														
65					70					75					80														
Cys	Phe	Pro	Glu	Cys	Leu	Asn	Trp	Leu	Ile	Asn	Asn	Gln	Leu	Asn	Asp														
				85					90					95															
Gly	Ser	Trp	Gly	Leu	Val	Asn	His	Thr	His	Asn	His	Asn	His	Pro	Leu														
			100					105					110																
Leu	Lys	Asp	Ser	Leu	Ser	Ser	Thr	Leu	Ala	Cys	Ile	Val	Ala	Leu	Lys														
		115					120					125																	
Arg	Trp	Asn	Val	Gly	Glu	Asp	Gln	Ile	Asn	Lys	Gly	Leu	Ser	Phe	Ile														
	130					135					140																		
Glu	Ser	Asn	Leu	Ala	Ser	Ala	Thr	Asp	Lys	Ser	Gln	Pro	Ser	Pro	Ile														
145					150					155					160														
Gly	Phe	Asp	Ile	Ile	Phe	Pro	Gly	Leu	Leu	Glu	Tyr	Ala	Lys	Asn	Leu														
				165					170					175															
Asp	Ile	Asn	Leu	Leu	Ser	Lys	Gln	Thr	Asp	Phe	Ser	Leu	Met	Leu	His														
			180					185					190																
Lys	Arg	Glu	Leu	Glu	Gln	Lys	Arg	Cys	His	Ser	Asn	Glu	Ile	Asp	Gly														
		195					200					205																	
Tyr	Leu	Ala	Tyr	Ile	Ser	Glu	Gly	Leu	Gly	Asn	Leu	Tyr	Asp	Trp	Asn														
	210					215					220																		
Met	Val	Lys	Lys	Tyr	Gln	Met	Lys	Asn	Gly	Ser	Val	Phe	Asn	Ser	Pro														
225					230					235					240														
Ser	Ala	Thr	Ala	Ala	Ala	Phe	Ile	Asn	His	Gln	Asn	Pro	Gly	Cys	Leu														
				245					250					255															
Asn	Tyr	Leu	Asn	Ser	Leu	Leu	Asp	Lys	Phe	Gly	Asn	Ala	Val	Pro	Thr														
			260					265					270																

SeqLst

Val Tyr Pro Leu Asp Leu Tyr Ile Arg Leu Ser Met Val Asp Thr Ile
275 280 285

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

Leu Asp Glu Thr Tyr Arg Cys Trp Val Glu Arg Asp Glu Gln Ile Phe
305 310 315 320

Met Asp Val Val Thr Cys Ala Leu Ala Phe Arg Leu Leu Arg Ile His
325 330 335

Gly Tyr Lys Val Ser Pro Asp Gln Leu Ala Glu Ile Thr Asn Glu Leu
340 345 350

Ala Phe Lys Asp Glu Tyr Ala Ala Leu Glu Thr Tyr His Ala Ser Gln
355 360 365

Ile Leu Tyr Gln Glu Asp Leu Ser Ser Gly Lys Gln Ile Leu Lys Ser
370 375 380

Ala Asp Phe Leu Lys Gly Ile Leu Ser Thr Asp Ser Asn Arg Leu Ser
385 390 395 400

Lys Leu Ile His Lys Glu Val Glu Asn Ala Leu Lys Phe Pro Ile Asn
405 410 415

Thr Gly Leu Glu Arg Ile Asn Thr Arg Arg Asn Ile Gln Leu Tyr Asn
420 425 430

Val Asp Asn Thr Arg Ile Leu Lys Thr Thr Tyr His Ser Ser Asn Ile
435 440 445

Ser Asn Thr Tyr Tyr Leu Arg Leu Ala Val Glu Asp Phe Tyr Thr Cys
450 455 460

Gln Ser Ile Tyr Arg Glu Glu Leu Lys Gly Leu Glu Arg Trp Val Val
465 470 475 480

Gln Asn Lys Leu Asp Gln Leu Lys Phe Ala Arg Gln Lys Thr Ala Tyr
485 490 495

Cys Tyr Phe Ser Val Ala Ala Thr Leu Ser Ser Pro Glu Leu Ser Asp
500 505 510

Ala Arg Ile Ser Trp Ala Lys Asn Gly Ile Leu Thr Thr Val Val Asp
515 520 525

SeqLst

Asp Phe Phe Asp Ile Gly Gly Thr Ile Asp Glu Leu Thr Asn Leu Ile
 530 535 540
 Gln Cys Val Glu Lys Trp Asn Val Asp Val Asp Lys Asp Cys Cys Ser
 545 550 555 560
 Glu His Val Arg Ile Leu Phe Leu Ala Leu Lys Asp Ala Ile Cys Trp
 565 570 575
 Ile Gly Asp Glu Ala Phe Lys Trp Gln Ala Arg Asp Val Thr Ser His
 580 585 590
 Val Ile Gln Thr Trp Leu Glu Leu Met Asn Ser Met Leu Arg Glu Ala
 595 600 605
 Ile Trp Thr Arg Asp Ala Tyr Val Pro Thr Leu Asn Glu Tyr Met Glu
 610 615 620
 Asn Ala Tyr Val Ser Phe Ala Leu Gly Pro Ile Val Lys Pro Ala Ile
 625 630 635 640
 Tyr Phe Val Gly Pro Lys Leu Ser Glu Glu Ile Val Glu Ser Ser Glu
 645 650 655
 Tyr His Asn Leu Phe Lys Leu Met Ser Thr Gln Gly Arg Leu Leu Asn
 660 665 670
 Asp Ile His Ser Phe Lys Arg Glu Phe Lys Glu Gly Lys Leu Asn Ala
 675 680 685
 Val Ala Leu His Leu Ser Asn Gly Glu Ser Gly Lys Val Glu Glu Glu
 690 695 700
 Val Val Glu Glu Met Met Met Met Ile Lys Asn Lys Arg Lys Glu Leu
 705 710 715 720
 Met Lys Leu Ile Phe Glu Glu Asn Gly Ser Ile Val Pro Arg Ala Cys
 725 730 735
 Lys Asp Ala Phe Trp Asn Met Cys His Val Leu Asn Phe Phe Tyr Ala
 740 745 750
 Asn Asp Asp Gly Phe Thr Gly Asn Thr Ile Leu Asp Thr Val Lys Asp
 755 760 765
 Ile Ile Tyr Asn Pro Leu Val Leu Val Asn Glu Asn Glu Glu Gln Arg
 770 775 780

SeqLst

<210> 134

<211> 590

<212> PRT

<213> Zea mays

<400> 134

Met Ala Met Pro Val Lys Leu Thr Pro Ala Ser Leu Ser Leu Lys Ala
 1 5 10 15

Val Cys Cys Arg Phe Ser Ser Gly Gly His Ala Leu Arg Phe Gly Ser
 20 25 30

Ser Leu Pro Cys Trp Arg Arg Thr Pro Thr Gln Arg Ser Thr Ser Ser
 35 40 45

Ser Thr Thr Arg Pro Ala Ala Glu Val Ser Ser Gly Lys Ser Lys Gln
 50 55 60

His Asp Gln Glu Ala Ser Glu Ala Thr Ile Arg Gln Gln Leu Gln Leu
 65 70 75 80

Val Asp Val Leu Glu Asn Met Gly Ile Ser Arg His Phe Ala Ala Glu
 85 90 95

Ile Lys Cys Ile Leu Asp Arg Thr Tyr Arg Ser Trp Leu Gln Arg His
 100 105 110

Glu Glu Ile Met Leu Asp Thr Met Thr Cys Ala Met Ala Phe Arg Ile
 115 120 125

Leu Arg Leu Asn Gly Tyr Asn Val Ser Ser Asp Glu Leu Tyr His Val
 130 135 140

Val Glu Ala Ser Gly Leu His Asn Ser Leu Gly Gly Tyr Leu Asn Asp
 145 150 155 160

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

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

Leu Arg Glu Gln Leu Glu Ser Gly Gly Ala Leu Arg Lys Pro Ser Leu
 195 200 205

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

SeqLst

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

SeqLst

Thr Phe Glu Arg Glu Tyr Asn Glu Gly Lys Leu Asn Ser Val Ser Leu
 485 490 495

Leu Val Leu His Gly Gly Pro Met Ser Ile Ser Asp Ala Lys Arg Lys
 500 505 510

Leu Gln Lys Pro Ile Asp Thr Cys Arg Arg Asp Leu Leu Ser Leu Val
 515 520 525

Leu Arg Glu Glu Ser Val Val Pro Arg Pro Cys Lys Glu Leu Phe Trp
 530 535 540

Lys Met Cys Lys Val Cys Tyr Phe Phe Tyr Ser Thr Thr Asp Gly Phe
 545 550 555 560

Ser Ser Gln Val Glu Arg Ala Lys Glu Val Asp Ala Val Ile Asn Glu
 565 570 575

Pro Leu Lys Leu Gln Gly Ser His Thr Leu Val Ser Asp Val
 580 585 590

<210> 135

<211> 743

<212> PRT

<213> Populus trichocarpa

<400> 135

Met Gln Asn Phe His Gly Thr Lys Glu Arg Ile Lys Lys Met Phe Asp
 1 5 10 15

Lys Ile Glu Leu Ser Val Ser Ser Tyr Asp Thr Ala Trp Val Ala Met
 20 25 30

Val Pro Ser Pro Asp Cys Pro Glu Thr Pro Cys Phe Pro Glu Cys Thr
 35 40 45

Lys Trp Ile Leu Glu Asn Gln Leu Gly Asp Gly Ser Trp Ser Leu Pro
 50 55 60

His Gly Asn Pro Leu Leu Val Lys Asp Ala Leu Ser Ser Thr Leu Ala
 65 70 75 80

Cys Ile Leu Ala Leu Lys Arg Trp Gly Ile Gly Glu Glu Gln Ile Asn
 85 90 95

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

SeqLst

Glu Gln His Lys Pro Ile Gly Phe Asp Ile Ile Phe Pro Gly Met Ile
 115 120 125
 Glu Tyr Ala Ile Asp Leu Asp Leu Asn Leu Pro Leu Lys Pro Thr Asp
 130 135 140
 Ile Asn Ser Met Leu His Arg Arg Ala Leu Glu Leu Thr Ser Gly Gly
 145 150 155 160
 Gly Lys Asn Leu Glu Gly Arg Arg Ala Tyr Leu Ala Tyr Val Ser Glu
 165 170 175
 Gly Ile Gly Lys Leu Gln Asp Trp Glu Met Ala Met Lys Tyr Gln Arg
 180 185 190
 Lys Asn Gly Ser Leu Phe Asn Ser Pro Ser Thr Thr Ala Ala Ala Phe
 195 200 205
 Ile His Ile Gln Asp Ala Glu Cys Leu His Tyr Ile Arg Ser Leu Leu
 210 215 220
 Gln Lys Phe Gly Asn Ala Val Pro Thr Ile Tyr Pro Leu Asp Ile Tyr
 225 230 235 240
 Ala Arg Leu Ser Met Val Asp Ala Leu Glu Arg Leu Gly Ile Asp Arg
 245 250 255
 His Phe Arg Lys Glu Arg Lys Phe Val Leu Asp Glu Thr Tyr Arg Phe
 260 265 270
 Trp Leu Gln Gly Glu Glu Glu Ile Phe Ser Asp Asn Ala Thr Cys Ala
 275 280 285
 Leu Ala Phe Arg Ile Leu Arg Leu Asn Gly Tyr Asp Val Ser Leu Glu
 290 295 300
 Asp His Phe Ser Asn Ser Leu Gly Gly Tyr Leu Lys Asp Ser Gly Ala
 305 310 315 320
 Ala Leu Glu Leu Tyr Arg Ala Leu Gln Leu Ser Tyr Pro Asp Glu Ser
 325 330 335
 Leu Leu Glu Lys Gln Asn Ser Arg Thr Ser Tyr Phe Leu Lys Gln Gly
 340 345 350
 Leu Ser Asn Val Ser Leu Cys Gly Asp Arg Leu Arg Lys Asn Ile Ile
 355 360 365

SeqLst

Gly Glu Val His Asp Ala Leu Asn Phe Ser Asp His Ala Asn Leu Gln
 370 375 380
 Arg Leu Ala Ile Arg Arg Arg Ile Lys His Tyr Ala Thr Asp Asp Thr
 385 390 395 400
 Arg Ile Leu Lys Thr Ser Tyr Arg Cys Ser Thr Ile Gly Asn Gln Asp
 405 410 415
 Phe Leu Lys Leu Ala Val Glu Asp Phe Asn Ile Cys Gln Ser Ile Gln
 420 425 430
 Arg Glu Glu Phe Lys His Ile Glu Arg Trp Val Val Glu Arg Arg Leu
 435 440 445
 Asp Lys Leu Lys Phe Ala Arg Gln Lys Glu Ala Tyr Cys Tyr Phe Ser
 450 455 460
 Ala Ala Ala Thr Leu Phe Ala Pro Glu Leu Ser Asp Ala Arg Met Ser
 465 470 475 480
 Trp Ala Lys Asn Gly Val Leu Thr Thr Val Val Asp Asp Phe Phe Asp
 485 490 495
 Val Gly Gly Ser Glu Glu Glu Leu Val Asn Leu Ile Glu Leu Ile Glu
 500 505 510
 Arg Trp Asp Val Asn Gly Ser Ala Asp Phe Cys Ser Glu Glu Val Glu
 515 520 525
 Ile Ile Tyr Ser Ala Ile His Ser Thr Ile Ser Glu Ile Gly Asp Lys
 530 535 540
 Ser Phe Gly Trp Gln Gly Arg Asp Val Lys Ser Gln Val Ile Lys Ile
 545 550 555 560
 Trp Leu Asp Leu Leu Lys Ser Met Leu Thr Glu Ala Gln Trp Ser Ser
 565 570 575
 Asn Lys Ser Val Pro Thr Leu Asp Glu Tyr Met Thr Thr Ala His Val
 580 585 590
 Ser Phe Ala Leu Gly Pro Ile Val Leu Pro Ala Leu Tyr Phe Val Gly
 595 600 605
 Pro Lys Leu Ser Glu Glu Val Ala Gly His Pro Glu Leu Leu Asn Leu

SeqLst
620

610

615

Tyr Lys Val Thr Ser Thr Cys Gly Arg Leu Leu Asn Asp Trp Arg Ser
625 630 635 640

Phe Lys Arg Glu Ser Glu Glu Gly Lys Leu Asn Ala Ile Ser Leu Tyr
645 650 655

Met Ile His Ser Gly Gly Ala Ser Thr Glu Glu Glu Thr Ile Glu His
660 665 670

Phe Lys Gly Leu Ile Asp Ser Gln Arg Arg Gln Leu Leu Gln Leu Val
675 680 685

Leu Gln Glu Lys Asp Ser Ile Ile Pro Arg Pro Cys Lys Asp Leu Phe
690 695 700

Trp Asn Met Ile Lys Leu Leu His Thr Phe Tyr Met Lys Asp Asp Gly
705 710 715 720

Phe Thr Ser Asn Glu Met Arg Asn Val Val Lys Ala Ile Ile Asn Glu
725 730 735

Pro Ile Ser Leu Asp Glu Leu
740

<210> 136

<211> 983

<212> PRT

<213> Phomopsis amygdali

<400> 136

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

Arg Thr Leu Gln Asp Tyr Asp Asp Arg Tyr Gly Phe Gly Thr Met Ser
20 25 30

Cys Ala Ala Tyr Asp Thr Ala Trp Val Ser Leu Val Thr Lys Thr Val
35 40 45

Asp Gly Arg Lys Gln Trp Leu Phe Pro Glu Cys Phe Glu Phe Leu Leu
50 55 60

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

Ile Asp Gly Ile Leu Asn Thr Ala Ala Ser Leu Leu Ala Leu Lys Arg
85 90 95

SeqLst

His Val Gln Thr Glu Gln Ile Ile Gln Pro Gln His Asp His Lys Asp
 100 105 110
 Leu Ala Gly Arg Ala Glu Arg Ala Ala Ala Ser Leu Arg Ala Gln Leu
 115 120 125
 Ala Ala Leu Asp Val Ser Thr Thr Glu His Val Gly Phe Glu Ile Ile
 130 135 140
 Val Pro Ala Met Leu Asp Pro Leu Glu Ala Glu Asp Pro Ser Leu Val
 145 150 155 160
 Phe Asp Phe Pro Ala Arg Lys Pro Leu Met Lys Ile His Asp Ala Lys
 165 170 175
 Met Ser Arg Phe Arg Pro Glu Tyr Leu Tyr Gly Lys Gln Pro Met Thr
 180 185 190
 Ala Leu His Ser Leu Glu Ala Phe Ile Gly Lys Ile Asp Phe Asp Lys
 195 200 205
 Val Arg His His Arg Thr His Gly Ser Met Met Gly Ser Pro Ser Ser
 210 215 220
 Thr Ala Ala Tyr Leu Met His Ala Ser Gln Trp Asp Gly Asp Ser Glu
 225 230 235 240
 Ala Tyr Leu Arg His Val Ile Lys His Ala Ala Gly Gln Gly Thr Gly
 245 250 255
 Ala Val Pro Ser Ala Phe Pro Ser Thr His Phe Glu Ser Ser Trp Ile
 260 265 270
 Leu Thr Thr Leu Phe Arg Ala Gly Phe Ser Ala Ser His Leu Ala Cys
 275 280 285
 Asp Glu Leu Asn Lys Leu Val Glu Ile Leu Glu Gly Ser Phe Glu Lys
 290 295 300
 Glu Gly Gly Ala Ile Gly Tyr Ala Pro Gly Phe Gln Ala Asp Val Asp
 305 310 315 320
 Asp Thr Ala Lys Thr Ile Ser Thr Leu Ala Val Leu Gly Arg Asp Ala
 325 330 335
 Thr Pro Arg Gln Met Ile Lys Val Phe Glu Ala Asn Thr His Phe Arg

SeqLst

340	345	350
Thr Tyr Pro Gly Glu Arg Asp	Pro Ser Leu Thr Ala	Asn Cys Asn Ala
355	360	365
Leu Ser Ala Leu Leu His Gln	Pro Asp Ala Ala Met	Tyr Gly Ser Gln
370	375	380
Ile Gln Lys Ile Thr Lys Phe Val Cys Asp	Tyr Trp Trp Lys Ser Asp	
385	390	400
Gly Lys Ile Lys Asp Lys Trp Asn Thr Cys Tyr Leu Tyr Pro Ser Val		
	405	410 415
Leu Leu Val Glu Val Leu Val Asp Leu Val Ser Leu Leu Glu Gln Gly		
	420 425	430
Lys Leu Pro Asp Val Leu Asp Gln Glu Leu Gln Tyr Arg Val Ala Ile		
	435 440	445
Thr Leu Phe Gln Ala Cys Leu Arg Pro Leu Leu Asp Gln Asp Ala Glu		
	450 455	460
Gly Ser Trp Asn Lys Ser Ile Glu Ala Thr Ala Tyr Gly Ile Leu Ile		
465	470	475 480
Leu Thr Glu Ala Arg Arg Val Cys Phe Phe Asp Arg Leu Ser Glu Pro		
	485	490 495
Leu Asn Glu Ala Ile Arg Arg Gly Ile Ala Phe Ala Asp Ser Met Ser		
	500	505 510
Gly Thr Glu Ala Gln Leu Asn Tyr Ile Trp Ile Glu Lys Val Ser Tyr		
	515	520 525
Ala Pro Ala Leu Leu Thr Lys Ser Tyr Leu Leu Ala Ala Arg Trp Ala		
	530 535	540
Ala Lys Ser Pro Leu Gly Ala Ser Val Gly Ser Ser Leu Trp Thr Pro		
545	550 555	560
Pro Arg Glu Gly Leu Asp Lys His Val Arg Leu Phe His Gln Ala Glu		
	565	570 575
Leu Phe Arg Ser Leu Pro Glu Trp Glu Leu Arg Ala Ser Met Ile Glu		
	580	585 590

SeqLst

Ala Ala Leu Phe Thr Pro Leu Leu Arg Ala His Arg Leu Asp Val Phe
595 600 605

Pro Arg Gln Asp Val Gly Glu Asp Lys Tyr Leu Asp Val Val Pro Phe
610 615 620

Phe Trp Thr Ala Ala Asn Asn Arg Asp Arg Thr Tyr Ala Ser Thr Leu
625 630 635 640

Phe Leu Tyr Asp Met Cys Phe Ile Ala Met Leu Asn Phe Gln Leu Asp
645 650 655

Glu Phe Met Glu Ala Thr Ala Gly Ile Leu Phe Arg Asp His Met Asp
660 665 670

Asp Leu Arg Gln Leu Ile His Asp Leu Leu Ala Glu Lys Thr Ser Pro
675 680 685

Lys Ser Ser Gly Arg Ser Ser Gln Gly Thr Lys Asp Ala Asp Ser Gly
690 695 700

Ile Glu Glu Asp Val Ser Met Ser Asp Ser Ala Ser Asp Ser Gln Asp
705 710 715 720

Arg Ser Pro Glu Tyr Asp Leu Val Phe Ser Ala Leu Ser Thr Phe Thr
725 730 735

Lys His Val Leu Gln His Pro Ser Ile Gln Ser Ala Ser Val Trp Asp
740 745 750

Arg Lys Leu Leu Ala Arg Glu Met Lys Ala Tyr Leu Leu Ala His Ile
755 760 765

Gln Gln Ala Glu Asp Ser Thr Pro Leu Ser Glu Leu Lys Asp Val Pro
770 775 780

Gln Lys Thr Asp Val Thr Arg Val Ser Thr Ser Thr Thr Thr Phe Phe
785 790 795 800

Asn Trp Val Arg Thr Thr Ser Ala Asp His Ile Ser Cys Pro Tyr Ser
805 810 815

Phe His Phe Val Ala Cys His Leu Gly Ala Ala Leu Ser Pro Lys Gly
820 825 830

Ser Asn Gly Asp Cys Tyr Pro Ser Ala Gly Glu Lys Phe Leu Ala Ala
835 840 845

SeqLst

Ala Val Cys Arg His Leu Ala Thr Met Cys Arg Met Tyr Asn Asp Leu
850 855 860

Gly Ser Ala Glu Arg Asp Ser Asp Glu Gly Asn Leu Asn Ser Leu Asp
865 870 875 880

Phe Pro Glu Phe Ala Asp Ser Ala Gly Asn Gly Gly Ile Glu Ile Gln
885 890 895

Lys Ala Ala Leu Leu Arg Leu Ala Glu Phe Glu Arg Asp Ser Tyr Leu
900 905 910

Glu Ala Phe Arg Arg Leu Gln Asp Glu Ser Asn Arg Val His Gly Pro
915 920 925

Ala Gly Gly Asp Glu Ala Arg Leu Ser Arg Arg Arg Met Ala Ile Leu
930 935 940

Glu Phe Phe Ala Gln Gln Val Asp Leu Tyr Gly Gln Val Tyr Val Ile
945 950 955 960

Arg Asp Ile Ser Ala Arg Ile Pro Lys Asn Glu Val Glu Lys Lys Arg
965 970 975

Lys Leu Asp Asp Ala Phe Asn
980

<210> 137

<211> 881

<212> PRT

<213> Physcomitrella patens

<400> 137

Met Ala Ser Ser Thr Leu Ile Gln Asn Arg Ser Cys Gly Val Thr Ser
1 5 10 15

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

Gly Thr Arg Thr Pro Ala Ala Val Gln Cys Leu Lys Lys Arg Arg Cys
35 40 45

Leu Arg Pro Thr Glu Ser Val Leu Glu Ser Ser Pro Gly Ser Gly Ser
50 55 60

Tyr Arg Ile Val Thr Gly Pro Ser Gly Ile Asn Pro Ser Ser Asn Gly
65 70 75 80

SeqLst

His Leu Gln Glu Gly Ser Leu Thr His Arg Leu Pro Ile Pro Met Glu
85 90 95

Lys Ser Ile Asp Asn Phe Gln Ser Thr Leu Tyr Val Ser Asp Ile Trp
100 105 110

Ser Glu Thr Leu Gln Arg Thr Glu Cys Leu Leu Gln Val Thr Glu Asn
115 120 125

Val Gln Met Asn Glu Trp Ile Glu Glu Ile Arg Met Tyr Phe Arg Asn
130 135 140

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

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

Ser Leu Gln Trp Ile Ile Asp Asn Gln Leu Pro Asp Gly Asp Trp Gly
180 185 190

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

Cys Val Ile Ala Leu Lys Thr Trp Gly Val Gly Ala Gln Asn Val Glu
210 215 220

Arg Gly Ile Gln Phe Leu Gln Ser Asn Ile Tyr Lys Met Glu Glu Asp
225 230 235 240

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

Met Glu Asp Ala Lys Ala Leu Gly Leu Asp Leu Pro Tyr Asp Ala Thr
260 265 270

Ile Leu Gln Gln Ile Ser Ala Glu Arg Glu Lys Lys Met Lys Lys Ile
275 280 285

Pro Met Ala Met Val Tyr Lys Tyr Pro Thr Thr Leu Leu His Ser Leu
290 295 300

Glu Gly Leu His Arg Glu Val Asp Trp Asn Lys Leu Leu Gln Leu Gln
305 310 315 320

Ser Glu Asn Gly Ser Phe Leu Tyr Ser Pro Ala Ser Thr Ala Cys Ala
325 330 335

SeqLst

Leu Met Tyr Thr Lys Asp Val Lys Cys Phe Asp Tyr Leu Asn Gln Leu
 340 345 350
 Leu Ile Lys Phe Asp His Ala Cys Pro Asn Val Tyr Pro Val Asp Leu
 355 360 365
 Phe Glu Arg Leu Trp Met Val Asp Arg Leu Gln Arg Leu Gly Ile Ser
 370 375 380
 Arg Tyr Phe Glu Arg Glu Ile Arg Asp Cys Leu Gln Tyr Val Tyr Arg
 385 390 395 400
 Tyr Trp Lys Asp Cys Gly Ile Gly Trp Ala Ser Asn Ser Ser Val Gln
 405 410 415
 Asp Val Asp Asp Thr Ala Met Ala Phe Arg Leu Leu Arg Thr His Gly
 420 425 430
 Phe Asp Val Lys Glu Asp Cys Phe Arg Gln Phe Phe Lys Asp Gly Glu
 435 440 445
 Phe Phe Cys Phe Ala Gly Gln Ser Ser Gln Ala Val Thr Gly Met Phe
 450 455 460
 Asn Leu Ser Arg Ala Ser Gln Thr Leu Phe Pro Gly Glu Ser Leu Leu
 465 470 475 480
 Lys Lys Ala Arg Thr Phe Ser Arg Asn Phe Leu Arg Thr Lys His Glu
 485 490 495
 Asn Asn Glu Cys Phe Asp Lys Trp Ile Ile Thr Lys Asp Leu Ala Gly
 500 505 510
 Glu Val Glu Tyr Asn Leu Thr Phe Pro Trp Tyr Ala Ser Leu Pro Arg
 515 520 525
 Leu Glu His Arg Thr Tyr Leu Asp Gln Tyr Gly Ile Asp Asp Ile Trp
 530 535 540
 Ile Gly Lys Ser Leu Tyr Lys Met Pro Ala Val Thr Asn Glu Val Phe
 545 550 555 560
 Leu Lys Leu Ala Lys Ala Asp Phe Asn Met Cys Gln Ala Leu His Lys
 565 570 575
 Lys Glu Leu Glu Gln Val Ile Lys Trp Asn Ala Ser Cys Gln Phe Arg
 580 585 590

SeqLst

Asp Leu Glu Phe Ala Arg Gln Lys Ser Val Glu Cys Tyr Phe Ala Gly
 595 600 605
 Ala Ala Thr Met Phe Glu Pro Glu Met Val Gln Ala Arg Leu Val Trp
 610 615 620
 Ala Arg Cys Cys Val Leu Thr Thr Val Leu Asp Asp Tyr Phe Asp His
 625 630 635 640
 Gly Thr Pro Val Glu Glu Leu Arg Val Phe Val Gln Ala Val Arg Thr
 645 650 655
 Trp Asn Pro Glu Leu Ile Asn Gly Leu Pro Glu Gln Ala Lys Ile Leu
 660 665 670
 Phe Met Gly Leu Tyr Lys Thr Val Asn Thr Ile Ala Glu Glu Ala Phe
 675 680 685
 Met Ala Gln Lys Arg Asp Val His His His Leu Lys His Tyr Trp Asp
 690 695 700
 Lys Leu Ile Thr Ser Ala Leu Lys Glu Ala Glu Trp Ala Glu Ser Gly
 705 710 715 720
 Tyr Val Pro Thr Phe Asp Glu Tyr Met Glu Val Ala Glu Ile Ser Val
 725 730 735
 Ala Leu Glu Pro Ile Val Cys Ser Thr Leu Phe Phe Ala Gly His Arg
 740 745 750
 Leu Asp Glu Asp Val Leu Asp Ser Tyr Asp Tyr His Leu Val Met His
 755 760 765
 Leu Val Asn Arg Val Gly Arg Ile Leu Asn Asp Ile Gln Gly Met Lys
 770 775 780
 Arg Glu Ala Ser Gln Gly Lys Ile Ser Ser Val Gln Ile Tyr Met Glu
 785 790 795 800
 Glu His Pro Ser Val Pro Ser Glu Ala Met Ala Ile Ala His Leu Gln
 805 810 815
 Glu Leu Val Asp Asn Ser Met Gln Gln Leu Thr Tyr Glu Val Leu Arg
 820 825 830
 Phe Thr Ala Val Pro Lys Ser Cys Lys Arg Ile His Leu Asn Met Ala

	835						840				SeqLst		845					
Lys	Ile 850	Met	His	Ala	Phe	Tyr 855	Lys	Asp	Thr	Asp	Gly 860	Phe	Ser	Ser	Leu			
Thr 865	Ala	Met	Thr	Gly	Phe 870	Val	Lys	Lys	Val	Leu 875	Phe	Glu	Pro	Val	Pro 880			
Glu																		
<210> 138																		
<211> 513																		
<212> PRT																		
<213> Stevia rebaudiana																		
<400> 138																		
Met 1	Asp	Ala	Val	Thr 5	Gly	Leu	Leu	Thr	Val 10	Pro	Ala	Thr	Ala	Ile 15	Thr			
Ile	Gly	Gly	Thr 20	Ala	Val	Ala	Leu	Ala 25	Val	Ala	Leu	Ile	Phe 30	Trp	Tyr			
Leu	Lys	Ser 35	Tyr	Thr	Ser	Ala	Arg 40	Arg	Ser	Gln	Ser	Asn 45	His	Leu	Pro			
Arg	Val 50	Pro	Glu	Val	Pro	Gly 55	Val	Pro	Leu	Leu	Gly 60	Asn	Leu	Leu	Gln			
Leu 65	Lys	Glu	Lys	Lys	Pro 70	Tyr	Met	Thr	Phe	Thr 75	Arg	Trp	Ala	Ala	Thr 80			
Tyr	Gly	Pro	Ile	Tyr 85	Ser	Ile	Lys	Thr	Gly 90	Ala	Thr	Ser	Met	Val 95	Val			
Val	Ser	Ser	Asn 100	Glu	Ile	Ala	Lys	Glu 105	Ala	Leu	Val	Thr	Arg 110	Phe	Gln			
Ser	Ile	Ser 115	Thr	Arg	Asn	Leu	Ser 120	Lys	Ala	Leu	Lys	Val 125	Leu	Thr	Ala			
Asp	Lys 130	Thr	Met	Val	Ala	Met 135	Ser	Asp	Tyr	Asp	Asp 140	Tyr	His	Lys	Thr			
Val 145	Lys	Arg	His	Ile	Leu 150	Thr	Ala	Val	Leu	Gly 155	Pro	Asn	Ala	Gln	Lys 160			
Lys	His	Arg	Ile	His 165	Arg	Asp	Ile	Met	Met 170	Asp	Asn	Ile	Ser	Thr 175	Gln			

SeqLst

Leu His Glu Phe Val Lys Asn Asn Pro Glu Gln Glu Glu Val Asp Leu
 180 185 190
 Arg Lys Ile Phe Gln Ser Glu Leu Phe Gly Leu Ala Met Arg Gln Ala
 195 200 205
 Leu Gly Lys Asp Val Glu Ser Leu Tyr Val Glu Asp Leu Lys Ile Thr
 210 215 220
 Met Asn Arg Asp Glu Ile Phe Gln Val Leu Val Val Asp Pro Met Met
 225 230 235 240
 Gly Ala Ile Asp Val Asp Trp Arg Asp Phe Phe Pro Tyr Leu Lys Trp
 245 250 255
 Val Pro Asn Lys Lys Phe Glu Asn Thr Ile Gln Gln Met Tyr Ile Arg
 260 265 270
 Arg Glu Ala Val Met Lys Ser Leu Ile Lys Glu His Lys Lys Arg Ile
 275 280 285
 Ala Ser Gly Glu Lys Leu Asn Ser Tyr Ile Asp Tyr Leu Leu Ser Glu
 290 295 300
 Ala Gln Thr Leu Thr Asp Gln Gln Leu Leu Met Ser Leu Trp Glu Pro
 305 310 315 320
 Ile Ile Glu Ser Ser Asp Thr Thr Met Val Thr Thr Glu Trp Ala Met
 325 330 335
 Tyr Glu Leu Ala Lys Asn Pro Lys Leu Gln Asp Arg Leu Tyr Arg Asp
 340 345 350
 Ile Lys Ser Val Cys Gly Ser Glu Lys Ile Thr Glu Glu His Leu Ser
 355 360 365
 Gln Leu Pro Tyr Ile Thr Ala Ile Phe His Glu Thr Leu Arg Arg His
 370 375 380
 Ser Pro Val Pro Ile Ile Pro Leu Arg His Val His Glu Asp Thr Val
 385 390 395 400
 Leu Gly Gly Tyr His Val Pro Ala Gly Thr Glu Leu Ala Val Asn Ile
 405 410 415
 Tyr Gly Cys Asn Met Asp Lys Asn Val Trp Glu Asn Pro Glu Glu Trp

SeqLst

420

425

430

Asn Pro Glu Arg Phe Met Lys Glu Asn Glu Thr Ile Asp Phe Gln Lys
 435 440 445

Thr Met Ala Phe Gly Gly Gly Lys Arg Val Cys Ala Gly Ser Leu Gln
 450 455 460

Ala Leu Leu Thr Ala Ser Ile Gly Ile Gly Arg Met Val Gln Glu Phe
 465 470 475 480

Glu Trp Lys Leu Lys Asp Met Thr Gln Glu Glu Val Asn Thr Ile Gly
 485 490 495

Leu Thr Thr Gln Met Leu Arg Pro Leu Arg Ala Ile Ile Lys Pro Arg
 500 505 510

Ile

<210> 139

<211> 509

<212> PRT

<213> Arabidopsis thaliana

<400> 139

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

Ser Phe Ile Phe Ile Phe Phe Phe Lys Lys Leu Leu Ser Phe Ser Arg
 20 25 30

Lys Asn Met Ser Glu Val Ser Thr Leu Pro Ser Val Pro Val Val Pro
 35 40 45

Gly Phe Pro Val Ile Gly Asn Leu Leu Gln Leu Lys Glu Lys Lys Pro
 50 55 60

His Lys Thr Phe Thr Arg Trp Ser Glu Ile Tyr Gly Pro Ile Tyr Ser
 65 70 75 80

Ile Lys Met Gly Ser Ser Ser Leu Ile Val Leu Asn Ser Thr Glu Thr
 85 90 95

Ala Lys Glu Ala Met Val Thr Arg Phe Ser Ser Ile Ser Thr Arg Lys
 100 105 110

Leu Ser Asn Ala Leu Thr Val Leu Thr Cys Asp Lys Ser Met Val Ala
 115 120 125

SeqLst

Thr Ser Asp Tyr Asp Asp Phe His Lys Leu Val Lys Arg Cys Leu Leu
 130 135 140
 Asn Gly Leu Leu Gly Ala Asn Ala Gln Lys Arg Lys Arg His Tyr Arg
 145 150 155 160
 Asp Ala Leu Ile Glu Asn Val Ser Ser Lys Leu His Ala His Ala Arg
 165 170 175
 Asp His Pro Gln Glu Pro Val Asn Phe Arg Ala Ile Phe Glu His Glu
 180 185 190
 Leu Phe Gly Val Ala Leu Lys Gln Ala Phe Gly Lys Asp Val Glu Ser
 195 200 205
 Ile Tyr Val Lys Glu Leu Gly Val Thr Leu Ser Lys Asp Glu Ile Phe
 210 215 220
 Lys Val Leu Val His Asp Met Met Glu Gly Ala Ile Asp Val Asp Trp
 225 230 235 240
 Arg Asp Phe Phe Pro Tyr Leu Lys Trp Ile Pro Asn Lys Ser Phe Glu
 245 250 255
 Ala Arg Ile Gln Gln Lys His Lys Arg Arg Leu Ala Val Met Asn Ala
 260 265 270
 Leu Ile Gln Asp Arg Leu Lys Gln Asn Gly Ser Glu Ser Asp Asp Asp
 275 280 285
 Cys Tyr Leu Asn Phe Leu Met Ser Glu Ala Lys Thr Leu Thr Lys Glu
 290 295 300
 Gln Ile Ala Ile Leu Val Trp Glu Thr Ile Ile Glu Thr Ala Asp Thr
 305 310 315 320
 Thr Leu Val Thr Thr Glu Trp Ala Ile Tyr Glu Leu Ala Lys His Pro
 325 330 335
 Ser Val Gln Asp Arg Leu Cys Lys Glu Ile Gln Asn Val Cys Gly Gly
 340 345 350
 Glu Lys Phe Lys Glu Glu Gln Leu Ser Gln Val Pro Tyr Leu Asn Gly
 355 360 365
 Val Phe His Glu Thr Leu Arg Lys Tyr Ser Pro Ala Pro Leu Val Pro

SeqLst

370 375 380

Ile Arg Tyr Ala His Glu Asp Thr Gln Ile Gly Gly Tyr His Val Pro
385 390 395 400

Ala Gly Ser Glu Ile Ala Ile Asn Ile Tyr Gly Cys Asn Met Asp Lys
 405 410 415

Lys Arg Trp Glu Arg Pro Glu Asp Trp Trp Pro Glu Arg Phe Leu Asp
 420 425 430

Asp Gly Lys Tyr Glu Thr Ser Asp Leu His Lys Thr Met Ala Phe Gly
 435 440 445

Ala Gly Lys Arg Val Cys Ala Gly Ala Leu Gln Ala Ser Leu Met Ala
 450 455 460

Gly Ile Ala Ile Gly Arg Leu Val Gln Glu Phe Glu Trp Lys Leu Arg
465 470 475 480

Asp Gly Glu Glu Glu Asn Val Asp Thr Tyr Gly Leu Thr Ser Gln Lys
 485 490 495

Leu Tyr Pro Leu Met Ala Ile Ile Asn Pro Arg Arg Ser
 500 505

<210> 140
<211> 525
<212> PRT
<213> Gibberella fujikoroii

<400> 140
Met Ser Lys Ser Asn Ser Met Asn Ser Thr Ser His Glu Thr Leu Phe
1 5 10 15

Gln Gln Leu Val Leu Gly Leu Asp Arg Met Pro Leu Met Asp Val His
 20 25 30

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

His Val Leu Ser Ser Ser Ser Thr Val Lys Val Pro Val Val Gly Tyr
50 55 60

Arg Ser Val Phe Glu Pro Thr Trp Leu Leu Arg Leu Arg Phe Val Trp
65 70 75 80

Glu Gly Gly Ser Ile Ile Gly Gln Gly Tyr Asn Lys Phe Lys Asp Ser
 85 90 95

SeqLst

Ile Phe Gln Val Arg Lys Leu Gly Thr Asp Ile Val Ile Ile Pro Pro
 100 105 110
 Asn Tyr Ile Asp Glu Val Arg Lys Leu Ser Gln Asp Lys Thr Arg Ser
 115 120 125
 Val Glu Pro Phe Ile Asn Asp Phe Ala Gly Gln Tyr Thr Arg Gly Met
 130 135 140
 Val Phe Leu Gln Ser Asp Leu Gln Asn Arg Val Ile Gln Gln Arg Leu
 145 150 155 160
 Thr Pro Lys Leu Val Ser Leu Thr Lys Val Met Lys Glu Glu Leu Asp
 165 170 175
 Tyr Ala Leu Thr Lys Glu Met Pro Asp Met Lys Asn Asp Glu Trp Val
 180 185 190
 Glu Val Asp Ile Ser Ser Ile Met Val Arg Leu Ile Ser Arg Ile Ser
 195 200 205
 Ala Arg Val Phe Leu Gly Pro Glu His Cys Arg Asn Gln Glu Trp Leu
 210 215 220
 Thr Thr Thr Ala Glu Tyr Ser Glu Ser Leu Phe Ile Thr Gly Phe Ile
 225 230 235 240
 Leu Arg Val Val Pro His Ile Leu Arg Pro Phe Ile Ala Pro Leu Leu
 245 250 255
 Pro Ser Tyr Arg Thr Leu Leu Arg Asn Val Ser Ser Gly Arg Arg Val
 260 265 270
 Ile Gly Asp Ile Ile Arg Ser Gln Gln Gly Asp Gly Asn Glu Asp Ile
 275 280 285
 Leu Ser Trp Met Arg Asp Ala Ala Thr Gly Glu Glu Lys Gln Ile Asp
 290 295 300
 Asn Ile Ala Gln Arg Met Leu Ile Leu Ser Leu Ala Ser Ile His Thr
 305 310 315 320
 Thr Ala Met Thr Met Thr His Ala Met Tyr Asp Leu Cys Ala Cys Pro
 325 330 335
 Glu Tyr Ile Glu Pro Leu Arg Asp Glu Val Lys Ser Val Val Gly Ala

SeqLst

340

345

350

Ser Gly Trp Asp Lys Thr Ala Leu Asn Arg Phe His Lys Leu Asp Ser
 355 360 365

Phe Leu Lys Glu Ser Gln Arg Phe Asn Pro Val Phe Leu Leu Thr Phe
 370 375 380

Asn Arg Ile Tyr His Gln Ser Met Thr Leu Ser Asp Gly Thr Asn Ile
 385 390 395 400

Pro Ser Gly Thr Arg Ile Ala Val Pro Ser His Ala Met Leu Gln Asp
 405 410 415

Ser Ala His Val Pro Gly Pro Thr Pro Pro Thr Glu Phe Asp Gly Phe
 420 425 430

Arg Tyr Ser Lys Ile Arg Ser Asp Ser Asn Tyr Ala Gln Lys Tyr Leu
 435 440 445

Phe Ser Met Thr Asp Ser Ser Asn Met Ala Phe Gly Tyr Gly Lys Tyr
 450 455 460

Ala Cys Pro Gly Arg Phe Tyr Ala Ser Asn Glu Met Lys Leu Thr Leu
 465 470 475 480

Ala Ile Leu Leu Leu Gln Phe Glu Phe Lys Leu Pro Asp Gly Lys Gly
 485 490 495

Arg Pro Arg Asn Ile Thr Ile Asp Ser Asp Met Ile Pro Asp Pro Arg
 500 505 510

Ala Arg Leu Cys Val Arg Lys Arg Ser Leu Arg Asp Glu
 515 520 525

<210> 141

<211> 499

<212> PRT

<213> Trametes versicolor

<400> 141

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

Thr Phe Val Val Arg Trp Tyr Arg Asp Pro Leu Arg Ser Ile Pro Thr
 20 25 30

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

SeqLst

Trp Thr Arg Arg Gly Arg Glu Ile Leu Gln Glu Gly Tyr Asp Gly Tyr
 50 55 60
 Arg Gly Ser Thr Phe Lys Ile Ala Met Leu Asp Arg Trp Ile Val Ile
 65 70 75 80
 Ala Asn Gly Pro Lys Leu Ala Asp Glu Val Arg Arg Arg Pro Asp Glu
 85 90 95
 Glu Leu Asn Phe Met Asp Gly Leu Gly Ala Phe Val Gln Thr Lys Tyr
 100 105 110
 Thr Leu Gly Glu Ala Ile His Asn Asp Pro Tyr His Val Asp Ile Ile
 115 120 125
 Arg Glu Lys Leu Thr Arg Gly Leu Pro Ala Val Leu Pro Asp Val Ile
 130 135 140
 Glu Glu Leu Thr Leu Ala Val Arg Gln Tyr Ile Pro Thr Glu Gly Asp
 145 150 155 160
 Glu Trp Val Ser Val Asn Cys Ser Lys Ala Ala Arg Asp Ile Val Ala
 165 170 175
 Arg Ala Ser Asn Arg Val Phe Val Gly Leu Pro Ala Cys Arg Asn Gln
 180 185 190
 Gly Tyr Leu Asp Leu Ala Ile Asp Phe Thr Leu Ser Val Val Lys Asp
 195 200 205
 Arg Ala Ile Ile Asn Met Phe Pro Glu Leu Leu Lys Pro Ile Val Gly
 210 215 220
 Arg Val Val Gly Asn Ala Thr Arg Asn Val Arg Arg Ala Val Pro Phe
 225 230 235 240
 Val Ala Pro Leu Val Glu Glu Arg Arg Arg Leu Met Glu Glu Tyr Gly
 245 250 255
 Glu Asp Trp Ser Glu Lys Pro Asn Asp Met Leu Gln Trp Ile Met Asp
 260 265 270
 Glu Ala Ala Ser Arg Asp Ser Ser Val Lys Ala Ile Ala Glu Arg Leu
 275 280 285
 Leu Met Val Asn Phe Ala Ala Ile His Thr Ser Ser Asn Thr Ile Thr

															SeqLst	
290					295					300						
His	Ala	Leu	Tyr	His	Leu	Ala	Glu	Met	Pro	Glu	Thr	Leu	Gln	Pro	Leu	
305					310					315					320	
Arg	Glu	Glu	Ile	Glu	Pro	Leu	Val	Lys	Glu	Glu	Gly	Trp	Thr	Lys	Ala	
				325					330					335		
Ala	Met	Gly	Lys	Met	Trp	Trp	Leu	Asp	Ser	Phe	Leu	Arg	Glu	Ser	Gln	
			340					345					350			
Arg	Tyr	Asn	Gly	Ile	Asn	Ile	Val	Ser	Leu	Thr	Arg	Met	Ala	Asp	Lys	
		355					360					365				
Asp	Ile	Thr	Leu	Ser	Asp	Gly	Thr	Phe	Leu	Pro	Lys	Gly	Thr	Leu	Val	
	370					375					380					
Ala	Val	Pro	Ala	Tyr	Ser	Thr	His	Arg	Asp	Asp	Ala	Val	Tyr	Ala	Asp	
385					390					395					400	
Ala	Leu	Val	Phe	Asp	Pro	Phe	Arg	Phe	Ser	Arg	Met	Arg	Ala	Arg	Glu	
				405					410					415		
Gly	Glu	Gly	Thr	Lys	His	Gln	Phe	Val	Asn	Thr	Ser	Val	Glu	Tyr	Val	
			420					425					430			
Pro	Phe	Gly	His	Gly	Lys	His	Ala	Cys	Pro	Gly	Arg	Phe	Phe	Ala	Ala	
		435					440					445				
Asn	Glu	Leu	Lys	Ala	Met	Leu	Ala	Tyr	Ile	Val	Leu	Asn	Tyr	Asp	Val	
	450					455					460					
Lys	Leu	Pro	Gly	Asp	Gly	Lys	Arg	Pro	Leu	Asn	Met	Tyr	Trp	Gly	Pro	
465					470					475					480	
Thr	Val	Leu	Pro	Ala	Pro	Ala	Gly	Gln	Val	Leu	Phe	Arg	Lys	Arg	Gln	
				485					490					495		
Val Ser Leu																

<210> 142
 <211> 525
 <212> PRT
 <213> Stevia rebaudiana

<400> 142
 Met Gly Leu Phe Pro Leu Glu Asp Ser Tyr Ala Leu Val Phe Glu Gly
 1 5 10 15

SeqLst

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

SeqLst															
260				265				270							
Trp	Leu	Asp 275	Glu	His	Arg	Lys	Lys 280	Gln	Ala	Asn	Asp	Asp 285	Lys	Lys	Glu
Asp	Met 290	Asp	Phe	Met	Asp	Ile 295	Met	Ile	Ser	Met	Thr 300	Glu	Ala	Asn	Ser
Pro 305	Leu	Glu	Gly	Tyr	Gly 310	Thr	Asp	Thr	Ile	Ile 315	Lys	Thr	Thr	Cys	Met 320
Thr	Leu	Ile	Val	Ser 325	Gly	Val	Asp	Thr	Thr 330	Ser	Ile	Val	Leu	Thr 335	Trp
Ala	Leu	Ser	Leu 340	Leu	Leu	Asn	Asn	Arg 345	Asp	Thr	Leu	Lys	Lys 350	Ala	Gln
Glu	Glu	Leu 355	Asp	Met	Cys	Val	Gly 360	Lys	Gly	Arg	Gln	Val 365	Asn	Glu	Ser
Asp	Leu 370	Val	Asn	Leu	Ile	Tyr 375	Leu	Glu	Ala	Val	Leu 380	Lys	Glu	Ala	Leu
Arg 385	Leu	Tyr	Pro	Ala	Ala 390	Phe	Leu	Gly	Gly	Pro 395	Arg	Ala	Phe	Leu	Glu 400
Asp	Cys	Thr	Val	Ala 405	Gly	Tyr	Arg	Ile	Pro 410	Lys	Gly	Thr	Cys	Leu 415	Leu
Ile	Asn	Met	Trp 420	Lys	Leu	His	Arg	Asp 425	Pro	Asn	Ile	Trp	Ser 430	Asp	Pro
Cys	Glu	Phe 435	Lys	Pro	Glu	Arg	Phe 440	Leu	Thr	Pro	Asn	Gln 445	Lys	Asp	Val
Asp	Val 450	Ile	Gly	Met	Asp	Phe 455	Glu	Leu	Ile	Pro	Phe 460	Gly	Ala	Gly	Arg
Arg 465	Tyr	Cys	Pro	Gly	Thr 470	Arg	Leu	Ala	Leu	Gln 475	Met	Leu	His	Ile	Val 480
Leu	Ala	Thr	Leu	Leu 485	Gln	Asn	Phe	Glu	Met 490	Ser	Thr	Pro	Asn	Asp 495	Ala
Pro	Val	Asp	Met 500	Thr	Ala	Ser	Val	Gly 505	Met	Thr	Asn	Ala	Lys 510	Ala	Ser

SeqLst
 Pro Leu Glu Val Leu Leu Ser Pro Arg Val Lys Trp Ser
 515 520 525

<210> 143
 <211> 476
 <212> PRT
 <213> Stevia rebaudiana

<400> 143
 Met Ile Gln Val Leu Thr Pro Ile Leu Leu Phe Leu Ile Phe Phe Val
 1 5 10 15

Phe Trp Lys Val Tyr Lys His Gln Lys Thr Lys Ile Asn Leu Pro Pro
 20 25 30

Gly Ser Phe Gly Trp Pro Phe Leu Gly Glu Thr Leu Ala Leu Leu Arg
 35 40 45

Ala Gly Trp Asp Ser Glu Pro Glu Arg Phe Val Arg Glu Arg Ile Lys
 50 55 60

Lys His Gly Ser Pro Leu Val Phe Lys Thr Ser Leu Phe Gly Asp Arg
 65 70 75 80

Phe Ala Val Leu Cys Gly Pro Ala Gly Asn Lys Phe Leu Phe Cys Asn
 85 90 95

Glu Asn Lys Leu Val Ala Ser Trp Trp Pro Val Pro Val Arg Lys Leu
 100 105 110

Phe Gly Lys Ser Leu Leu Thr Ile Arg Gly Asp Glu Ala Lys Trp Met
 115 120 125

Arg Lys Met Leu Leu Ser Tyr Leu Gly Pro Asp Ala Phe Ala Thr His
 130 135 140

Tyr Ala Val Thr Met Asp Val Val Thr Arg Arg His Ile Asp Val His
 145 150 155 160

Trp Arg Gly Lys Glu Glu Val Asn Val Phe Gln Thr Val Lys Leu Tyr
 165 170 175

Ala Phe Glu Leu Ala Cys Arg Leu Phe Met Asn Leu Asp Asp Pro Asn
 180 185 190

His Ile Ala Lys Leu Gly Ser Leu Phe Asn Ile Phe Leu Lys Gly Ile
 195 200 205

Ile Glu Leu Pro Ile Asp Val Pro Gly Thr Arg Phe Tyr Ser Ser Lys

										SeqLst							
210					215					220							
Lys	Ala	Ala	Ala	Ala	Ile	Arg	Ile	Glu	Leu	Lys	Lys	Leu	Ile	Lys	Ala		
225					230					235					240		
Arg	Lys	Leu	Glu	Leu	Lys	Glu	Gly	Lys	Ala	Ser	Ser	Ser	Gln	Asp	Leu		
				245					250					255			
Leu	Ser	His	Leu	Leu	Thr	Ser	Pro	Asp	Glu	Asn	Gly	Met	Phe	Leu	Thr		
			260					265					270				
Glu	Glu	Glu	Ile	Val	Asp	Asn	Ile	Leu	Leu	Leu	Leu	Phe	Ala	Gly	His		
		275					280					285					
Asp	Thr	Ser	Ala	Leu	Ser	Ile	Thr	Leu	Leu	Met	Lys	Thr	Leu	Gly	Glu		
	290					295					300						
His	Ser	Asp	Val	Tyr	Asp	Lys	Val	Leu	Lys	Glu	Gln	Leu	Glu	Ile	Ser		
305					310					315					320		
Lys	Thr	Lys	Glu	Ala	Trp	Glu	Ser	Leu	Lys	Trp	Glu	Asp	Ile	Gln	Lys		
				325					330					335			
Met	Lys	Tyr	Ser	Trp	Ser	Val	Ile	Cys	Glu	Val	Met	Arg	Leu	Asn	Pro		
			340					345					350				
Pro	Val	Ile	Gly	Thr	Tyr	Arg	Glu	Ala	Leu	Val	Asp	Ile	Asp	Tyr	Ala		
		355					360					365					
Gly	Tyr	Thr	Ile	Pro	Lys	Gly	Trp	Lys	Leu	His	Trp	Ser	Ala	Val	Ser		
	370					375					380						
Thr	Gln	Arg	Asp	Glu	Ala	Asn	Phe	Glu	Asp	Val	Thr	Arg	Phe	Asp	Pro		
385					390					395					400		
Ser	Arg	Phe	Glu	Gly	Ala	Gly	Pro	Thr	Pro	Phe	Thr	Phe	Val	Pro	Phe		
				405					410					415			
Gly	Gly	Gly	Pro	Arg	Met	Cys	Leu	Gly	Lys	Glu	Phe	Ala	Arg	Leu	Glu		
			420					425					430				
Val	Leu	Ala	Phe	Leu	His	Asn	Ile	Val	Thr	Asn	Phe	Lys	Trp	Asp	Leu		
		435					440				445						
Leu	Ile	Pro	Asp	Glu	Lys	Ile	Glu	Tyr	Asp	Pro	Met	Ala	Thr	Pro	Ala		
	450					455					460						

SeqLst
 Lys Gly Leu Pro Ile Arg Leu His Pro His Gln Val
 465 470 475

<210> 144
 <211> 525
 <212> PRT
 <213> Arabidopsis thaliana

<400> 144
 Met Glu Ser Leu Val Val His Thr Val Asn Ala Ile Trp Cys Ile Val
 1 5 10 15

Ile Val Gly Ile Phe Ser Val Gly Tyr His Val Tyr Gly Arg Ala Val
 20 25 30

Val Glu Gln Trp Arg Met Arg Arg Ser Leu Lys Leu Gln Gly Val Lys
 35 40 45

Gly Pro Pro Pro Ser Ile Phe Asn Gly Asn Val Ser Glu Met Gln Arg
 50 55 60

Ile Gln Ser Glu Ala Lys His Cys Ser Gly Asp Asn Ile Ile Ser His
 65 70 75 80

Asp Tyr Ser Ser Ser Leu Phe Pro His Phe Asp His Trp Arg Lys Gln
 85 90 95

Tyr Gly Arg Ile Tyr Thr Tyr Ser Thr Gly Leu Lys Gln His Leu Tyr
 100 105 110

Ile Asn His Pro Glu Met Val Lys Glu Leu Ser Gln Thr Asn Thr Leu
 115 120 125

Asn Leu Gly Arg Ile Thr His Ile Thr Lys Arg Leu Asn Pro Ile Leu
 130 135 140

Gly Asn Gly Ile Ile Thr Ser Asn Gly Pro His Trp Ala His Gln Arg
 145 150 155 160

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

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

Met Val Lys Arg Gly Gly Glu Met Gly Cys Asp Ile Arg Val Asp Glu
 195 200 205

Asp Leu Lys Asp Val Ser Ala Asp Val Ile Ala Lys Ala Cys Phe Gly

															SeqLst	
210					215					220						
Ser	Ser	Phe	Ser	Lys	Gly	Lys	Ala	Ile	Phe	Ser	Met	Ile	Arg	Asp	Leu	
225					230					235					240	
Leu	Thr	Ala	Ile	Thr	Lys	Arg	Ser	Val	Leu	Phe	Arg	Phe	Asn	Gly	Phe	
				245					250					255		
Thr	Asp	Met	Val	Phe	Gly	Ser	Lys	Lys	His	Gly	Asp	Val	Asp	Ile	Asp	
			260					265					270			
Ala	Leu	Glu	Met	Glu	Leu	Glu	Ser	Ser	Ile	Trp	Glu	Thr	Val	Lys	Glu	
		275					280					285				
Arg	Glu	Ile	Glu	Cys	Lys	Asp	Thr	His	Lys	Lys	Asp	Leu	Met	Gln	Leu	
	290					295					300					
Ile	Leu	Glu	Gly	Ala	Met	Arg	Ser	Cys	Asp	Gly	Asn	Leu	Trp	Asp	Lys	
305					310					315					320	
Ser	Ala	Tyr	Arg	Arg	Phe	Val	Val	Asp	Asn	Cys	Lys	Ser	Ile	Tyr	Phe	
				325					330					335		
Ala	Gly	His	Asp	Ser	Thr	Ala	Val	Ser	Val	Ser	Trp	Cys	Leu	Met	Leu	
			340					345					350			
Leu	Ala	Leu	Asn	Pro	Ser	Trp	Gln	Val	Lys	Ile	Arg	Asp	Glu	Ile	Leu	
		355					360					365				
Ser	Ser	Cys	Lys	Asn	Gly	Ile	Pro	Asp	Ala	Glu	Ser	Ile	Pro	Asn	Leu	
	370					375					380					
Lys	Thr	Val	Thr	Met	Val	Ile	Gln	Glu	Thr	Met	Arg	Leu	Tyr	Pro	Pro	
385					390					395					400	
Ala	Pro	Ile	Val	Gly	Arg	Glu	Ala	Ser	Lys	Asp	Ile	Arg	Leu	Gly	Asp	
				405					410					415		
Leu	Val	Val	Pro	Lys	Gly	Val	Cys	Ile	Trp	Thr	Leu	Ile	Pro	Ala	Leu	
			420					425					430			
His	Arg	Asp	Pro	Glu	Ile	Trp	Gly	Pro	Asp	Ala	Asn	Asp	Phe	Lys	Pro	
		435					440					445				
Glu	Arg	Phe	Ser	Glu	Gly	Ile	Ser	Lys	Ala	Cys	Lys	Tyr	Pro	Gln	Ser	
	450					455					460					

SeqLst

Tyr Ile Pro Phe Gly Leu Gly Pro Arg Thr Cys Val Gly Lys Asn Phe
 465 470 475 480

Gly Met Met Glu Val Lys Val Leu Val Ser Leu Ile Val Ser Lys Phe
 485 490 495

Ser Phe Thr Leu Ser Pro Thr Tyr Gln His Ser Pro Ser His Lys Leu
 500 505 510

Leu Val Glu Pro Gln His Gly Val Val Ile Arg Val Val
 515 520 525

<210> 145
 <211> 529
 <212> PRT
 <213> Vitis vinifera

<400> 145
 Met Tyr Phe Leu Leu Gln Tyr Leu Asn Ile Thr Thr Val Gly Val Phe
 1 5 10 15

Ala Thr Leu Phe Leu Ser Tyr Cys Leu Leu Leu Trp Arg Ser Arg Ala
 20 25 30

Gly Asn Lys Lys Ile Ala Pro Glu Ala Ala Ala Ala Trp Pro Ile Ile
 35 40 45

Gly His Leu His Leu Leu Ala Gly Gly Ser His Gln Leu Pro His Ile
 50 55 60

Thr Leu Gly Asn Met Ala Asp Lys Tyr Gly Pro Val Phe Thr Ile Arg
 65 70 75 80

Ile Gly Leu His Arg Ala Val Val Val Ser Ser Trp Glu Met Ala Lys
 85 90 95

Glu Cys Ser Thr Ala Asn Asp Gln Val Ser Ser Ser Arg Pro Glu Leu
 100 105 110

Leu Ala Ser Lys Leu Leu Gly Tyr Asn Tyr Ala Met Phe Gly Phe Ser
 115 120 125

Pro Tyr Gly Ser Tyr Trp Arg Glu Met Arg Lys Ile Ile Ser Leu Glu
 130 135 140

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

Glu Val Val Thr Ser Ile Lys Glu Leu Tyr Lys Leu Trp Ala Glu Lys

SeqLst															
165								170				175			
Lys	Asn	Glu	Ser 180	Gly	Leu	Val	Ser	Val 185	Glu	Met	Lys	Gln	Trp 190	Phe	Gly
Asp	Leu	Thr 195	Leu	Asn	Val	Ile	Leu 200	Arg	Met	Val	Ala	Gly 205	Lys	Arg	Tyr
Phe	Ser 210	Ala	Ser	Asp	Ala	Ser 215	Glu	Asn	Lys	Gln	Ala 220	Gln	Arg	Cys	Arg
Arg 225	Val	Phe	Arg	Glu	Phe 230	Phe	His	Leu	Ser	Gly 235	Leu	Phe	Val	Val	Ala 240
Asp	Ala	Ile	Pro	Phe 245	Leu	Gly	Trp	Leu	Asp 250	Trp	Gly	Arg	His	Glu 255	Lys
Thr	Leu	Lys	Lys 260	Thr	Ala	Ile	Glu	Met 265	Asp	Ser	Ile	Ala	Gln 270	Glu	Trp
Leu	Glu	Glu 275	His	Arg	Arg	Arg	Lys 280	Asp	Ser	Gly	Asp	Asp 285	Asn	Ser	Thr
Gln	Asp 290	Phe	Met	Asp	Val	Met 295	Gln	Ser	Val	Leu	Asp 300	Gly	Lys	Asn	Leu
Gly 305	Gly	Tyr	Asp	Ala	Asp 310	Thr	Ile	Asn	Lys	Ala 315	Thr	Cys	Leu	Thr	Leu 320
Ile	Ser	Gly	Gly	Ser 325	Asp	Thr	Thr	Val	Val 330	Ser	Leu	Thr	Trp	Ala 335	Leu
Ser	Leu	Val	Leu 340	Asn	Asn	Arg	Asp	Thr 345	Leu	Lys	Lys	Ala	Gln 350	Glu	Glu
Leu	Asp	Ile 355	Gln	Val	Gly	Lys	Glu 360	Arg	Leu	Val	Asn	Glu 365	Gln	Asp	Ile
Ser	Lys 370	Leu	Val	Tyr	Leu	Gln 375	Ala	Ile	Val	Lys	Glu 380	Thr	Leu	Arg	Leu
Tyr 385	Pro	Pro	Gly	Pro	Leu 390	Gly	Gly	Leu	Arg	Gln 395	Phe	Thr	Glu	Asp	Cys 400
Thr	Leu	Gly	Gly	Tyr 405	His	Val	Ser	Lys	Gly 410	Thr	Arg	Leu	Ile	Met 415	Asn

SeqLst

Leu Ser Lys Ile Gln Lys Asp Pro Arg Ile Trp Ser Asp Pro Thr Glu
 420 425 430

Phe Gln Pro Glu Arg Phe Leu Thr Thr His Lys Asp Val Asp Pro Arg
 435 440 445

Gly Lys His Phe Glu Phe Ile Pro Phe Gly Ala Gly Arg Arg Ala Cys
 450 455 460

Pro Gly Ile Thr Phe Gly Leu Gln Val Leu His Leu Thr Leu Ala Ser
 465 470 475 480

Phe Leu His Ala Phe Glu Phe Ser Thr Pro Ser Asn Glu Gln Val Asn
 485 490 495

Met Arg Glu Ser Leu Gly Leu Thr Asn Met Lys Ser Thr Pro Leu Glu
 500 505 510

Val Leu Ile Ser Pro Arg Leu Ser Leu Asn Cys Phe Asn Leu Met Lys
 515 520 525

Ile

<210> 146

<211> 479

<212> PRT

<213> Medicago trunculata

<400> 146

Met Glu Pro Asn Phe Tyr Leu Ser Leu Leu Leu Leu Phe Val Thr Phe
 1 5 10 15

Ile Ser Leu Ser Leu Phe Phe Ile Phe Tyr Lys Gln Lys Ser Pro Leu
 20 25 30

Asn Leu Pro Pro Gly Lys Met Gly Tyr Pro Ile Ile Gly Glu Ser Leu
 35 40 45

Glu Phe Leu Ser Thr Gly Trp Lys Gly His Pro Glu Lys Phe Ile Phe
 50 55 60

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

Gly Glu Ser Thr Val Val Cys Cys Gly Ala Ala Ser Asn Lys Phe Leu
 85 90 95

Phe Ser Asn Glu Asn Lys Leu Val Thr Ala Trp Trp Pro Asp Ser Val

SeqLst

Leu Ser Pro Pro Leu Gln Gly Gly Phe Arg Glu Ala Ile Thr Asp Phe
355 360 365

Met Phe Asn Gly Phe Ser Ile Pro Lys Gly Trp Lys Leu Tyr Trp Ser
370 375 380

Ala Asn Ser Thr His Lys Asn Ala Glu Cys Phe Pro Met Pro Glu Lys
385 390 395 400

Phe Asp Pro Thr Arg Phe Glu Gly Asn Gly Pro Ala Pro Tyr Thr Phe
405 410 415

Val Pro Phe Gly Gly Gly Pro Arg Met Cys Pro Gly Lys Glu Tyr Ala
420 425 430

Arg Leu Glu Ile Leu Val Phe Met His Asn Leu Val Lys Arg Phe Lys
435 440 445

Trp Glu Lys Val Ile Pro Asp Glu Lys Ile Ile Val Asp Pro Phe Pro
450 455 460

Ile Pro Ala Lys Asp Leu Pro Ile Arg Leu Tyr Pro His Lys Ala
465 470 475

<210> 147
<211> 710
<212> PRT
<213> Stevia rebaudiana

<400> 147
Met Gln Ser Asp Ser Val Lys Val Ser Pro Phe Asp Leu Val Ser Ala
1 5 10 15

Ala Met Asn Gly Lys Ala Met Glu Lys Leu Asn Ala Ser Glu Ser Glu
20 25 30

Asp Pro Thr Thr Leu Pro Ala Leu Lys Met Leu Val Glu Asn Arg Glu
35 40 45

Leu Leu Thr Leu Phe Thr Thr Ser Phe Ala Val Leu Ile Gly Cys Leu
50 55 60

Val Phe Leu Met Trp Arg Arg Ser Ser Ser Lys Lys Leu Val Gln Asp
65 70 75 80

Pro Val Pro Gln Val Ile Val Val Lys Lys Lys Glu Lys Glu Ser Glu
85 90 95

Val Asp Asp Gly Lys Lys Lys Val Ser Ile Phe Tyr Gly Thr Gln Thr

SeqLst

Tyr Ser Glu Asn Leu Ser Glu Val Val Asp Glu Ala Leu Lys Leu Leu
355 360 365

Gly Leu Ser Pro Asp Thr Tyr Phe Ser Val His Ala Asp Lys Glu Asp
370 375 380

Gly Thr Pro Ile Gly Gly Ala Ser Leu Pro Pro Pro Phe Pro Pro Cys
385 390 395 400

Thr Leu Arg Asp Ala Leu Thr Arg Tyr Ala Asp Val Leu Ser Ser Pro
405 410 415

Lys Lys Val Ala Leu Leu Ala Leu Ala Ala His Ala Ser Asp Pro Ser
420 425 430

Glu Ala Asp Arg Leu Lys Phe Leu Ala Ser Pro Ala Gly Lys Asp Glu
435 440 445

Tyr Ala Gln Trp Ile Val Ala Asn Gln Arg Ser Leu Leu Glu Val Met
450 455 460

Gln Ser Phe Pro Ser Ala Lys Pro Pro Leu Gly Val Phe Phe Ala Ala
465 470 475 480

Val Ala Pro Arg Leu Gln Pro Arg Tyr Tyr Ser Ile Ser Ser Ser Pro
485 490 495

Lys Met Ser Pro Asn Arg Ile His Val Thr Cys Ala Leu Val Tyr Glu
500 505 510

Thr Thr Pro Ala Gly Arg Ile His Arg Gly Leu Cys Ser Thr Trp Met
515 520 525

Lys Asn Ala Val Pro Leu Thr Glu Ser Pro Asp Cys Ser Gln Ala Ser
530 535 540

Ile Phe Val Arg Thr Ser Asn Phe Arg Leu Pro Val Asp Pro Lys Val
545 550 555 560

Pro Val Ile Met Ile Gly Pro Gly Thr Gly Leu Ala Pro Phe Arg Gly
565 570 575

Phe Leu Gln Glu Arg Leu Ala Leu Lys Glu Ser Gly Thr Glu Leu Gly
580 585 590

Ser Ser Ile Phe Phe Phe Gly Cys Arg Asn Arg Lys Val Asp Phe Ile
595 600 605

SeqLst

Tyr Glu Asp Glu Leu Asn Asn Phe Val Glu Thr Gly Ala Leu Ser Glu
610 615 620

Leu Ile Val Ala Phe Ser Arg Glu Gly Thr Ala Lys Glu Tyr Val Gln
625 630 635 640

His Lys Met Ser Gln Lys Ala Ser Asp Ile Trp Lys Leu Leu Ser Glu
645 650 655

Gly Ala Tyr Leu Tyr Val Cys Gly Asp Ala Lys Gly Met Ala Lys Asp
660 665 670

Val His Arg Thr Leu His Thr Ile Val Gln Glu Gln Gly Ser Leu Asp
675 680 685

Ser Ser Lys Ala Glu Leu Tyr Val Lys Asn Leu Gln Met Ser Gly Arg
690 695 700

Tyr Leu Arg Asp Val Trp
705 710

<210> 148

<211> 692

<212> PRT

<213> Arabidopsis thaliana

<400> 148

Met Thr Ser Ala Leu Tyr Ala Ser Asp Leu Phe Lys Gln Leu Lys Ser
1 5 10 15

Ile Met Gly Thr Asp Ser Leu Ser Asp Asp Val Val Leu Val Ile Ala
20 25 30

Thr Thr Ser Leu Ala Leu Val Ala Gly Phe Val Val Leu Leu Trp Lys
35 40 45

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

Lys Ser Leu Met Ala Lys Asp Glu Asp Asp Asp Leu Asp Leu Gly Ser
65 70 75 80

Gly Lys Thr Arg Val Ser Ile Phe Phe Gly Thr Gln Thr Gly Thr Ala
85 90 95

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

SeqLst

Lys Ala Ala Val Lys Val Ile Asp Leu Asp Asp Tyr Ala Ala Asp Asp
 115 120 125

Asp Gln Tyr Glu Glu Lys Leu Lys Lys Glu Thr Leu Ala Phe Phe Cys
 130 135 140

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

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

Leu Ala Tyr Gly Val Phe Ala Leu Gly Asn Arg Gln Tyr Glu His Phe
 180 185 190

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

Lys Arg Leu Ile Glu Val Gly Leu Gly Asp Asp Asp Gln Ser Ile Glu
 210 215 220

Asp Asp Phe Asn Ala Trp Lys Glu Ser Leu Trp Ser Glu Leu Asp Lys
 225 230 235 240

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

Val Ile Pro Glu Tyr Arg Val Val Thr His Asp Pro Arg Phe Thr Thr
 260 265 270

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

Ile His His Pro Cys Arg Val Asp Val Ala Val Gln Lys Glu Leu His
 290 295 300

Thr His Glu Ser Asp Arg Ser Cys Ile His Leu Glu Phe Asp Ile Ser
 305 310 315 320

Arg Thr Gly Ile Thr Tyr Glu Thr Gly Asp His Val Gly Val Tyr Ala
 325 330 335

Glu Asn His Val Glu Ile Val Glu Glu Ala Gly Lys Leu Leu Gly His
 340 345 350

Ser Leu Asp Leu Val Phe Ser Ile His Ala Asp Lys Glu Asp Gly Ser
 355 360 365

SeqLst

Pro Leu Glu Ser Ala Val Pro Pro Pro Phe Pro Gly Pro Cys Thr Leu
 370 375 380

Gly Thr Gly Leu Ala Arg Tyr Ala Asp Leu Leu Asn Pro Pro Arg Lys
 385 390 395 400

Ser Ala Leu Val Ala Leu Ala Ala Tyr Ala Thr Glu Pro Ser Glu Ala
 405 410 415

Glu Lys Leu Lys His Leu Thr Ser Pro Asp Gly Lys Asp Glu Tyr Ser
 420 425 430

Gln Trp Ile Val Ala Ser Gln Arg Ser Leu Leu Glu Val Met Ala Ala
 435 440 445

Phe Pro Ser Ala Lys Pro Pro Leu Gly Val Phe Phe Ala Ala Ile Ala
 450 455 460

Pro Arg Leu Gln Pro Arg Tyr Tyr Ser Ile Ser Ser Ser Pro Arg Leu
 465 470 475 480

Ala Pro Ser Arg Val His Val Thr Ser Ala Leu Val Tyr Gly Pro Thr
 485 490 495

Pro Thr Gly Arg Ile His Lys Gly Val Cys Ser Thr Trp Met Lys Asn
 500 505 510

Ala Val Pro Ala Glu Lys Ser His Glu Cys Ser Gly Ala Pro Ile Phe
 515 520 525

Ile Arg Ala Ser Asn Phe Lys Leu Pro Ser Asn Pro Ser Thr Pro Ile
 530 535 540

Val Met Val Gly Pro Gly Thr Gly Leu Ala Pro Phe Arg Gly Phe Leu
 545 550 555 560

Gln Glu Arg Met Ala Leu Lys Glu Asp Gly Glu Glu Leu Gly Ser Ser
 565 570 575

Leu Leu Phe Phe Gly Cys Arg Asn Arg Gln Met Asp Phe Ile Tyr Glu
 580 585 590

Asp Glu Leu Asn Asn Phe Val Asp Gln Gly Val Ile Ser Glu Leu Ile
 595 600 605

Met Ala Phe Ser Arg Glu Gly Ala Gln Lys Glu Tyr Val Gln His Lys
 610 615 620

SeqLst

Met Met Glu Lys Ala Ala Gln Val Trp Asp Leu Ile Lys Glu Glu Gly
625 630 635 640

Tyr Leu Tyr Val Cys Gly Asp Ala Lys Gly Met Ala Arg Asp Val His
645 650 655

Arg Thr Leu His Thr Ile Val Gln Glu Gln Glu Gly Val Ser Ser Ser
660 665 670

Glu Ala Glu Ala Ile Val Lys Lys Leu Gln Thr Glu Gly Arg Tyr Leu
675 680 685

Arg Asp Val Trp
690

<210> 149

<211> 713

<212> PRT

<213> Gibberella fujikuroi

<400> 149

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

Leu Gly Thr Val Ala Tyr Phe Thr Lys Gly Lys Leu Trp Gly Val Thr
20 25 30

Lys Asp Pro Tyr Ala Asn Gly Phe Ala Ala Gly Gly Ala Ser Lys Pro
35 40 45

Gly Arg Thr Arg Asn Ile Val Glu Ala Met Glu Glu Ser Gly Lys Asn
50 55 60

Cys Val Val Phe Tyr Gly Ser Gln Thr Gly Thr Ala Glu Asp Tyr Ala
65 70 75 80

Ser Arg Leu Ala Lys Glu Gly Lys Ser Arg Phe Gly Leu Asn Thr Met
85 90 95

Ile Ala Asp Leu Glu Asp Tyr Asp Phe Asp Asn Leu Asp Thr Val Pro
100 105 110

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

Pro Thr Asp Asn Ala Val Asp Phe Tyr Glu Phe Ile Thr Gly Glu Asp
130 135 140

SeqLst

Ala Ser Phe Asn Glu Gly Asn Asp Pro Pro Leu Gly Asn Leu Asn Tyr
 145 150 155 160
 Val Ala Phe Gly Leu Gly Asn Asn Thr Tyr Glu His Tyr Asn Ser Met
 165 170 175
 Val Arg Asn Val Asn Lys Ala Leu Glu Lys Leu Gly Ala His Arg Ile
 180 185 190
 Gly Glu Ala Gly Glu Gly Asp Asp Gly Ala Gly Thr Met Glu Glu Asp
 195 200 205
 Phe Leu Ala Trp Lys Asp Pro Met Trp Glu Ala Leu Ala Lys Lys Met
 210 215 220
 Gly Leu Glu Glu Arg Glu Ala Val Tyr Glu Pro Ile Phe Ala Ile Asn
 225 230 235 240
 Glu Arg Asp Asp Leu Thr Pro Glu Ala Asn Glu Val Tyr Leu Gly Glu
 245 250 255
 Pro Asn Lys Leu His Leu Glu Gly Thr Ala Lys Gly Pro Phe Asn Ser
 260 265 270
 His Asn Pro Tyr Ile Ala Pro Ile Ala Glu Ser Tyr Glu Leu Phe Ser
 275 280 285
 Ala Lys Asp Arg Asn Cys Leu His Met Glu Ile Asp Ile Ser Gly Ser
 290 295 300
 Asn Leu Lys Tyr Glu Thr Gly Asp His Ile Ala Ile Trp Pro Thr Asn
 305 310 315 320
 Pro Gly Glu Glu Val Asn Lys Phe Leu Asp Ile Leu Asp Leu Ser Gly
 325 330 335
 Lys Gln His Ser Val Val Thr Val Lys Ala Leu Glu Pro Thr Ala Lys
 340 345 350
 Val Pro Phe Pro Asn Pro Thr Thr Tyr Asp Ala Ile Leu Arg Tyr His
 355 360 365
 Leu Glu Ile Cys Ala Pro Val Ser Arg Gln Phe Val Ser Thr Leu Ala
 370 375 380
 Ala Phe Ala Pro Asn Asp Asp Ile Lys Ala Glu Met Asn Arg Leu Gly
 385 390 395 400

SeqLst

Ser Asp Lys Asp Tyr Phe His Glu Lys Thr Gly Pro His Tyr Tyr Asn
 405 410 415
 Ile Ala Arg Phe Leu Ala Ser Val Ser Lys Gly Glu Lys Trp Thr Lys
 420 425 430
 Ile Pro Phe Ser Ala Phe Ile Glu Gly Leu Thr Lys Leu Gln Pro Arg
 435 440 445
 Tyr Tyr Ser Ile Ser Ser Ser Ser Leu Val Gln Pro Lys Lys Ile Ser
 450 455 460
 Ile Thr Ala Val Val Glu Ser Gln Gln Ile Pro Gly Arg Asp Asp Pro
 465 470 475 480
 Phe Arg Gly Val Ala Thr Asn Tyr Leu Phe Ala Leu Lys Gln Lys Gln
 485 490 495
 Asn Gly Asp Pro Asn Pro Ala Pro Phe Gly Gln Ser Tyr Glu Leu Thr
 500 505 510
 Gly Pro Arg Asn Lys Tyr Asp Gly Ile His Val Pro Val His Val Arg
 515 520 525
 His Ser Asn Phe Lys Leu Pro Ser Asp Pro Gly Lys Pro Ile Ile Met
 530 535 540
 Ile Gly Pro Gly Thr Gly Val Ala Pro Phe Arg Gly Phe Val Gln Glu
 545 550 555 560
 Arg Ala Lys Gln Ala Arg Asp Gly Val Glu Val Gly Lys Thr Leu Leu
 565 570 575
 Phe Phe Gly Cys Arg Lys Ser Thr Glu Asp Phe Met Tyr Gln Lys Glu
 580 585 590
 Trp Gln Glu Tyr Lys Glu Ala Leu Gly Asp Lys Phe Glu Met Ile Thr
 595 600 605
 Ala Phe Ser Arg Glu Gly Ser Lys Lys Val Tyr Val Gln His Arg Leu
 610 615 620
 Lys Glu Arg Ser Lys Glu Val Ser Asp Leu Leu Ser Gln Lys Ala Tyr
 625 630 635 640
 Phe Tyr Val Cys Gly Asp Ala Ala His Met Ala Arg Glu Val Asn Thr

SeqLst															
645								650				655			
Val	Leu	Ala	Gln 660	Ile	Ile	Ala	Glu	Gly 665	Arg	Gly	Val	Ser	Glu 670	Ala	Lys
Gly	Glu	Glu 675	Ile	Val	Lys	Asn	Met 680	Arg	Ser	Ala	Asn	Gln 685	Tyr	Gln	Val
Cys	Ser 690	Asp	Phe	Val	Thr	Leu 695	His	Cys	Lys	Glu	Thr 700	Thr	Tyr	Ala	Asn
Ser 705	Glu	Leu	Gln	Glu	Asp 710	Val	Trp	Ser							
<210> 150															
<211> 453															
<212> PRT															
<213> Arabidopsis thaliana															
<400> 150															
Met 1	Gly	Gly	Leu	Lys 5	Phe	His	Val	Leu	Met 10	Tyr	Pro	Trp	Phe	Ala 15	Thr
Gly	His	Met	Thr 20	Pro	Phe	Leu	Phe	Leu 25	Ala	Asn	Lys	Leu	Ala 30	Glu	Lys
Gly	His	Thr 35	Val	Thr	Phe	Leu	Leu 40	Pro	Lys	Lys	Ser	Leu 45	Lys	Gln	Leu
Glu	His 50	Phe	Asn	Leu	Phe	Pro 55	His	Asn	Ile	Val	Phe 60	Arg	Ser	Val	Thr
Val 65	Pro	His	Val	Asp	Gly 70	Leu	Pro	Val	Gly	Thr 75	Glu	Thr	Ala	Ser	Glu 80
Ile	Pro	Val	Thr	Ser 85	Thr	Asp	Leu	Leu	Met 90	Ser	Ala	Met	Asp	Leu 95	Thr
Arg	Asp	Gln	Val 100	Glu	Ala	Val	Val	Arg 105	Ala	Val	Glu	Pro	Asp 110	Leu	Ile
Phe	Phe	Asp 115	Phe	Ala	His	Trp	Ile 120	Pro	Glu	Val	Ala	Arg 125	Asp	Phe	Gly
Leu	Lys 130	Thr	Val	Lys	Tyr	Val 135	Val	Val	Ser	Ala	Ser 140	Thr	Ile	Ala	Ser
Met 145	Leu	Val	Pro	Gly	Gly 150	Glu	Leu	Gly	Val	Pro 155	Pro	Pro	Gly	Tyr	Pro 160

SeqLst

Ser Ser Lys Val₁₆₅ Leu₁₆₅ Leu Arg Lys Gln Asp₁₇₀ Ala Tyr Thr Met Lys₁₇₅ Lys
 Leu Glu Pro Thr₁₈₀ Asn Thr Ile Asp Val₁₈₅ Gly Pro Asn Leu₁₉₀ Leu₁₉₀ Glu Arg
 Val Thr Thr₁₉₅ Ser Leu Met Asn Ser₂₀₀ Asp Val Ile Ala Ile₂₀₅ Arg Thr Ala
 Arg Glu₂₁₀ Ile Glu Gly Asn Phe₂₁₅ Cys Asp Tyr Ile Glu₂₂₀ Lys His Cys Arg
 Lys₂₂₅ Lys Val Leu Leu Thr₂₃₀ Gly Pro Val Phe Pro₂₃₅ Glu Pro Asp Lys Thr₂₄₀
 Arg Glu Leu Glu₂₄₅ Glu Arg Trp Val Lys Trp₂₅₀ Leu Ser Gly Tyr Glu₂₅₅ Pro
 Asp Ser Val Val₂₆₀ Phe Cys Ala Leu Gly₂₆₅ Ser Gln Val Ile Leu₂₇₀ Glu Lys
 Asp Gln Phe₂₇₅ Gln Glu Leu Cys Leu₂₈₀ Gly Met Glu Leu Thr₂₈₅ Gly Ser Pro
 Phe Leu₂₉₀ Val Ala Val Lys Pro₂₉₅ Pro Arg Gly Ser Ser₃₀₀ Thr Ile Gln Glu
 Ala Leu Pro Glu Gly Phe₃₁₀ Glu Glu Arg Val Lys₃₁₅ Gly Arg Gly Leu Val₃₂₀
 Trp Gly Gly Trp Val₃₂₅ Gln Gln Pro Leu Ile₃₃₀ Leu Ser His Pro Ser₃₃₅ Val
 Gly Cys Phe Val₃₄₀ Ser His Cys Gly Phe₃₄₅ Gly Ser Met Trp Glu₃₅₀ Ser Leu
 Leu Ser Asp₃₅₅ Cys Gln Ile Val Leu₃₆₀ Val Pro Gln Leu Gly₃₆₅ Asp Gln Val
 Leu Asn Thr Arg Leu Leu Ser₃₇₅ Asp Glu Leu Lys Val₃₈₀ Ser Val Glu Val
 Ala Arg Glu Glu Thr Gly₃₉₀ Trp Phe Ser Lys Glu₃₉₅ Ser Leu Cys Asp Ala₄₀₀
 Val Asn Ser Val Met Lys Arg Asp Ser Glu Leu Gly Asn Leu Val Arg

SeqLst

405 410 415

Lys Asn His Thr 420 Lys Trp Arg Glu Thr 425 Val Ala Ser Pro Gly 430 Leu Met

Thr Gly Tyr 435 Val Asp Ala Phe Val 440 Glu Ser Leu Gln 445 Asp Leu Val Ser

Gly Thr Thr His Asp 450

SeqLst

aagtggaggg agacagtagc tagtcctgga ctaatgactg gttatgtcga tgcttttcgta	1320
gagtcattgc aggatcttgt ctctgggacc acccatgact ga	1362

<210> 152
 <211> 462
 <212> PRT
 <213> Oryza sativa

<400> 152

Met	Asp	Ser	Gly	Tyr	Ser	Ser	Ser	Tyr	Ala	Ala	Ala	Ala	Gly	Met	His
1				5					10					15	
Val	Val	Ile	Cys	Pro	Trp	Leu	Ala	Phe	Gly	His	Leu	Leu	Pro	Cys	Leu
			20					25					30		
Asp	Leu	Ala	Gln	Arg	Leu	Ala	Ser	Arg	Gly	His	Arg	Val	Ser	Phe	Val
		35					40					45			
Ser	Thr	Pro	Arg	Asn	Ile	Ser	Arg	Leu	Pro	Pro	Val	Arg	Pro	Ala	Leu
		50				55					60				
Ala	Pro	Leu	Val	Ala	Phe	Val	Ala	Leu	Pro	Leu	Pro	Arg	Val	Glu	Gly
65					70					75				80	
Leu	Pro	Asp	Gly	Ala	Glu	Ser	Thr	Asn	Asp	Val	Pro	His	Asp	Arg	Pro
				85					90					95	
Asp	Met	Val	Glu	Leu	His	Arg	Arg	Ala	Phe	Asp	Gly	Leu	Ala	Ala	Pro
			100					105					110		
Phe	Ser	Glu	Phe	Leu	Gly	Thr	Ala	Cys	Ala	Asp	Trp	Val	Ile	Val	Asp
		115					120					125			
Val	Phe	His	His	Trp	Ala	Ala	Ala	Ala	Ala	Leu	Glu	His	Lys	Val	Pro
	130				135						140				
Cys	Ala	Met	Met	Leu	Leu	Gly	Ser	Ala	His	Met	Ile	Ala	Ser	Ile	Ala
145					150					155					160
Asp	Arg	Arg	Leu	Glu	Arg	Ala	Glu	Thr	Glu	Ser	Pro	Ala	Ala	Ala	Gly
			165						170					175	
Gln	Gly	Arg	Pro	Ala	Ala	Ala	Pro	Thr	Phe	Glu	Val	Ala	Arg	Met	Lys
		180						185					190		
Leu	Ile	Arg	Thr	Lys	Gly	Ser	Ser	Gly	Met	Ser	Leu	Ala	Glu	Arg	Phe
		195					200					205			
Ser	Leu	Thr	Leu	Ser	Arg	Ser	Ser	Leu	Val	Val	Gly	Arg	Ser	Cys	Val
	210					215					220				
Glu	Phe	Glu	Pro	Glu	Thr	Val	Pro	Leu	Leu	Ser	Thr	Leu	Arg	Gly	Lys
225					230					235					240
Pro	Ile	Thr	Phe	Leu	Gly	Leu	Met	Pro	Pro	Leu	His	Glu	Gly	Arg	Arg
			245						250					255	
Glu	Asp	Gly	Glu	Asp	Ala	Thr	Val	Arg	Trp	Leu	Asp	Ala	Gln	Pro	Ala
			260					265					270		
Lys	Ser	Val	Val	Tyr	Val	Ala	Leu	Gly	Ser	Glu	Val	Pro	Leu	Gly	Val
		275					280					285			
Glu	Lys	Val	His	Glu	Leu	Ala	Leu	Gly	Leu	Glu	Leu	Ala	Gly	Thr	Arg
	290					295					300				
Phe	Leu	Trp	Ala	Leu	Arg	Lys	Pro	Thr	Gly	Val	Ser	Asp	Ala	Asp	Leu
305					310					315					320
Leu	Pro	Ala	Gly	Phe	Glu	Glu	Arg	Thr	Arg	Gly	Arg	Gly	Val	Val	Ala
			325						330					335	
Thr	Arg	Trp	Val	Pro	Gln	Met	Ser	Ile	Leu	Ala	His	Ala	Ala	Val	Gly
			340					345					350		
Ala	Phe	Leu	Thr	His	Cys	Gly	Trp	Asn	Ser	Thr	Ile	Glu	Gly	Leu	Met
		355					360					365			
Phe	Gly	His	Pro	Leu	Ile	Met	Leu	Pro	Ile	Phe	Gly	Asp	Gln	Gly	Pro
	370					375					380				
Asn	Ala	Arg	Leu	Ile	Glu	Ala	Lys	Asn	Ala	Gly	Leu	Gln	Val	Ala	Arg
385					390					395					400
Asn	Asp	Gly	Asp	Gly	Ser	Phe	Asp	Arg	Glu	Gly	Val	Ala	Ala	Ala	Ile
				405					410					415	

SeqLst

Arg	Ala	Val	Ala	Val	Glu	Glu	Glu	Ser	Ser	Lys	Val	Phe	Gln	Ala	Lys
			420					425					430		
Ala	Lys	Lys	Leu	Gln	Glu	Ile	Val	Ala	Asp	Met	Ala	Cys	His	Glu	Arg
		435					440					445			
Tyr	Ile	Asp	Gly	Phe	Ile	Gln	Gln	Leu	Arg	Ser	Tyr	Lys	Asp		
	450					455					460				

<210> 153
 <211> 1389
 <212> DNA
 <213> Oryza sativa

<400> 153

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cggggccacc	gcgtgtcggt	cgtctccacg	ccgcggaaca	tatccccgct	cccgcgggtg	180
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tgcgccgact	gggtcatcgt	cgacgtcttc	caccactggg	ccgcagccgc	cgctctcgag	420
cacaaggtgc	catgtgcaat	gatgttggtg	ggctctgcac	atatgatcgc	ttccatagca	480
gacagacggc	tcgagcgcg	ggagacagag	tcgcctgcgg	ctgccgggca	gggacgcca	540
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cggagctgcg	tggagttcga	gccggagacc	gtcccgctcc	tgtcgacgct	ccgcggtaag	720
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aacgacggcg	atggatcggt	cgaccgagaa	ggcgctcgcg	cggcgattcg	tgcagtcgcg	1260
gtggaggaag	aaagcagcaa	agtgtttcaa	gccaaagcca	agaagctgca	ggagatcgct	1320
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aaggattga						1389

<210> 154
 <211> 1389
 <212> DNA
 <213> Artificial Sequence

<220>
 <223> Oryza sativa sequence that has been codon optimized for yeast

<400> 154

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agaggccata	gagtatcatt	tgtgtctact	cctagaaata	tctctcgttt	accaccagtc	180
agacctgctc	tagctcctct	agttgcattc	gttgctcttc	cacttccaag	agtagaagga	240
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cataaggtgc	cttgtgctat	gatgttggtt	gggtcagcac	acatgatcgc	atccatagct	480
gatagaagat	tggaaagagc	tgaaacagaa	tccccagccg	cagcaggaca	aggtaggcca	540
gctgccgccc	caacctttga	agtggctaga	atgaaattga	ttcgtactaa	aggtagttca	600
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agatcctgcg	tcgagttcga	acctgaaaca	gtacctttac	tatctacttt	gagaggcaaa	720
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SeqLst

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aatgatgggtg	atgggttcctt	tgatagagaa	ggcgttgacg	ctgccatcag	agcagtcgcc	1260
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aaagactaa						1389

<210> 155

<211> 2506

<212> DNA

<213> Arabidopsis thaliana

<400> 155

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aaaggagaag	attaggaaga	tggtggagaa	agtggagctt	tctgtttc	cctacgata	240
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aagagaagca	tatctggcct	atgttttaga	ggggacaaga	aacctaaaag	attgggattt	720
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<210> 156

<211> 785

<212> PRT

SeqLst

<213> Arabidopsis thaliana

<400> 156

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Val Ser Phe Glu Gln Thr Lys Glu Lys Ile Arg Lys Met Leu Glu Lys
 35      40      45
Val Glu Leu Ser Val Ser Ala Tyr Asp Thr Ser Trp Val Ala Met Val
 50      55      60
Pro Ser Pro Ser Ser Gln Asn Ala Pro Leu Phe Pro Gln Cys Val Lys
 65      70      75      80
Trp Leu Leu Asp Asn Gln His Glu Asp Gly Ser Trp Gly Leu Asp Asn
 85      90      95
His Asp His Gln Ser Leu Lys Lys Asp Val Leu Ser Ser Thr Leu Ala
100      105      110
Ser Ile Leu Ala Leu Lys Lys Trp Gly Ile Gly Glu Arg Gln Ile Asn
115      120      125
Lys Gly Leu Gln Phe Ile Glu Leu Asn Ser Ala Leu Val Thr Asp Glu
130      135      140
Thr Ile Gln Lys Pro Thr Gly Phe Asp Ile Ile Phe Pro Gly Met Ile
145      150      155      160
Lys Tyr Ala Arg Asp Leu Asn Leu Thr Ile Pro Leu Gly Ser Glu Val
165      170      175
Val Asp Asp Met Ile Arg Lys Arg Asp Leu Asp Leu Lys Cys Asp Ser
180      185      190
Glu Lys Phe Ser Lys Gly Arg Glu Ala Tyr Leu Ala Tyr Val Leu Glu
195      200      205
Gly Thr Arg Asn Leu Lys Asp Trp Asp Leu Ile Val Lys Tyr Gln Arg
210      215      220
Lys Asn Gly Ser Leu Phe Asp Ser Pro Ala Thr Thr Ala Ala Ala Phe
225      230      235      240
Thr Gln Phe Gly Asn Asp Gly Cys Leu Arg Tyr Leu Cys Ser Leu Leu
245      250      255
Gln Lys Phe Glu Ala Ala Val Pro Ser Val Tyr Pro Phe Asp Gln Tyr
260      265      270
Ala Arg Leu Ser Ile Ile Val Thr Leu Glu Ser Leu Gly Ile Asp Arg
275      280      285
Asp Phe Lys Thr Glu Ile Lys Ser Ile Leu Asp Glu Thr Tyr Arg Tyr
290      295      300
Trp Leu Arg Gly Asp Glu Glu Ile Cys Leu Asp Leu Ala Thr Cys Ala
305      310      315      320
Leu Ala Phe Arg Leu Leu Leu Ala His Gly Tyr Asp Val Ser Tyr Asp
325      330      335
Pro Leu Lys Pro Phe Ala Glu Glu Ser Gly Phe Ser Asp Thr Leu Glu
340      345      350
Gly Tyr Val Lys Asn Thr Phe Ser Val Leu Glu Leu Phe Lys Ala Ala
355      360      365
Gln Ser Tyr Pro His Glu Ser Ala Leu Lys Lys Gln Cys Cys Trp Thr
370      375      380
Lys Gln Tyr Leu Glu Met Glu Leu Ser Ser Trp Val Lys Thr Ser Val
385      390      395      400
Arg Asp Lys Tyr Leu Lys Lys Glu Val Glu Asp Ala Leu Ala Phe Pro
405      410      415
Ser Tyr Ala Ser Leu Glu Arg Ser Asp His Arg Arg Lys Ile Leu Asn
420      425      430
Gly Ser Ala Val Glu Asn Thr Arg Val Thr Lys Thr Ser Tyr Arg Leu
435      440      445
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Asn Phe Cys Gln Ser Ile His Arg Glu Glu Met Glu Arg Leu Asp Arg
465      470      475      480

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SeqLst

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			500					505					510		
Leu	Ser	Asp	Ala	Arg	Ile	Ser	Trp	Ala	Lys	Gly	Gly	Val	Leu	Thr	Thr
		515					520					525			
Val	Val	Asp	Asp	Phe	Phe	Asp	Val	Gly	Gly	Ser	Lys	Glu	Glu	Leu	Glu
	530					535					540				
Asn	Leu	Ile	His	Leu	Val	Glu	Lys	Trp	Asp	Leu	Asn	Gly	Val	Pro	Glu
545				550					555					560	
Tyr	Ser	Ser	Glu	His	Val	Glu	Ile	Ile	Phe	Ser	Val	Leu	Arg	Asp	Thr
				565					570					575	
Ile	Leu	Glu	Thr	Gly	Asp	Lys	Ala	Phe	Thr	Tyr	Gln	Gly	Arg	Asn	Val
			580					585					590		
Thr	His	His	Ile	Val	Lys	Ile	Trp	Leu	Asp	Leu	Leu	Lys	Ser	Met	Leu
	595						600					605			
Arg	Glu	Ala	Glu	Trp	Ser	Ser	Asp	Lys	Ser	Thr	Pro	Ser	Leu	Glu	Asp
	610					615					620				
Tyr	Met	Glu	Asn	Ala	Tyr	Ile	Ser	Phe	Ala	Leu	Gly	Pro	Ile	Val	Leu
625				630					635					640	
Pro	Ala	Thr	Tyr	Leu	Ile	Gly	Pro	Pro	Leu	Pro	Glu	Lys	Thr	Val	Asp
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Ser	His	Gln	Tyr	Asn	Gln	Leu	Tyr	Lys	Leu	Val	Ser	Thr	Met	Gly	Arg
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		675					680					685			
Leu	Asn	Ala	Val	Ser	Leu	His	Met	Lys	His	Glu	Arg	Asp	Asn	Arg	Ser
	690					695					700				
Lys	Glu	Val	Ile	Ile	Glu	Ser	Met	Lys	Gly	Leu	Ala	Glu	Arg	Lys	Arg
705					710					715					720
Glu	Glu	Leu	His	Lys	Leu	Val	Leu	Glu	Glu	Lys	Gly	Ser	Val	Val	Pro
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Arg	Glu	Cys	Lys	Glu	Ala	Phe	Leu	Lys	Met	Ser	Lys	Val	Leu	Asn	Leu
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Phe	Tyr	Arg	Lys	Asp	Asp	Gly	Phe	Thr	Ser	Asn	Asp	Leu	Met	Ser	Leu
		755					760					765			
Val	Lys	Ser	Val	Ile	Tyr	Glu	Pro	Val	Ser	Leu	Gln	Lys	Glu	Ser	Leu
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Thr															
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<210> 157
 <211> 2490
 <212> DNA
 <213> Zea mays

<400> 157
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SeqLst

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<210> 158

<211> 827

<212> PRT

<213> Zea mays

<400> 158

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35      40      45
Ala Arg Ala Gln His Thr Ser Glu Ser Ala Ala Val Ala Lys Gly Ser
50      55      60
Ser Leu Thr Pro Ile Val Arg Thr Asp Ala Glu Ser Arg Arg Thr Arg
65      70      75      80
Trp Pro Thr Asp Asp Asp Asp Ala Glu Pro Leu Val Asp Glu Ile Arg
85      90      95
Ala Met Leu Thr Ser Met Ser Asp Gly Asp Ile Ser Val Ser Ala Tyr
100     105     110
Asp Thr Ala Trp Val Gly Leu Val Pro Arg Leu Asp Gly Gly Glu Gly
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Asp Gly Ser Trp Gly Asp Ala Ala Leu Phe Ser Ala Tyr Asp Arg Leu
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Lys Leu Ala Thr Glu Asp Glu Glu Ser Met Pro Ile Gly Phe Glu Leu
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SeqLst

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 His Cys Ser Lys Leu Arg Thr Gln Glu Tyr Ile Asn Ser Gln Glu Val
 50 55 60
 Gln His Asp Leu Pro Leu Ile His Glu Trp Gln Gln Leu Gln Gly Glu
 65 70 75 80
 Asp Ala Pro Gln Ile Ser Val Gly Ser Asn Ser Asn Ala Phe Lys Glu
 85 90 95
 Ala Val Lys Ser Val Lys Thr Ile Leu Arg Asn Leu Thr Asp Gly Glu
 100 105 110
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 405 410 415
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 420 425 430
 Ala Phe Pro Arg Glu Glu Ile Leu Lys Asn Ala Lys Glu Phe Ser Tyr
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SeqLst

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

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Glu His Gly Val Thr Ser Leu Lys Arg Gln Leu Ala Val Trp Asn Asp

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	SeqLst														
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145	Leu	Ser	Met	Leu	Glu 150	Lys	Glu	Leu	Asp	Val 155	Pro	Ser	Phe	Glu	Phe 160
					165	Glu	Arg	Met	His 170	Gly	Glu	Lys	Leu	Gly	His 175
Cys	Arg	Ser	Ile 180	Leu	Glu	Arg	Met	His 185	Pro	Ser	Ser	Leu	Leu	His 190	Ser
Asp	Leu	Glu 195	Gln	Val	Tyr	Gly	Lys 200	Pro	Ser	Ser	Leu	Leu	His	Ser	Leu
Glu	Ala 210	Phe	Leu	Gly	Lys	Leu 215	Asp	Phe	Asp	Arg	Leu 220	Ser	His	His	Leu
Tyr	His	Gly	Ser	Met	Met 230	Ala	Ser	Pro	Ser	Ser	Thr 235	Ala	Ala	Tyr	Leu 240
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Val	Met	Arg	Asn 260	Gly	Ala	Gly	His	Gly 265	Asn	Gly	Gly	Ile	Ser 270	Gly	Thr
Phe	Pro	Thr 275	Thr	His	Phe	Glu	Cys 280	Ser	Trp	Ile	Ile	Ala 285	Thr	Leu	Leu
Lys	Val 290	Gly	Phe	Thr	Leu	Lys 295	Gln	Ile	Asp	Gly	Asp 300	Gly	Leu	Arg	Gly
Leu	Ser	Thr	Ile	Leu	Leu 310	Glu	Ala	Leu	Arg	Asp 315	Glu	Asn	Gly	Val	Ile 320
305	Gly	Phe	Ala	Pro	Arg 325	Thr	Ala	Asp	Val	Asp 330	Thr	Ala	Lys	Ala	Leu 335
Leu	Ala	Leu	Ser 340	Leu	Val	Asn	Gln	Pro 345	Val	Ser	Pro	Asp	Ile 350	Met	Ile
Lys	Val 355	Phe	Glu	Gly	Lys	Asp	His 360	Phe	Thr	Thr	Phe	Gly 365	Ser	Glu	Arg
Asp	Pro 370	Ser	Leu	Thr	Ser	Asn 375	Leu	His	Val	Leu	Leu	Ser 380	Leu	Leu	Lys
Gln	Ser	Asn	Leu	Ser	Gln 390	Tyr	His	Pro	Gln	Ile 395	Leu	Lys	Thr	Thr	Leu 400
385	Phe	Thr	Cys	Arg	Trp 405	Trp	Trp	Gly	Ser	Asp 410	His	Cys	Val	Lys	Asp 415
Trp	Asn	Leu	Ser 420	His	Leu	Tyr	Pro	Thr 425	Met	Leu	Leu	Val	Glu 430	Ala	Phe
Thr	Glu	Val 435	Leu	His	Leu	Ile	Asp 440	Gly	Gly	Glu	Leu	Ser 445	Ser	Leu	Phe
Asp	Glu 450	Ser	Phe	Lys	Cys	Lys 455	Ile	Gly	Leu	Ser	Ile 460	Phe	Gln	Ala	Val
Leu	Arg	Ile	Ile	Leu	Thr 470	Gln	Asp	Asn	Asp	Gly 475	Ser	Trp	Arg	Gly	Tyr 480
465	Arg	Glu	Gln	Thr	Cys 485	Tyr	Ala	Ile	Leu	Ala 490	Leu	Val	Gln	Ala	Arg 495
Val	Cys	Phe	Phe 500	Thr	His	Met	Val	Asp 505	Arg	Leu	Gln	Ser	Cys 510	Val	Asp
Arg	Gly	Phe 515	Ser	Trp	Leu	Lys	Ser 520	Cys	Ser	Phe	His	Ser 525	Gln	Asp	Leu
Thr	Trp 530	Thr	Ser	Lys	Thr	Ala 535	Tyr	Glu	Val	Gly	Phe 540	Val	Ala	Glu	Ala
Tyr	Lys	Leu	Ala	Ala	Leu 550	Gln	Ser	Ala	Ser	Leu 555	Glu	Val	Pro	Ala	Ala 560
545	Thr	Ile	Gly	His	Ser 565	Val	Thr	Ser	Ala	Val 570	Pro	Ser	Ser	Asp	Leu 575
Lys	Tyr	Met	Arg 580	Leu	Val	Arg	Lys	Thr 585	Ala	Leu	Phe	Ser	Pro 590	Leu	Asp
Glu	Trp	Gly 595	Leu	Met	Ala	Ser	Ile 600	Ile	Glu	Ser	Ser	Phe 605	Phe	Val	Pro
Leu	Leu	Gln	Ala	Gln	Arg	Val 615	Glu	Ile	Tyr	Pro	Arg 620	Asp	Asn	Ile	Lys
610	Val	Asp	Glu	Asp	Lys	Tyr 630	Leu	Ser	Ile	Ile	Pro 635	Phe	Thr	Trp	Val
625															Gly 640

SeqLst

Cys	Asn	Asn	Arg	Ser	Arg	Thr	Phe	Ala	Ser	Asn	Arg	Trp	Leu	Tyr	Asp
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Met	Met	Tyr	Leu	Ser	Leu	Leu	Gly	Tyr	Gln	Thr	Asp	Glu	Tyr	Met	Glu
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Ala	Val	Ala	Gly	Pro	Val	Phe	Gly	Asp	Val	Ser	Leu	Leu	His	Gln	Thr
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Ile	Asp	Lys	Val	Ile	Asp	Asn	Thr	Met	Gly	Asn	Leu	Ala	Arg	Ala	Asn
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Gly	Thr	Val	His	Ser	Gly	Asn	Gly	His	Gln	His	Glu	Ser	Pro	Asn	Ile
705					710				715					720	
Gly	Gln	Val	Glu	Asp	Thr	Leu	Thr	Arg	Phe	Thr	Asn	Ser	Val	Leu	Asn
				725					730					735	
His	Lys	Asp	Val	Leu	Asn	Ser	Ser	Ser	Ser	Asp	Gln	Asp	Thr	Leu	Arg
			740					745					750		
Arg	Glu	Phe	Arg	Thr	Phe	Met	His	Ala	His	Ile	Thr	Gln	Ile	Glu	Asp
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Asn	Ser	Arg	Phe	Ser	Lys	Gln	Ala	Ser	Ser	Asp	Ala	Phe	Ser	Ser	Pro
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Glu	Gln	Ser	Tyr	Phe	Gln	Trp	Val	Asn	Ser	Thr	Gly	Gly	Ser	His	Val
785					790					795					800
Ala	Cys	Ala	Tyr	Ser	Phe	Ala	Phe	Ser	Asn	Cys	Leu	Met	Ser	Ala	Asn
				805					810					815	
Leu	Leu	Gln	Gly	Lys	Asp	Ala	Phe	Pro	Ser	Gly	Thr	Gln	Lys	Tyr	Leu
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Ile	Ser	Ser	Val	Met	Arg	His	Ala	Thr	Asn	Met	Cys	Arg	Met	Tyr	Asn
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Asp	Phe	Gly	Ser	Ile	Ala	Arg	Asp	Asn	Ala	Glu	Arg	Asn	Val	Asn	Ser
	850					855					860				
Ile	His	Phe	Pro	Glu	Phe	Thr	Leu	Cys	Asn	Gly	Thr	Ser	Gln	Asn	Leu
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Asp	Glu	Arg	Lys	Glu	Arg	Leu	Leu	Lys	Ile	Ala	Thr	Tyr	Glu	Gln	Gly
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Tyr	Leu	Asp	Arg	Ala	Leu	Glu	Ala	Leu	Glu	Arg	Gln	Ser	Arg	Asp	Asp
			900					905					910		
Ala	Gly	Asp	Arg	Ala	Gly	Ser	Lys	Asp	Met	Arg	Lys	Leu	Lys	Ile	Val
		915					920					925			
Lys	Leu	Phe	Cys	Asp	Val	Thr	Asp	Leu	Tyr	Asp	Gln	Leu	Tyr	Val	Ile
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 <211> 1503
 <212> DNA
 <213> Stevia rebaudiana

<400> 163
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 atcgggtcatc tctacctcct caaaaaacca ctctatagaa cactagccaa aattgccgcc 180
 aaatacggcc ctatcctcca actccaacta ggggtaccgcc gtgtcctcgt aatctcctcc 240
 ccttccgccg ccgaagaatg cttcaccaac aacgacgta tcttcgcaa ccgtccgaag 300
 acgtatttcg gaaaaattgt aggggggtacc agcctcgggt cgctgtcgta cgccgaccag 360
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 aaagtgggaa aaggaaggaa gacgatgac gagttgttgt tatccctaca agaacttgaa 840
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SeqLst

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gagtcgcaca tagggaatat accttacatt gggtgcatca taaacgagac gctcagattg 1080
taccctgcgg gcccgttgct atttcccatc gagtcatcag cggactgtgt tatcagcggg 1140
tacaacatcc ctcgtgggac gatgcttatt gtcaaccaat gggcgatata tcatgaccca 1200
aagggtgtggg acgaccctga gacattcaaa ccggaaagat tccaagggtc tgaagggaca 1260
cgagacgggt ttaagctgat gccttttggg tccggaagga ggggttgtcc aggggagggg 1320
ttggcgattc gtttgcttgg gatgactctc gggtcgggta tccaatgctt tgattgggaa 1380
cgagtcggtg acgagatggg tgatatgacc gaaggtcttg gggtcacgtt gcctaaagct 1440
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<210> 164
 <211> 500
 <212> PRT
 <213> Stevia rebaudiana

<400> 164

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Thr Val Phe Pro Ser Ile Pro Ile Ile Gly His Leu Tyr Leu Leu Lys
      35      40      45
Lys Pro Leu Tyr Arg Thr Leu Ala Lys Ile Ala Ala Lys Tyr Gly Pro
      50      55      60
Ile Leu Gln Leu Gln Leu Gly Tyr Arg Arg Val Leu Val Ile Ser Ser
      65      70      75      80
Pro Ser Ala Ala Glu Cys Phe Thr Asn Asn Asp Val Ile Phe Ala
      85      90      95
Asn Arg Pro Lys Thr Leu Phe Gly Lys Ile Val Gly Gly Thr Ser Leu
      100      105      110
Gly Ser Leu Ser Tyr Gly Asp Gln Trp Arg Asn Leu Arg Arg Val Ala
      115      120      125
Ser Ile Glu Ile Leu Ser Val His Arg Leu Asn Glu Phe His Asp Ile
      130      135      140
Arg Val Asp Glu Asn Arg Leu Leu Ile Arg Lys Leu Arg Ser Ser Ser
      145      150      155      160
Ser Pro Val Thr Leu Ile Thr Val Phe Tyr Ala Leu Thr Leu Asn Val
      165      170      175
Ile Met Arg Met Ile Ser Gly Lys Arg Tyr Phe Asp Ser Gly Asp Arg
      180      185      190
Glu Leu Glu Glu Gly Lys Arg Phe Arg Glu Ile Leu Asp Glu Thr
      195      200      205
Leu Leu Leu Ala Gly Ala Ser Asn Val Gly Asp Tyr Leu Pro Ile Leu
      210      215      220
Asn Trp Leu Gly Val Lys Ser Leu Glu Lys Lys Leu Ile Ala Leu Gln
      225      230      235      240
Lys Lys Arg Asp Asp Phe Phe Gln Gly Leu Ile Glu Gln Val Arg Lys
      245      250      255
Ser Arg Gly Ala Lys Val Gly Lys Gly Arg Lys Thr Met Ile Glu Leu
      260      265      270
Leu Leu Ser Leu Gln Glu Ser Glu Pro Glu Tyr Tyr Thr Asp Ala Met
      275      280      285
Ile Arg Ser Phe Val Leu Gly Leu Leu Ala Ala Gly Ser Asp Thr Ser
      290      295      300
Ala Gly Thr Met Glu Trp Ala Met Ser Leu Leu Val Asn His Pro His
      305      310      315      320
Val Leu Lys Lys Ala Gln Ala Glu Ile Asp Arg Val Ile Gly Asn Asn
      325      330      335
Arg Leu Ile Asp Glu Ser Asp Ile Gly Asn Ile Pro Tyr Ile Gly Cys
      340      345      350
Ile Ile Asn Glu Thr Leu Arg Leu Tyr Pro Ala Gly Pro Leu Leu Phe

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SeqLst

Pro	His	355	Glu	Ser	Ser	Ala	Asp	360	Cys	Val	Ile	Ser	Gly	365	Tyr	Asn	Ile	Pro
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				405						410								
Leu	Glu	Gly	Thr	Arg	Asp	Gly	Phe	Lys	Leu	Met	Pro	Phe	Gly	Ser	Gly			
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Arg	Arg	Gly	Cys	Pro	Gly	Glu	Gly	Leu	Ala	Ile	Arg	Leu	Leu	Gly	Met			
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Thr	Leu	Gly	Ser	Val	Ile	Gln	Cys	Phe	Asp	Trp	Glu	Arg	Val	Gly	Asp			
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Glu	Met	Val	Asp	Met	Thr	Glu	Gly	Leu	Gly	Val	Thr	Leu	Pro	Lys	Ala			
465					470					475					480			
Val	Pro	Leu	Val	Ala	Lys	Cys	Lys	Pro	Arg	Ser	Glu	Met	Thr	Asn	Leu			
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Leu	Ser	Glu	Leu															
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<210> 165
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 <212> DNA
 <213> Stevia rebaudiana

<400> 165
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 attggacact tatacttact caaaaagcct ctttatagaa ctttagcaaa aattgccgct 180
 aagtacggac caatactgca attacaactc ggctacagac gtgttctggt gatttcctca 240
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 acattgtttg gcaaaatagt ggggtgaaca tcccttggca gtttatccta cggcgatcaa 360
 tggcgtaatc taaggagagt agcttctatc gaaatcctat cagttcatag gttgaacgaa 420
 tttcatgata tcagagtggg tgagaacaga ttgttaatta gaaaacttag aagttcatct 480
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 taa 1503

<210> 166
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 <212> PRT
 <213> Saccharomyces cerevisiae

<400> 166
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SeqLst															
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Asp	Ile	Ala	Gln	Val	Val	Thr	Glu	Asn	Asn	Lys	Asn	Tyr	Leu	Val	Leu
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Tyr	Ala	Ser	Gln	Thr	Gly	Thr	Ala	Glu	Asp	Tyr	Ala	Lys	Lys	Phe	Ser
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Lys	Glu	Leu	Val	Ala	Lys	Phe	Asn	Leu	Asn	Val	Met	Cys	Ala	Asp	Val
				85					90					95	
Glu	Asn	Tyr	Asp	Phe	Glu	Ser	Leu	Asn	Asp	Val	Pro	Val	Ile	Val	Ser
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Ile	Phe	Ile	Ser	Thr	Tyr	Gly	Glu	Gly	Asp	Phe	Pro	Asp	Gly	Ala	Val
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Asn	Phe	Glu	Asp	Phe	Ile	Cys	Asn	Ala	Glu	Ala	Gly	Ala	Leu	Ser	Asn
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Leu	Arg	Tyr	Asn	Met	Phe	Gly	Leu	Gly	Asn	Ser	Thr	Tyr	Glu	Phe	Phe
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Asn	Gly	Ala	Ala	Lys	Lys	Ala	Glu	Lys	His	Leu	Ser	Ala	Ala	Gly	Ala
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Ile	Arg	Leu	Gly	Lys	Leu	Gly	Glu	Ala	Asp	Asp	Gly	Ala	Gly	Thr	Thr
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Asp	Glu	Asp	Tyr	Met	Ala	Trp	Lys	Asp	Ser	Ile	Leu	Glu	Val	Leu	Lys
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Asp	Glu	Leu	His	Leu	Asp	Glu	Gln	Glu	Ala	Lys	Phe	Thr	Ser	Gln	Phe
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Gln	Tyr	Thr	Val	Leu	Asn	Glu	Ile	Thr	Asp	Ser	Met	Ser	Leu	Gly	Glu
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Pro	Ser	Ala	His	Tyr	Leu	Pro	Ser	His	Gln	Leu	Asn	Arg	Asn	Ala	Asp
				245					250					255	
Gly	Ile	Gln	Leu	Gly	Pro	Phe	Asp	Leu	Ser	Gln	Pro	Tyr	Ile	Ala	Pro
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Ile	Val	Lys	Ser	Arg	Glu	Leu	Phe	Ser	Ser	Asn	Asp	Arg	Asn	Cys	Ile
		275					280					285			
His	Ser	Glu	Phe	Asp	Leu	Ser	Gly	Ser	Asn	Ile	Lys	Tyr	Ser	Thr	Gly
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Asp	His	Leu	Ala	Val	Trp	Pro	Ser	Asn	Pro	Leu	Glu	Lys	Val	Glu	Gln
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Phe	Leu	Ser	Ile	Phe	Asn	Leu	Asp	Pro	Glu	Thr	Ile	Phe	Asp	Leu	Lys
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Pro	Leu	Asp	Pro	Thr	Val	Lys	Val	Pro	Phe	Pro	Thr	Pro	Thr	Thr	Ile
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Gly	Ala	Ala	Ile	Lys	His	Tyr	Leu	Glu	Ile	Thr	Gly	Pro	Val	Ser	Arg
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Gln	Leu	Phe	Ser	Ser	Leu	Ile	Gln	Phe	Ala	Pro	Asn	Ala	Asp	Val	Lys
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Glu	Lys	Leu	Thr	Leu	Leu	Ser	Lys	Asp	Lys	Asp	Gln	Phe	Ala	Val	Glu
385					390					395				400	
Ile	Thr	Ser	Lys	Tyr	Phe	Asn	Ile	Ala	Asp	Ala	Leu	Lys	Tyr	Leu	Ser
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Asp	Gly	Ala	Lys	Trp	Asp	Thr	Val	Pro	Met	Gln	Phe	Leu	Val	Glu	Ser
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Val	Pro	Gln	Met	Thr	Pro	Arg	Tyr	Tyr	Ser	Ile	Ser	Ser	Ser	Ser	Leu
		435					440					445			
Ser	Glu	Lys	Gln	Thr	Val	His	Val	Thr	Ser	Ile	Val	Glu	Asn	Phe	Pro
	450					455					460				
Asn	Pro	Glu	Leu	Pro	Asp	Ala	Pro	Pro	Val	Val	Gly	Val	Thr	Thr	Asn
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Leu	Leu	Arg	Asn	Ile	Gln	Leu	Ala	Gln	Asn	Asn	Val	Asn	Ile	Ala	Glu
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Thr	Asn	Leu	Pro	Val	His	Tyr	Asp	Leu	Asn	Gly	Pro	Arg	Lys	Leu	Phe
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Ala	Asn	Tyr	Lys	Leu	Pro	Val	His	Val	Arg	Arg	Ser	Asn	Phe	Arg	Leu
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SeqLst

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545					550					555					560
Ser	Gln	Lys	Lys	Gly	Gly	Asn	Asn	Val	Ser	Leu	Gly	Lys	His	Ile	Leu
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Phe	Tyr	Gly	Ser	Arg	Asn	Thr	Asp	Asp	Phe	Leu	Tyr	Gln	Asp	Glu	Trp
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Pro	Glu	Tyr	Ala	Lys	Lys	Leu	Asp	Gly	Ser	Phe	Glu	Met	Val	Val	Ala
		595					600					605			
His	Ser	Arg	Leu	Pro	Asn	Thr	Lys	Lys	Val	Tyr	Val	Gln	Asp	Lys	Leu
	610					615					620				
Lys	Asp	Tyr	Glu	Asp	Gln	Val	Phe	Glu	Met	Ile	Asn	Asn	Gly	Ala	Phe
625					630					635					640
Ile	Tyr	Val	Cys	Gly	Asp	Ala	Lys	Gly	Met	Ala	Lys	Gly	Val	Ser	Thr
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Ala	Leu	Val	Gly	Ile	Leu	Ser	Arg	Gly	Lys	Ser	Ile	Thr	Thr	Asp	Glu
			660					665					670		
Ala	Thr	Glu	Leu	Ile	Lys	Met	Leu	Lys	Thr	Ser	Gly	Arg	Tyr	Gln	Glu
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Asp	Val	Trp													
690															

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 <212> PRT
 <213> Saccharomyces cerevisiae

<400> 167

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

SeqLst

Lys	Leu	Ile	260	Gln	Ile	Leu	Glu	Phe	265	Asp	Thr	Asn	Ser	Leu	270	Ala	Tyr	Thr
		275						280						285				
Lys	Asn	Phe	Ile	Asn	Gln	Leu	Val	Asn	Met	Ile	Lys	Asn	Asp	Asn	Glu			
	290				295						300							
Asn	Lys	Tyr	Leu	Pro	Asp	Leu	Ala	Ser	His	Ser	Asp	Thr	Ala	Thr	Asn			
	305				310					315					320			
Leu	His	Asp	Glu	Leu	Leu	Tyr	Ile	Ile	Asp	His	Leu	Ser	Glu	Leu				
			325						330					335				

<210> 168
 <211> 712
 <212> PRT
 <213> Arabidopsis thaliana

<400> 168

Met	Ser	Ser	Ser	Ser	Ser	Ser	Ser	Thr	Ser	Met	Ile	Asp	Leu	Met	Ala			
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			20					25					30					
Ser	Ala	Tyr	Glu	Ser	Val	Ala	Ala	Glu	Leu	Ser	Ser	Met	Leu	Ile	Glu			
		35				40						45						
Asn	Arg	Gln	Phe	Ala	Met	Ile	Val	Thr	Thr	Ser	Ile	Ala	Val	Leu	Ile			
	50				55					60								
Gly	Cys	Ile	Val	Met	Leu	Val	Trp	Arg	Arg	Ser	Gly	Ser	Gly	Asn	Ser			
	65				70					75				80				
Lys	Arg	Val	Glu	Pro	Leu	Lys	Pro	Leu	Val	Ile	Lys	Pro	Arg	Glu	Glu			
			85					90						95				
Glu	Ile	Asp	Asp	Gly	Arg	Lys	Lys	Val	Thr	Ile	Phe	Phe	Gly	Thr	Gln			
			100					105					110					
Thr	Gly	Thr	Ala	Glu	Gly	Phe	Ala	Lys	Ala	Leu	Gly	Glu	Glu	Ala	Lys			
		115					120					125						
Ala	Arg	Tyr	Glu	Lys	Thr	Arg	Phe	Lys	Ile	Val	Asp	Leu	Asp	Asp	Tyr			
	130					135					140							
Ala	Ala	Asp	Asp	Asp	Glu	Tyr	Glu	Glu	Lys	Leu	Lys	Lys	Glu	Asp	Val			
	145				150					155					160			
Ala	Phe	Phe	Phe	Leu	Ala	Thr	Tyr	Gly	Asp	Gly	Glu	Pro	Thr	Asp	Asn			
			165					170						175				
Ala	Ala	Arg	Phe	Tyr	Lys	Trp	Phe	Thr	Glu	Gly	Asn	Asp	Arg	Gly	Glu			
		180						185					190					
Trp	Leu	Lys	Asn	Leu	Lys	Tyr	Gly	Val	Phe	Gly	Leu	Gly	Asn	Arg	Gln			
		195					200					205						
Tyr	Glu	His	Phe	Asn	Lys	Val	Ala	Lys	Val	Val	Asp	Asp	Ile	Leu	Val			
	210					215					220							
Glu	Gln	Gly	Ala	Gln	Arg	Leu	Val	Gln	Val	Gly	Leu	Gly	Asp	Asp	Asp			
	225				230					235					240			
Gln	Cys	Ile	Glu	Asp	Phe	Thr	Ala	Trp	Arg	Glu	Ala	Leu	Trp	Pro				
			245					250					255					
Glu	Leu	Asp	Thr	Ile	Leu	Arg	Glu	Glu	Gly	Asp	Thr	Ala	Val	Ala	Thr			
			260					265					270					
Pro	Tyr	Thr	Ala	Ala	Val	Leu	Glu	Tyr	Arg	Val	Ser	Ile	His	Asp	Ser			
		275					280					285						
Glu	Asp	Ala	Lys	Phe	Asn	Asp	Ile	Thr	Leu	Ala	Asn	Gly	Asn	Gly	Tyr			
	290				295						300							
Thr	Val	Phe	Asp	Ala	Gln	His	Pro	Tyr	Lys	Ala	Asn	Val	Ala	Val	Lys			
	305				310					315					320			
Arg	Glu	Leu	His	Thr	Pro	Glu	Ser	Asp	Arg	Ser	Cys	Ile	His	Leu	Glu			
			325						330					335				
Phe	Asp	Ile	Ala	Gly	Ser	Gly	Leu	Thr	Met	Lys	Leu	Gly	Asp	His	Val			
			340					345					350					
Gly	Val	Leu	Cys	Asp	Asn	Leu	Ser	Glu	Thr	Val	Asp	Glu	Ala	Leu	Arg			
		355					360					365						

SeqLst

Leu	Leu	Asp	Met	Ser	Pro	Asp	Thr	Tyr	Phe	Ser	Leu	His	Ala	Glu	Lys
370	370					375					380				
Glu	Asp	Gly	Thr	Pro	Ile	Ser	Ser	Ser	Leu	Pro	Pro	Pro	Phe	Pro	Pro
385					390					395					400
Cys	Asn	Leu	Arg	Thr	Ala	Leu	Thr	Arg	Tyr	Ala	Cys	Leu	Leu	Ser	Ser
				405					410					415	
Pro	Lys	Lys	Ser	Ala	Leu	Val	Ala	Leu	Ala	Ala	His	Ala	Ser	Asp	Pro
			420					425					430		
Thr	Glu	Ala	Glu	Arg	Leu	Lys	His	Leu	Ala	Ser	Pro	Ala	Gly	Lys	Asp
		435					440					445			
Glu	Tyr	Ser	Lys	Trp	Val	Val	Glu	Ser	Gln	Arg	Ser	Leu	Leu	Glu	Val
450					455						460				
Met	Ala	Glu	Phe	Pro	Ser	Ala	Lys	Pro	Pro	Leu	Gly	Val	Phe	Phe	Ala
465					470					475					480
Gly	Val	Ala	Pro	Arg	Leu	Gln	Pro	Arg	Phe	Tyr	Ser	Ile	Ser	Ser	Ser
				485					490					495	
Pro	Lys	Ile	Ala	Glu	Thr	Arg	Ile	His	Val	Thr	Cys	Ala	Leu	Val	Tyr
			500					505					510		
Glu	Lys	Met	Pro	Thr	Gly	Arg	Ile	His	Lys	Gly	Val	Cys	Ser	Thr	Trp
		515					520					525			
Met	Lys	Asn	Ala	Val	Pro	Tyr	Glu	Lys	Ser	Glu	Lys	Leu	Phe	Leu	Gly
530						535					540				
Arg	Pro	Ile	Phe	Val	Arg	Gln	Ser	Asn	Phe	Lys	Leu	Pro	Ser	Asp	Ser
545					550					555					560
Lys	Val	Pro	Ile	Ile	Met	Ile	Gly	Pro	Gly	Thr	Gly	Leu	Ala	Pro	Phe
			565						570					575	
Arg	Gly	Phe	Leu	Gln	Glu	Arg	Leu	Ala	Leu	Val	Glu	Ser	Gly	Val	Glu
			580					585					590		
Leu	Gly	Pro	Ser	Val	Leu	Phe	Phe	Gly	Cys	Arg	Asn	Arg	Arg	Met	Asp
		595					600					605			
Phe	Ile	Tyr	Glu	Glu	Glu	Leu	Gln	Arg	Phe	Val	Glu	Ser	Gly	Ala	Leu
610						615					620				
Ala	Glu	Leu	Ser	Val	Ala	Phe	Ser	Arg	Glu	Gly	Pro	Thr	Lys	Glu	Tyr
625					630					635					640
Val	Gln	His	Lys	Met	Met	Asp	Lys	Ala	Ser	Asp	Ile	Trp	Asn	Met	Ile
				645					650					655	
Ser	Gln	Gly	Ala	Tyr	Leu	Tyr	Val	Cys	Gly	Asp	Ala	Lys	Gly	Met	Ala
			660					665					670		
Arg	Asp	Val	His	Arg	Ser	Leu	His	Thr	Ile	Ala	Gln	Glu	Gln	Gly	Ser
		675					680					685			
Met	Asp	Ser	Thr	Lys	Ala	Glu	Gly	Phe	Val	Lys	Asn	Leu	Gln	Thr	Ser
690						695					700				
Gly	Arg	Tyr	Leu	Arg	Asp	Val	Trp								
705					710										

<210> 169
 <211> 709
 <212> PRT
 <213> Stevia rebaudiana

<400> 169

Met	Gln	Ser	Glu	Ser	Val	Glu	Ala	Ser	Thr	Ile	Asp	Leu	Met	Thr	Ala
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Val	Leu	Lys	Asp	Thr	Val	Ile	Asp	Thr	Ala	Asn	Ala	Ser	Asp	Asn	Gly
			20					25					30		
Asp	Ser	Lys	Met	Pro	Pro	Ala	Leu	Ala	Met	Met	Phe	Glu	Ile	Arg	Asp
		35					40					45			
Leu	Leu	Leu	Ile	Leu	Thr	Thr	Ser	Val	Ala	Val	Leu	Val	Gly	Cys	Phe
		50				55					60				
Val	Val	Leu	Val	Trp	Lys	Arg	Ser	Ser	Gly	Lys	Lys	Ser	Gly	Lys	Glu
65					70					75					80
Leu	Glu	Pro	Pro	Lys	Ile	Val	Val	Pro	Lys	Arg	Arg	Leu	Glu	Gln	Glu

SeqLst																		
				85					90					95				
Val	Asp	Asp	Gly	Lys	Lys	Lys	Val	Thr	Ile	Phe	Phe	Gly	Thr	Gln	Thr			
			100					105					110					
Gly	Thr	Ala	Glu	Gly	Phe	Ala	Lys	Ala	Leu	Phe	Glu	Glu	Ala	Lys	Ala			
		115					120					125						
Arg	Tyr	Glu	Lys	Ala	Ala	Phe	Lys	Val	Ile	Asp	Leu	Asp	Asp	Tyr	Ala			
		130				135					140							
Ala	Asp	Leu	Asp	Glu	Tyr	Ala	Glu	Lys	Leu	Lys	Lys	Glu	Thr	Tyr	Ala			
145					150					155					160			
Phe	Phe	Phe	Leu	Ala	Thr	Tyr	Gly	Asp	Gly	Glu	Pro	Thr	Asp	Asn	Ala			
				165					170					175				
Ala	Lys	Phe	Tyr	Lys	Trp	Phe	Thr	Glu	Gly	Asp	Glu	Lys	Gly	Val	Trp			
			180					185						190				
Leu	Gln	Lys	Leu	Gln	Tyr	Gly	Val	Phe	Gly	Leu	Gly	Asn	Arg	Gln	Tyr			
		195					200					205						
Glu	His	Phe	Asn	Lys	Ile	Gly	Ile	Val	Val	Asp	Asp	Gly	Leu	Thr	Glu			
	210					215					220							
Gln	Gly	Ala	Lys	Arg	Ile	Val	Pro	Val	Gly	Leu	Gly	Asp	Asp	Asp	Gln			
225					230					235					240			
Ser	Ile	Glu	Asp	Asp	Phe	Ser	Ala	Trp	Lys	Glu	Leu	Val	Trp	Pro	Glu			
				245					250					255				
Leu	Asp	Leu	Leu	Leu	Arg	Asp	Glu	Asp	Asp	Lys	Ala	Ala	Ala	Thr	Pro			
			260					265					270					
Tyr	Thr	Ala	Ala	Ile	Pro	Glu	Tyr	Arg	Val	Val	Phe	His	Asp	Lys	Pro			
		275					280					285						
Asp	Ala	Phe	Ser	Asp	Asp	His	Thr	Gln	Thr	Asn	Gly	His	Ala	Val	His			
	290					295					300							
Asp	Ala	Gln	His	Pro	Cys	Arg	Ser	Asn	Val	Ala	Val	Lys	Lys	Glu	Leu			
305					310					315					320			
His	Thr	Pro	Glu	Ser	Asp	Arg	Ser	Cys	Thr	His	Leu	Glu	Phe	Asp	Ile			
				325					330					335				
Ser	His	Thr	Gly	Leu	Ser	Tyr	Glu	Thr	Gly	Asp	His	Val	Gly	Val	Tyr			
			340					345					350					
Cys	Glu	Asn	Leu	Ile	Glu	Val	Val	Glu	Glu	Ala	Gly	Lys	Leu	Leu	Gly			
		355					360					365						
Leu	Ser	Thr	Asp	Thr	Tyr	Phe	Ser	Leu	His	Ile	Asp	Asn	Glu	Asp	Gly			
		370				375					380							
Ser	Pro	Leu	Gly	Gly	Pro	Ser	Leu	Gln	Pro	Pro	Phe	Pro	Pro	Cys	Thr			
385					390				395					400				
Leu	Arg	Lys	Ala	Leu	Thr	Asn	Tyr	Ala	Asp	Leu	Leu	Ser	Ser	Pro	Lys			
				405					410					415				
Lys	Ser	Thr	Leu	Leu	Ala	Leu	Ala	Ala	His	Ala	Ser	Asp	Pro	Thr	Glu			
			420					425					430					
Ala	Asp	Arg	Leu	Arg	Phe	Leu	Ala	Ser	Arg	Glu	Gly	Lys	Asp	Glu	Tyr			
		435					440					445						
Ala	Glu	Trp	Val	Val	Ala	Asn	Gln	Arg	Ser	Leu	Leu	Glu	Val	Met	Glu			
	450					455					460							
Ala	Phe	Pro	Ser	Ala	Arg	Pro	Pro	Leu	Gly	Val	Phe	Phe	Ala	Ala	Val			
465					470					475					480			
Ala	Pro	Arg	Leu	Gln	Pro	Arg	Tyr	Tyr	Ser	Ile	Ser	Ser	Ser	Pro	Lys			
				485					490					495				
Met	Glu	Pro	Asn	Arg	Ile	His	Val	Thr	Cys	Ala	Leu	Val	Tyr	Glu	Lys			
			500					505					510					
Thr	Pro	Ala	Gly	Arg	Ile	His	Lys	Gly	Ile	Cys	Ser	Thr	Trp	Met	Lys			
		515					520					525						
Asn	Ala	Val	Pro	Leu	Thr	Glu	Ser	Gln	Asp	Cys	Ser	Trp	Ala	Pro	Ile			
	530					535						540						
Phe	Val	Arg	Thr	Ser	Asn	Phe	Arg	Leu	Pro	Ile	Asp	Pro	Lys	Val	Pro			
545					550					555					560			
Val	Ile	Met	Ile	Gly	Pro	Gly	Thr	Gly	Leu	Ala	Pro	Phe	Arg	Gly	Phe			
				565					570					575				
Leu	Gln	Glu	Arg	Leu	Ala	Leu	Lys	Glu	Ser	Gly	Thr	Glu	Leu	Gly	Ser			
			580					585					590					

SeqLst

Ser	Ile	Leu	Phe	Phe	Gly	Cys	Arg	Asn	Arg	Lys	Val	Asp	Tyr	Ile	Tyr
		595					600					605			
Glu	Asn	Glu	Leu	Asn	Asn	Phe	Val	Glu	Asn	Gly	Ala	Leu	Ser	Glu	Leu
	610					615					620				
Asp	Val	Ala	Phe	Ser	Arg	Asp	Gly	Pro	Thr	Lys	Glu	Tyr	Val	Gln	His
625					630					635					640
Lys	Met	Thr	Gln	Lys	Ala	Ser	Glu	Ile	Trp	Asn	Met	Leu	Ser	Glu	Gly
				645					650					655	
Ala	Tyr	Leu	Tyr	Val	Cys	Gly	Asp	Ala	Lys	Gly	Met	Ala	Lys	Asp	Val
			660					665					670		
His	Arg	Thr	Leu	His	Thr	Ile	Val	Gln	Glu	Gln	Gly	Ser	Leu	Asp	Ser
		675					680					685			
Ser	Lys	Ala	Glu	Leu	Tyr	Val	Lys	Asn	Leu	Gln	Met	Ser	Gly	Arg	Tyr
	690					695					700				
Leu	Arg	Asp	Val	Trp											
705															

<210> 170
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 <212> PRT
 <213> Stevia rebaudiana

<400> 170

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			20					25					30		
Glu	Ser	Ala	Met	Leu	Pro	Thr	Ile	Ala	Met	Ile	Met	Glu	Asn	Arg	Glu
		35					40					45			
Leu	Leu	Met	Ile	Leu	Thr	Thr	Ser	Val	Ala	Val	Leu	Ile	Gly	Cys	Val
	50					55					60				
Val	Val	Leu	Val	Trp	Arg	Arg	Ser	Ser	Thr	Lys	Lys	Ser	Ala	Leu	Glu
65				70					75						80
Pro	Pro	Val	Ile	Val	Val	Pro	Lys	Arg	Val	Gln	Glu	Glu	Glu	Val	Asp
				85					90					95	
Asp	Gly	Lys	Lys	Lys	Val	Thr	Val	Phe	Phe	Gly	Thr	Gln	Thr	Gly	Thr
			100					105					110		
Ala	Glu	Gly	Phe	Ala	Lys	Ala	Leu	Val	Glu	Glu	Ala	Lys	Ala	Arg	Tyr
		115					120					125			
Glu	Lys	Ala	Val	Phe	Lys	Val	Ile	Asp	Leu	Asp	Asp	Tyr	Ala	Ala	Asp
	130					135					140				
Asp	Asp	Glu	Tyr	Glu	Glu	Lys	Leu	Lys	Lys	Glu	Ser	Leu	Ala	Phe	Phe
145				150						155					160
Phe	Leu	Ala	Thr	Tyr	Gly	Asp	Gly	Glu	Pro	Thr	Asp	Asn	Ala	Ala	Arg
			165						170					175	
Phe	Tyr	Lys	Trp	Phe	Thr	Glu	Gly	Asp	Ala	Lys	Gly	Glu	Trp	Leu	Asn
			180					185					190		
Lys	Leu	Gln	Tyr	Gly	Val	Phe	Gly	Leu	Gly	Asn	Arg	Gln	Tyr	Glu	His
		195					200					205			
Phe	Asn	Lys	Ile	Ala	Lys	Val	Val	Asp	Asp	Gly	Leu	Val	Glu	Gln	Gly
	210					215					220				
Ala	Lys	Arg	Leu	Val	Pro	Val	Gly	Leu	Gly	Asp	Asp	Asp	Gln	Cys	Ile
225					230					235					240
Glu	Asp	Asp	Phe	Thr	Ala	Trp	Lys	Glu	Leu	Val	Trp	Pro	Glu	Leu	Asp
				245					250					255	
Gln	Leu	Leu	Arg	Asp	Glu	Asp	Asp	Thr	Thr	Val	Ala	Thr	Pro	Tyr	Thr
			260					265					270		
Ala	Ala	Val	Ala	Glu	Tyr	Arg	Val	Phe	His	Glu	Lys	Pro	Asp	Ala	
		275					280				285				
Leu	Ser	Glu	Asp	Tyr	Ser	Tyr	Thr	Asn	Gly	His	Ala	Val	His	Asp	Ala
	290					295					300				
Gln	His	Pro	Cys	Arg	Ser	Asn	Val	Ala	Val	Lys	Lys	Glu	Leu	His	Ser

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305	Pro	Glu	Ser	Asp	Arg	310	Ser	Cys	Thr	His	Leu	315	Glu	Phe	Asp	Ile	Ser	320	Asn											
					325						330						335													
	Thr	Gly	Leu	Ser	Tyr	Glu	Thr	Gly	Asp	His	Val	Gly	Val	Tyr	Cys	Glu														
				340					345						350															
	Asn	Leu	Ser	Glu	Val	Val	Asn	Asp	Ala	Glu	Arg	Leu	Val	Gly	Leu	Pro														
			355					360					365																	
	Pro	Asp	Thr	Tyr	Ser	Ser	Ile	His	Thr	Asp	Ser	Glu	Asp	Gly	Ser	Pro														
		370				375						380																		
	Leu	Gly	Gly	Ala	Ser	Leu	Pro	Pro	Pro	Phe	Pro	Pro	Cys	Thr	Leu	Arg														
	385				390					395						400														
	Lys	Ala	Leu	Thr	Cys	Tyr	Ala	Asp	Val	Leu	Ser	Ser	Pro	Lys	Lys	Ser														
				405					410						415															
	Ala	Leu	Leu	Ala	Leu	Ala	Ala	His	Ala	Thr	Asp	Pro	Ser	Glu	Ala	Asp														
				420				425						430																
	Arg	Leu	Lys	Phe	Leu	Ala	Ser	Pro	Ala	Gly	Lys	Asp	Glu	Tyr	Ser	Gln														
		435					440						445																	
	Trp	Ile	Val	Ala	Ser	Gln	Arg	Ser	Leu	Leu	Glu	Val	Met	Glu	Ala	Phe														
		450				455						460																		
	Pro	Ser	Ala	Lys	Pro	Ser	Leu	Gly	Val	Phe	Phe	Ala	Ser	Val	Ala	Pro														
	465				470					475						480														
	Arg	Leu	Gln	Pro	Arg	Tyr	Tyr	Ser	Ile	Ser	Ser	Ser	Pro	Lys	Met	Ala														
				485					490						495															
	Pro	Asp	Arg	Ile	His	Val	Thr	Cys	Ala	Leu	Val	Tyr	Glu	Lys	Thr	Pro														
			500					505					510																	
	Ala	Gly	Arg	Ile	His	Lys	Gly	Val	Cys	Ser	Thr	Trp	Met	Lys	Asn	Ala														
		515				520						525																		
	Val	Pro	Met	Thr	Glu	Ser	Gln	Asp	Cys	Ser	Trp	Ala	Pro	Ile	Tyr	Val														
		530			535							540																		
	Arg	Thr	Ser	Asn	Phe	Arg	Leu	Pro	Ser	Asp	Pro	Lys	Val	Pro	Val	Ile														
	545			550						555						560														
	Met	Ile	Gly	Pro	Gly	Thr	Gly	Leu	Ala	Pro	Phe	Arg	Gly	Phe	Leu	Gln														
			565		570									575																
	Glu	Arg	Leu	Ala	Leu	Lys	Glu	Ala	Gly	Thr	Asp	Leu	Gly	Leu	Ser	Ile														
			580		585								590																	
	Leu	Phe	Phe	Gly	Cys	Arg	Asn	Arg	Lys	Val	Asp	Phe	Ile	Tyr	Glu	Asn														
		595			600							605																		
	Glu	Leu	Asn	Asn	Phe	Val	Glu	Thr	Gly	Ala	Leu	Ser	Glu	Leu	Ile	Val														
		610			615							620																		
	Ala	Phe	Ser	Arg	Glu	Gly	Pro	Thr	Lys	Glu	Tyr	Val	Gln	His	Lys	Met														
	625			630						635					640															
	Ser	Glu	Lys	Ala	Ser	Asp	Ile	Trp	Asn	Leu	Leu	Ser	Glu	Gly	Ala	Tyr														
				645					650						655															
	Leu	Tyr	Val	Cys																										
			660																											

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 <211> 2079
 <212> DNA
 <213> Artificial sequence

<220>
 <223> Arabidopsis thaliana sequence that has been codon optimized for yeast

<400> 171
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 ggtttcgttg tcttattgtg gaaaaagacc acggcagatc gttccggcga gctaaagcca 180
 ctaatgatcc ctaagtctct gatggcgaaa gatgaggatg atgacttaga tctaggttct 240
 ggaaaaacga gagtctctat cttcttcggc acacaaaccg gaacagccga aggattcgct 300
 aaagcacttt cagaagagat caaagcaaga tacgaaaagg cggctgtaaa agtaatcgat 360

SeqLst

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<210> 172

<211> 2139

<212> DNA

<213> Artificial Sequence

<220>

<223> Arabidopsis thaliana sequence that has been codon optimized for yeast

<400> 172

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<210> 173

<211> 2130

<212> DNA

<213> Stevia rebaudiana

<400> 173

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<211> 2124

<212> DNA

<213> Stevia rebaudiana

<400> 174

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<211> 2427

<212> DNA

<213> Arabidopsis thaliana

<400> 175

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<211> 2421

<212> DNA

<213> Stevia rebaudiana

<400> 176

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 <213> Coffea arabica

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

<212> PRT

<213> Arabidopsis thaliana

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115      120      125
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130      135      140
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Lys Phe Ala Glu Asp His Arg Lys Thr Ala Gly Asp Leu Ala Gly Pro
385      390      395      400
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 <213> *Saccharomyces cerevisiae*
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 ggtcagcagc tctgatgtag atacacgtat ctcgacatgt tttattttta ctatacatatc 60
 ataaaagaaa taaaaaatga taacgtgtat attattattc atataatcaa tgaggggtcat 120
 tttctgaaac gcaaaaaacg gtaaatggaa aaaaaataaa gatagaaaaa gaaaacaaac 180
 aaaggaaagg ttagcatatt aaataactga gctgatactt caacagcatc gctgaagaga 240
 acagtattga aaccgaaaca ttttctaaag gcaaacaagg tactccatat ttgctggacg 300
 tgttctttct ctcgtttcat atgcataatt ctgtcataag cctgtttctt ttcctggcct 360
 aaacatcccg ttttgtaaaa gagaaatcta ttccacatat ttcattcatt cggctaccat 420
 actaaggata aactaatccc gttgtttttt ggcctcgtca cataattata aactactaac 480

	SeqLst	
ccattatcag a		491
<210> 187		
<211> 28		
<212> DNA		
<213> Artificial Sequence		
<220>		
<223> Hairpin loop forming sequence		
<400> 187		
cacaaataca cacactaaat taataatg		28
<210> 188		
<211> 47		
<212> DNA		
<213> Artificial Sequence		
<220>		
<223> Hairpin loop forming sequence		
<400> 188		
cacaaataca cacactaaat taatatgaat tcgttaacga attcatg		47
<210> 189		
<211> 47		
<212> DNA		
<213> Artificial Sequence		
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<223> Hairpin loop forming sequence		
<400> 189		
cacaaataca cacactaaat taatatgaat tcgttaacga actcatg		47
<210> 190		
<211> 47		
<212> DNA		
<213> Artificial Sequence		
<220>		
<223> Hairpin loop forming sequence		
<400> 190		
cacaaataca cacactaaat taatatgaat tcgttaacga agtcatg		47
<210> 191		
<211> 47		
<212> DNA		
<213> Artificial Sequence		
<220>		
<223> Hairpin loop forming sequence		
<400> 191		
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<210> 192		
<211> 444		
<212> PRT		
<213> Saccharomyces cerevisiae		
<400> 192		

															SeqLst		
Met	Gly	Lys	Leu	Leu	Gln	Leu	Ala	Leu	His	Pro	Val	Glu	Met	Lys	Ala		
1				5					10					15			
Ala	Leu	Lys	Leu	Lys	Phe	Cys	Arg	Thr	Pro	Leu	Phe	Ser	Ile	Tyr	Asp		
			20					25					30				
Gln	Ser	Thr	Ser	Pro	Tyr	Leu	Leu	His	Cys	Phe	Glu	Leu	Leu	Asn	Leu		
		35					40					45					
Thr	Ser	Arg	Ser	Phe	Ala	Ala	Val	Ile	Arg	Glu	Leu	His	Pro	Glu	Leu		
	50					55					60						
Arg	Asn	Cys	Val	Thr	Leu	Phe	Tyr	Leu	Ile	Leu	Arg	Ala	Leu	Asp	Thr		
65					70					75				80			
Ile	Glu	Asp	Asp	Met	Ser	Ile	Glu	His	Asp	Leu	Lys	Ile	Asp	Leu	Leu		
				85					90					95			
Arg	His	Phe	His	Glu	Lys	Leu	Leu	Leu	Thr	Lys	Trp	Ser	Phe	Asp	Gly		
			100					105					110				
Asn	Ala	Pro	Asp	Val	Lys	Asp	Arg	Ala	Val	Leu	Thr	Asp	Phe	Glu	Ser		
		115					120					125					
Ile	Leu	Ile	Glu	Phe	His	Lys	Leu	Lys	Pro	Glu	Tyr	Gln	Glu	Val	Ile		
	130					135					140						
Lys	Glu	Ile	Thr	Glu	Lys	Met	Gly	Asn	Gly	Met	Ala	Asp	Tyr	Ile	Leu		
145					150					155					160		
Asp	Glu	Asn	Tyr	Asn	Leu	Asn	Gly	Leu	Gln	Thr	Val	His	Asp	Tyr	Asp		
				165					170					175			
Val	Tyr	Cys	His	Tyr	Val	Ala	Gly	Leu	Val	Gly	Asp	Gly	Leu	Thr	Arg		
			180					185					190				
Leu	Ile	Val	Ile	Ala	Lys	Phe	Ala	Asn	Glu	Ser	Leu	Tyr	Ser	Asn	Glu		
		195					200					205					
Gln	Leu	Tyr	Glu	Ser	Met	Gly	Leu	Phe	Leu	Gln	Lys	Thr	Asn	Ile	Ile		
	210					215					220						
Arg	Asp	Tyr	Asn	Glu	Asp	Leu	Val	Asp	Gly	Arg	Ser	Phe	Trp	Pro	Lys		
225					230					235					240		
Glu	Ile	Trp	Ser	Gln	Tyr	Ala	Pro	Gln	Leu	Lys	Asp	Phe	Met	Lys	Pro		
				245					250					255			
Glu	Asn	Glu	Gln	Leu	Gly	Leu	Asp	Cys	Ile	Asn	His	Leu	Val	Leu	Asn		
			260					265					270				
Ala	Leu	Ser	His	Val	Ile	Asp	Val	Leu	Thr	Tyr	Leu	Ala	Gly	Ile	His		
		275					280					285					
Glu	Gln	Ser	Thr	Phe	Gln	Phe	Cys	Ala	Ile	Pro	Gln	Val	Met	Ala	Ile		
	290					295					300						
Ala	Thr	Leu	Ala	Leu	Val	Phe	Asn	Asn	Arg	Glu	Val	Leu	His	Gly	Asn		
305					310					315					320		
Val	Lys	Ile	Arg	Lys	Gly	Thr	Thr	Cys	Tyr	Leu	Ile	Leu	Lys	Ser	Arg		
				325					330					335			
Thr	Leu	Arg	Gly	Cys	Val	Glu	Ile	Phe	Asp	Tyr	Tyr	Leu	Arg	Asp	Ile		
			340					345					350				
Lys	Ser	Lys	Leu	Ala	Val	Gln	Asp	Pro	Asn	Phe	Leu	Lys	Leu	Asn	Ile		
		355					360					365					
Gln	Ile	Ser	Lys	Ile	Glu	Gln	Phe	Met	Glu	Glu	Met	Tyr	Gln	Asp	Lys		
	370					375					380						
Leu	Pro	Pro	Asn	Val	Lys	Pro	Asn	Glu	Thr	Pro	Ile	Phe	Leu	Lys	Val		
385					390					395					400		
Lys	Glu	Arg	Ser	Arg	Tyr	Asp	Asp	Glu	Leu	Val	Pro	Thr	Gln	Gln	Glu		
				405					410					415			
Glu	Glu	Tyr	Lys	Phe	Asn	Met	Val	Leu	Ser	Ile	Ile	Leu	Ser	Val	Leu		
			420					425					430				
Leu	Gly	Phe	Tyr	Tyr	Ile	Tyr	Thr	Leu	His	Arg	Ala						
		435					440										

<210> 193
 <211> 460
 <212> PRT
 <213> Schizosaccharomyces pombe

SeqLst

<400> 193

```

Met Ser Leu Ala Asn Arg Ile Glu Glu Ile Arg Cys Leu Cys Gln Tyr
 1      5      10      15
Lys Leu Trp Asn Asp Leu Pro Ser Tyr Gly Glu Asp Glu Asn Val Pro
 20      25      30
Gln Asn Ile Arg Arg Cys Tyr Gln Leu Leu Asp Met Thr Ser Arg Ser
 35      40      45
Phe Ala Val Val Ile Lys Glu Leu Pro Asn Gly Ile Arg Glu Ala Val
 50      55      60
Met Ile Phe Tyr Leu Val Leu Arg Gly Leu Asp Thr Val Glu Asp Asp
 65      70      75      80
Met Thr Leu Pro Leu Asp Lys Lys Leu Pro Ile Leu Arg Asp Phe Tyr
 85      90      95
Lys Thr Ile Glu Val Glu Gly Trp Thr Phe Asn Glu Ser Gly Pro Asn
100      105      110
Glu Lys Asp Arg Gln Leu Leu Val Glu Phe Asp Val Val Ile Lys Glu
115      120      125
Tyr Leu Asn Leu Ser Glu Gly Tyr Arg Asn Val Ile Ser Asn Ile Thr
130      135      140
Lys Glu Met Gly Asp Gly Met Ala Tyr Tyr Ala Ser Leu Ala Glu Lys
145      150      155      160
Asn Asp Gly Phe Ser Val Glu Thr Ile Glu Asp Phe Asn Lys Tyr Cys
165      170      175
His Tyr Val Ala Gly Leu Val Gly Ile Gly Leu Ser Arg Leu Phe Ala
180      185      190
Gln Ser Lys Leu Glu Asp Pro Asp Leu Ala His Ser Gln Ala Ile Ser
195      200      205
Asn Ser Leu Gly Leu Phe Leu Gln Lys Val Asn Ile Ile Arg Asp Tyr
210      215      220
Arg Glu Asp Phe Asp Asp Asn Arg His Phe Trp Pro Arg Glu Ile Trp
225      230      235      240
Ser Lys Tyr Thr Ser Ser Phe Gly Asp Leu Cys Leu Pro Asp Asn Ser
245      250      255
Glu Lys Ala Leu Glu Cys Leu Ser Asp Met Thr Ala Asn Ala Leu Thr
260      265      270
His Ala Thr Asp Ala Leu Val Tyr Leu Ser Gln Leu Lys Thr Gln Glu
275      280      285
Ile Phe Asn Phe Cys Ala Ile Pro Gln Val Met Ala Ile Ala Thr Leu
290      295      300
Ala Ala Val Phe Arg Asn Pro Asp Val Phe Gln Thr Asn Val Lys Ile
305      310      315      320
Arg Lys Gly Gln Ala Val Gln Ile Ile Leu His Ser Val Asn Leu Lys
325      330      335
Asn Val Cys Asp Leu Phe Leu Arg Tyr Thr Arg Asp Ile His Tyr Lys
340      345      350
Asn Thr Pro Lys Asp Pro Asn Phe Leu Lys Ile Ser Ile Glu Cys Gly
355      360      365
Lys Ile Glu Gln Val Ser Glu Ser Leu Phe Pro Arg Arg Phe Arg Glu
370      375      380
Met Tyr Glu Lys Ala Tyr Val Ser Lys Leu Ser Glu Gln Lys Lys Gly
385      390      395      400
Asn Gly Thr Gln Lys Ala Ile Leu Asn Asp Glu Gln Lys Glu Leu Tyr
405      410      415
Arg Lys Asp Leu Gln Lys Leu Gly Ile Ser Ile Leu Phe Val Phe Phe
420      425      430
Ile Ile Leu Val Cys Leu Ala Val Ile Phe Tyr Val Phe Asn Ile Arg
435      440      445
Ile His Trp Ser Asp Phe Lys Glu Leu Asn Leu Phe
450      455      460

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<210> 194

<211> 445

SeqLst

<212> PRT

<213> Yarrowia lipolytica

<400> 194

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Met Gly Lys Leu Ile Glu Leu Leu Leu His Pro Ser Glu Leu Ser Ala
 1      5      10      15
Ala Ile His Tyr Lys Leu Trp Arg Gln Pro Leu His Pro Arg Asp Leu
 20      25      30
Ser Lys Glu Ser Thr Glu Leu Arg Arg Cys Tyr Glu Leu Leu Asp Val
 35      40      45
Cys Ser Arg Ser Phe Ala Ala Val Ile Arg Glu Leu His Pro Glu Val
 50      55      60
Arg Asp Ala Val Met Leu Phe Tyr Leu Ile Leu Arg Ala Leu Asp Thr
 65      70      75      80
Ile Glu Asp Asp Met Thr Leu Ser Arg Asp Ile Lys Ile Pro Ile Leu
 85      90      95
Arg Asp Phe Thr Lys Cys Met Lys Thr Pro Gly Trp Lys Phe Thr Asp
100      105      110
Ser Asp Pro Asn Glu Arg Asp Arg Val Val Leu Gln Glu Phe Pro Val
115      120      125
Val Met Thr Glu Phe Asn Lys Leu Lys Pro Lys Tyr Gln Glu Val Ile
130      135      140
Tyr Asp Ile Thr Asp Arg Met Gly Asn Gly Met Ala Asp Tyr Val Ile
145      150      155      160
Asp Asp Asp Phe Asn Asn Gly Val Asp Thr Ile Ala Ala Tyr Asp
165      170      175
Leu Tyr Cys His His Val Ala Gly Ile Val Gly Glu Gly Leu Thr Arg
180      185      190
Ile Thr Ile Leu Ala Gly Phe Gly Thr Asp Val Leu His Glu Asn Pro
195      200      205
Arg Leu Gln Glu Ser Met Gly Leu Phe Leu Gln Lys Val Asn Ile Ile
210      215      220
Arg Asp Tyr Arg Glu Asp Ile Asp Val Asn Arg Ala Phe Trp Pro Arg
225      230      235      240
Glu Ile Trp His Lys Tyr Ala Glu Glu Met Arg Asp Phe Lys Asp Pro
245      250      255
Lys Tyr Ser Lys Lys Ala Leu His Cys Thr Ser Asp Leu Val Ala Asn
260      265      270
Ala Leu Gly His Ala Thr Asp Cys Leu Asp Tyr Leu Asp Asn Val Thr
275      280      285
Asp Pro Ser Thr Phe Thr Phe Cys Ala Ile Pro Gln Val Met Ala Ile
290      295      300
Ala Thr Leu Asp Leu Val Tyr Arg Asn Pro Asp Val Phe Gln Lys Asn
305      310      315      320
Val Lys Leu Arg Lys Gly Thr Thr Val Ser Leu Ile Leu Glu Ala Ser
325      330      335
Asn Val Ser Gly Val Cys Asp Ile Phe Thr Arg Tyr Ala Arg Lys Val
340      345      350
Tyr Lys Lys Ser Asp Pro Asn Asp Pro Asn Tyr Phe Arg Val Ser Val
355      360      365
Leu Cys Gly Lys Ile Glu Gln His Ala Ala Leu Ile Lys Arg Gln Arg
370      375      380
Gly Pro Pro Ala Lys Thr Ile Ala Gln Leu Glu Gly Glu Arg Lys Glu
385      390      395      400
Met Ala Leu Ser Leu Ile Val Cys Leu Ala Val Ile Phe Ser Met Ser
405      410      415
Gly Leu Met Ala Tyr Ile Ala Tyr Val Ser Gly Phe Arg Trp Ser Pro
420      425      430
Arg Glu Ile Phe Asp Ser Lys Met Phe Pro Leu Arg Asp
435      440      445

```

<210> 195

SeqLst

<211> 443

<212> PRT

<213> Candida glabrata

<400> 195

```

Met Gly Lys Val Leu Asp Leu Ala Leu His Pro Leu Glu Leu Arg Ala
 1      5      10      15
Ala Leu Lys Leu Lys Phe Ile Arg Gln Pro Leu Phe Ser Thr Asn Asp
 20      25      30
Thr Arg Ala Thr Pro Gln Leu Glu Arg Cys Tyr Glu Leu Leu Asn Leu
 35      40      45
Thr Ser Arg Ser Phe Ala Ala Val Ile Met Glu Leu His Pro Glu Leu
 50      55      60
Arg Asn Val Ile Met Val Phe Tyr Leu Ile Leu Arg Ala Leu Asp Thr
 65      70      75      80
Val Glu Asp Asp Met Thr Ile Asp Pro Gln Leu Lys Val Lys Val Leu
 85      90      95
Arg Glu Phe Asp Ser Lys Leu Asp Thr Asp Trp Ser Phe Asp Gly
100      105      110
Asn Asp Leu Lys Glu Lys Asp Arg Val Val Leu Thr Glu Phe Pro Cys
115      120      125
Ile Leu Gly Glu Tyr His Lys Leu Lys Pro Glu Tyr Gln Lys Val Ile
130      135      140
Lys Arg Ile Thr Gly Leu Met Gly Asn Gly Met Ala Asp Tyr Ile Leu
145      150      155      160
Asp Glu Asn Phe Asn Leu Asn Gly Val Gln Thr Val Lys Asp Tyr Asp
165      170      175
Lys Tyr Cys His Tyr Val Ala Gly Leu Val Gly Asp Gly Leu Thr Glu
180      185      190
Leu Ile Val Leu Ala Gly Phe Gly Ser Asp Asp Leu Tyr His Gly Lys
195      200      205
Asn Ser Phe Gln Leu Tyr Glu Ser Met Gly Leu Phe Leu Gln Lys Thr
210      215      220
Asn Ile Ile Arg Asp Tyr Ala Glu Asp Leu Asp Asp Gly Arg Ser Phe
225      230      235      240
Trp Pro Lys Glu Ile Trp Ser Glu Tyr Ala Thr Lys Leu Thr Asp Phe
245      250      255
Arg Asp Pro Lys Asn Thr Gln Lys Gly Val Asp Cys Ile Asn His Leu
260      265      270
Val Leu Asn Ala Leu Thr His Val Ile Asp Val Leu Thr Tyr Leu Ser
275      280      285
Ser Ile His Glu Gln Ser Ser Phe Gln Phe Cys Ala Ile Pro Gln Val
290      295      300
Met Ala Ile Ala Thr Leu Ala Lys Val Phe Asn Asn Pro Glu Val Leu
305      310      315      320
Arg Lys Asn Val Lys Ile Arg Lys Gly Thr Thr Cys Asp Leu Ile Leu
325      330      335
Asn Ser Arg Thr Leu Lys Gly Cys Val Asp Ile Phe Gln Tyr Tyr Leu
340      345      350
Arg Asp Met Lys Gln Arg Leu Pro Val Glu Asp Pro Asn Tyr Leu Lys
355      360      365
Phe Asn Ile Gln Val Ala Lys Ile Glu Gln Phe Ile Glu Glu Met Phe
370      375      380
Gln Asp Asn Leu Pro Ala Gly Val Glu Pro Arg Glu Thr Met Ile Tyr
385      390      395      400
Leu Lys Val Gln Glu Arg Leu Lys Trp Asp Thr Gln Val Ile Pro Arg
405      410      415
Val Gln Glu Glu Asp Tyr Lys Phe Asn Met Ala Leu Ser Val Val Phe
420      425      430
Cys Val Leu Ser Phe Tyr Phe Thr Lys
435      440

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SeqLst

<210> 196

<211> 441

<212> PRT

<213> Ashbya gossypii

<400> 196

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Met Gly Lys Val Val Gln Leu Phe Thr His Pro Leu Glu Leu Lys Ala
 1      5      10      15
Ala Leu Lys Leu Lys Phe Leu Arg Glu Pro Leu Tyr Pro Ala Asp Asp
 20      25      30
Thr Gln Gly Ser Ala Glu Leu Lys Arg Cys Tyr Gln Leu Gln Arg
 35      40      45
Thr Ser Arg Ser Phe Ala Ala Val Ile Met Glu Leu His Pro Glu Leu
 50      55      60
Arg Asn Ala Val Met Leu Phe Tyr Leu Ile Leu Arg Ala Leu Asp Thr
 65      70      75      80
Val Glu Asp Asp Met Thr Ile Ser Pro Lys Val Lys Val Pro Leu Leu
 85      90      95
Arg Glu Phe Asp Gln Lys Leu Lys Leu Asp Thr Trp Ser Phe Asp Gly
100      105      110
Asn Ala Lys Thr Glu Lys Asp Arg Asp Val Leu Val Glu Phe Ser Thr
115      120      125
Ile Leu Ala Glu Phe His Lys Leu Lys Pro Glu Tyr Gln Gln Val Ile
130      135      140
Ala Asp Ile Thr His Lys Met Gly Asn Gly Met Ala Asp Tyr Ile Leu
145      150      155      160
Asp Glu Lys Phe Asn Leu Ser Gly Leu Glu Thr Ile Gln Asp Tyr Asp
165      170      175
Arg Tyr Cys His Tyr Val Ala Gly Leu Val Gly Asp Gly Leu Thr His
180      185      190
Leu Ile Met Leu Ala Lys Phe Ser Pro Gly Leu Tyr Tyr Asp Ser
195      200      205
Pro Asp Leu Tyr Glu Ser Met Gly Leu Phe Leu Gln Lys Thr Asn Ile
210      215      220
Ile Arg Asp Tyr Ala Glu Asp Leu Ala Asp Gly Arg Ser Phe Trp Pro
225      230      235      240
Lys Glu Ile Trp Ser His Tyr Ala Asp Asp Leu Ala Ser Phe Ser Lys
245      250      255
Pro Glu Asn Ala Thr Ala Gly Val Tyr Cys Ile Asn His Leu Val Leu
260      265      270
Asn Ala Leu Gly His Val Gln His Val Leu Thr Tyr Leu Ala Ser Leu
275      280      285
Arg Glu Gln Ser Ser Phe Gln Phe Cys Ala Ile Pro Gln Val Met Ala
290      295      300
Ile Ala Thr Leu Ala Leu Val Phe Gly Asn Glu Arg Val Leu Gln Thr
305      310      315      320
Ser Val Lys Ile Arg Lys Gly Thr Thr Cys Tyr Leu Ile Leu Lys Ser
325      330      335
Arg Thr Phe Gln Gly Cys Val Glu Ile Phe Glu His Tyr Leu Arg Asp
340      345      350
Ile Arg Lys Arg Leu Thr Val Ala Asp Pro Asn Tyr Leu Lys Leu Asn
355      360      365
Ile Glu Ile Ala Lys Leu Asp Lys Phe Ile Glu Glu Met Tyr Gln Asp
370      375      380
Lys Leu Pro Val Gly Ala Lys Pro Gln Glu Thr Glu Ile Tyr Lys Lys
385      390      395      400
Val Arg Glu Arg Ser Ala Tyr Asp Leu Glu Val Leu Pro Arg Glu Gln
405      410      415
Glu Glu Glu Phe Lys Phe Asn Val Leu Ser Ile Leu Phe Thr Val
420      425      430
Phe Gly Ala Leu Tyr Trp Tyr Ala Lys
435      440

```

SeqLst

<210> 197
 <211> 443
 <212> PRT
 <213> Cyberlindnera jadinii

<400> 197
 Met Gly Lys Leu Leu Gln Leu Ala Leu His Pro Asp Glu Leu Ala Ser
 1 5 10 15
 Ile Val Gln Phe Lys Leu Phe Arg Lys Asn Glu Asn Ala Arg Asn Pro
 20 25 30
 Ala Thr Glu Ser Ala Glu Leu Ile Arg Cys Tyr Glu Leu Asn Leu
 35 40 45
 Thr Ser Arg Ser Phe Ala Ala Val Ile Glu Glu Leu His Pro Glu Leu
 50 55 60
 Arg Asn Val Ile Met Val Phe Tyr Leu Val Leu Arg Ala Leu Asp Thr
 65 70 75 80
 Val Glu Val Asp Met Ser Ile Glu Asn Ser Val Lys Leu Pro Val Leu
 85 90 95
 Arg Gln Phe His Glu Lys Leu Asp Thr Lys Asp Trp Thr Phe Asp Gly
 100 105 110
 Asn Ser Pro Asn Glu Lys Asp Arg Cys Val Leu Val Glu Phe Asp Arg
 115 120 125
 Ile Leu Gly Gln Tyr His Glu Leu Lys Pro Gln Tyr Gln Lys Val Ile
 130 135 140
 Lys Glu Ile Thr Glu Lys Met Gly Asn Gly Met Ala Asp Tyr Ile Glu
 145 150 155 160
 Asn Glu Asn Phe Asn Ser Asn Gly Leu Leu Thr Ile Glu Asp Tyr Asp
 165 170 175
 Leu Tyr Cys Tyr Tyr Val Ala Gly Leu Val Gly Asp Gly Leu Thr Gln
 180 185 190
 Leu Ile Val Leu Ala Lys Phe Gly Asn Ser Glu Leu Ser Val Asn Lys
 195 200 205
 Gln Leu Phe Lys Ser Met Gly Leu Phe Leu Gln Lys Thr Asn Ile Ile
 210 215 220
 Arg Asp Tyr Glu Glu Asp Gln Val Asp Gly Arg Ala Phe Trp Pro Lys
 225 230 235 240
 Glu Ile Trp Gly Lys Tyr Ala Asn Glu Leu Ser Asp Phe Met Lys Pro
 245 250 255
 Glu Asn Gln Ser Gln Gly Leu Trp Cys Ile Ser Glu Leu Val Cys Asn
 260 265 270
 Ala Leu Asp His Val Ile Asp Val Leu Gln Tyr Leu Ala Leu Val Glu
 275 280 285
 Glu Gln Thr Ser Phe Asn Phe Cys Ala Ile Pro Gln Val Met Ala Ile
 290 295 300
 Ala Thr Leu Glu Leu Val Phe Gln Asn Pro Gln Val Leu Thr Gln His
 305 310 315 320
 Val Lys Ile Arg Lys Gly Thr Thr Val Ser Leu Ile Leu Glu Ser Arg
 325 330 335
 Thr Leu Glu Gly Cys Ala Arg Ile Phe Arg Arg Tyr Leu Arg Lys Ile
 340 345 350
 His His Lys Ser His Pro Ser Asp Pro Asn Tyr Leu Arg Leu Gly Ile
 355 360 365
 Thr Ile Gly Lys Ile Glu Gln Phe Leu Asp Gly Met Tyr Pro His Tyr
 370 375 380
 Val Pro Lys Gly Ile Thr Pro Gln Thr Thr Ser Ile Arg Thr Gln Val
 385 390 395 400
 Val Lys Arg Leu Gln Leu Asp Glu Pro Met Lys Arg Asp Ile Asp Glu
 405 410 415
 Glu Ile Leu Lys Thr Arg Ile Leu Leu Ser Leu Gly Val Ala Val
 420 425 430
 Phe Gly Val Val Tyr Gly Val Val Arg Ile Ile
 435 440

SeqLst

<210> 198
 <211> 448
 <212> PRT
 <213> Candida albicans

<400> 198
 Met Gly Lys Phe Leu Gln Leu Leu Ser His Pro Thr Glu Leu Lys Ala
 1 5 10 15
 Val Ile Gln Leu Phe Gly Phe Arg Gln Pro Leu His Pro Gly Lys Arg
 20 25 30
 Asp Val Asn Asp Lys Glu Leu Gly Arg Cys Tyr Glu Leu Asn Leu
 35 40 45
 Thr Ser Arg Ser Phe Ala Ala Val Ile Glu Glu Leu His Pro Glu Leu
 50 55 60
 Arg Asp Ala Val Met Ile Phe Tyr Leu Val Leu Arg Ala Leu Asp Thr
 65 70 75 80
 Ile Glu Asp Asp Met Thr Ile Lys Ser Ser Ile Lys Ile Pro Leu Leu
 85 90 95
 Arg Glu Phe Asp Thr Lys Leu Asn Thr Lys Asn Trp Thr Phe Asp Gly
 100 105 110
 Tyr Gly Pro Asn Glu Lys Asp Arg Thr Val Leu Val Glu Phe Asp Lys
 115 120 125
 Ile Leu Asn Val Tyr His Arg Leu Lys Pro Gln Tyr Gln Asp Ile Ile
 130 135 140
 Lys Ser Ile Thr Phe Lys Met Gly Asn Gly Met Ala Asp Tyr Ile Leu
 145 150 155 160
 Asp Glu Glu Phe Asn Val Tyr Gly Val Ala Thr Val Glu Asp Tyr Asn
 165 170 175
 Leu Tyr Cys His Tyr Val Ala Gly Leu Val Gly Glu Gly Leu Thr Asn
 180 185 190
 Leu Phe Val Leu Ala Asn Phe Gly Asp Lys Thr Leu Thr Glu Asn Asn
 195 200 205
 Phe Ala Lys Ala Asp Ser Met Gly Leu Phe Leu Gln Lys Thr Asn Ile
 210 215 220
 Ile Arg Asp Tyr His Glu Asp Leu Gln Asp Gly Arg Ser Phe Trp Pro
 225 230 235 240
 Arg Glu Ile Trp Ser Lys Tyr Thr Glu Asn Leu Gln Asp Phe His Lys
 245 250 255
 Val Lys Thr Pro Ala Lys Glu Phe Ala Gly Val Ser Cys Ile Asn Glu
 260 265 270
 Leu Val Leu Asn Ala Leu Gly His Val Thr Asp Cys Leu Asp Tyr Leu
 275 280 285
 Ser Leu Val Lys Asp Pro Ser Ser Phe Ser Phe Cys Ala Ile Pro Gln
 290 295 300
 Val Met Ala Val Ala Thr Leu Ala Glu Val Tyr Asn Asn Pro Lys Val
 305 310 315 320
 Leu His Gly Val Val Lys Ile Arg Lys Gly Thr Thr Cys Arg Leu Ile
 325 330 335
 Leu Glu Ser Arg Thr Leu Pro Gly Val Val Lys Ile Phe Lys Glu Tyr
 340 345 350
 Ile Gln Val Ile Asn His Lys Ser Val Arg Asp Pro Asn Tyr Leu
 355 360 365
 Lys Ile Gly Ile Lys Cys Gly Glu Ile Glu Gln Tyr Cys Glu Met Ile
 370 375 380
 Tyr Pro Asn Lys Gln Ala Leu Pro Pro Ser Met Lys Ser Leu Pro Glu
 385 390 395 400
 Asn Lys Phe Thr Lys Ile Val Ala Ser Arg Glu Ser Ile Asp Leu Ser
 405 410 415
 Val Gln Arg Arg Ile Glu Pro Gly Asn Phe Asn Cys Asn Val Val Leu
 420 425 430
 Phe Gly Ile Gly Ala Leu Ile Leu Ser Leu Ile Tyr Phe Val Leu Tyr

435

440

SeqLst

445

<210> 199

<211> 731

<212> PRT

<213> *Saccharomyces cerevisiae*

<400> 199

Met	Thr	Glu	Phe	Tyr	Ser	Asp	Thr	Ile	Gly	Leu	Pro	Lys	Thr	Asp	Pro
1				5					10					15	
Arg	Leu	Trp	Arg	Leu	Arg	Thr	Asp	Glu	Leu	Gly	Arg	Glu	Ser	Trp	Glu
			20					25					30		
Tyr	Leu	Thr	Pro	Gln	Gln	Ala	Ala	Asn	Asp	Pro	Pro	Ser	Thr	Phe	Thr
		35				40						45			
Gln	Trp	Leu	Leu	Gln	Asp	Pro	Lys	Phe	Pro	Gln	Pro	His	Pro	Glu	Arg
	50					55					60				
Asn	Lys	His	Ser	Pro	Asp	Phe	Ser	Ala	Phe	Asp	Ala	Cys	His	Asn	Gly
65					70					75					80
Ala	Ser	Phe	Phe	Lys	Leu	Leu	Gln	Glu	Pro	Asp	Ser	Gly	Ile	Phe	Pro
				85					90					95	
Cys	Gln	Tyr	Lys	Gly	Pro	Met	Phe	Met	Thr	Ile	Gly	Tyr	Val	Ala	Val
			100					105					110		
Asn	Tyr	Ile	Ala	Gly	Ile	Glu	Ile	Pro	Glu	His	Glu	Arg	Ile	Glu	Leu
		115					120						125		
Ile	Arg	Tyr	Ile	Val	Asn	Thr	Ala	His	Pro	Val	Asp	Gly	Gly	Trp	Gly
	130					135					140				
Leu	His	Ser	Val	Asp	Lys	Ser	Thr	Val	Phe	Gly	Thr	Val	Leu	Asn	Tyr
145					150					155					160
Val	Ile	Leu	Arg	Leu	Gly	Leu	Pro	Lys	Asp	His	Pro	Val	Cys	Ala	
				165				170					175		
Lys	Ala	Arg	Ser	Thr	Leu	Leu	Arg	Leu	Gly	Gly	Ala	Ile	Gly	Ser	Pro
			180					185					190		
His	Trp	Gly	Lys	Ile	Trp	Leu	Ser	Ala	Leu	Asn	Leu	Tyr	Lys	Trp	Glu
		195					200					205			
Gly	Val	Asn	Pro	Ala	Pro	Pro	Glu	Thr	Trp	Leu	Leu	Pro	Tyr	Ser	Leu
	210					215					220				
Pro	Met	His	Pro	Gly	Arg	Trp	Trp	Val	His	Thr	Arg	Gly	Val	Tyr	Ile
225					230					235					240
Pro	Val	Ser	Tyr	Leu	Ser	Leu	Val	Lys	Phe	Ser	Cys	Pro	Met	Thr	Pro
				245					250					255	
Leu	Leu	Glu	Glu	Leu	Arg	Asn	Glu	Ile	Tyr	Thr	Lys	Pro	Phe	Asp	Lys
			260					265					270		
Ile	Asn	Phe	Ser	Lys	Asn	Arg	Asn	Thr	Val	Cys	Gly	Val	Asp	Leu	Tyr
		275					280					285			
Tyr	Pro	His	Ser	Thr	Thr	Leu	Asn	Ile	Ala	Asn	Ser	Leu	Val	Val	Phe
	290					295					300				
Tyr	Glu	Lys	Tyr	Leu	Arg	Asn	Arg	Phe	Ile	Tyr	Ser	Leu	Ser	Lys	Lys
305					310					315					320
Lys	Val	Tyr	Asp	Leu	Ile	Lys	Thr	Glu	Leu	Gln	Asn	Thr	Asp	Ser	Leu
				325					330					335	
Cys	Ile	Ala	Pro	Val	Asn	Gln	Ala	Phe	Cys	Ala	Leu	Val	Thr	Leu	Ile
			340					345					350		
Glu	Glu	Gly	Val	Asp	Ser	Glu	Ala	Phe	Gln	Arg	Leu	Gln	Tyr	Arg	Phe
		355					360					365			
Lys	Asp	Ala	Leu	Phe	His	Gly	Pro	Gln	Gly	Met	Thr	Ile	Met	Gly	Thr
	370					375					380				
Asn	Gly	Val	Gln	Thr	Trp	Asp	Cys	Ala	Phe	Ala	Ile	Gln	Tyr	Phe	Phe
385					390					395					400
Val	Ala	Gly	Leu	Ala	Glu	Arg	Pro	Glu	Phe	Tyr	Asn	Thr	Ile	Val	Ser
				405					410					415	
Ala	Tyr	Lys	Phe	Leu	Cys	His	Ala	Gln	Phe	Asp	Thr	Glu	Cys	Val	Pro
			420					425					430		

SeqLst

Gly	Ser	Tyr	Arg	Asp	Lys	Arg	Lys	Gly	Ala	Trp	Gly	Phe	Ser	Thr	Lys
		435					440					445			
Thr	Gln	Gly	Tyr	Thr	Val	Ala	Asp	Cys	Thr	Ala	Glu	Ala	Ile	Lys	Ala
	450					455					460				
Ile	Ile	Met	Val	Lys	Asn	Ser	Pro	Val	Phe	Ser	Glu	Val	His	His	Met
465				470					475						480
Ile	Ser	Ser	Glu	Arg	Leu	Phe	Glu	Gly	Ile	Asp	Val	Leu	Leu	Asn	Leu
				485					490					495	
Gln	Asn	Ile	Gly	Ser	Phe	Glu	Tyr	Gly	Ser	Phe	Ala	Thr	Tyr	Glu	Lys
			500					505					510		
Ile	Lys	Ala	Pro	Leu	Ala	Met	Glu	Thr	Leu	Asn	Pro	Ala	Glu	Val	Phe
		515					520					525			
Gly	Asn	Ile	Met	Val	Glu	Tyr	Pro	Tyr	Val	Glu	Cys	Thr	Asp	Ser	Ser
	530					535					540				
Val	Leu	Gly	Leu	Thr	Tyr	Phe	His	Lys	Tyr	Phe	Asp	Tyr	Arg	Lys	Glu
545					550					555					560
Glu	Ile	Arg	Thr	Arg	Ile	Arg	Ile	Ala	Ile	Glu	Phe	Ile	Lys	Lys	Ser
				565					570					575	
Gln	Leu	Pro	Asp	Gly	Ser	Trp	Tyr	Gly	Ser	Trp	Gly	Ile	Cys	Phe	Thr
			580					585					590		
Tyr	Ala	Gly	Met	Phe	Ala	Leu	Glu	Ala	Leu	His	Thr	Val	Gly	Glu	Thr
		595					600					605			
Tyr	Glu	Asn	Ser	Ser	Thr	Val	Arg	Lys	Gly	Cys	Asp	Phe	Leu	Val	Ser
	610					615					620				
Lys	Gln	Met	Lys	Asp	Gly	Gly	Trp	Gly	Glu	Ser	Met	Lys	Ser	Ser	Glu
625					630					635					640
Leu	His	Ser	Tyr	Val	Asp	Ser	Glu	Lys	Ser	Leu	Val	Val	Gln	Thr	Ala
				645					650					655	
Trp	Ala	Leu	Ile	Ala	Leu	Leu	Phe	Ala	Glu	Tyr	Pro	Asn	Lys	Glu	Val
			660					665					670		
Ile	Asp	Arg	Gly	Ile	Asp	Leu	Leu	Lys	Asn	Arg	Gln	Glu	Glu	Ser	Gly
		675					680					685			
Glu	Trp	Lys	Phe	Glu	Ser	Val	Glu	Gly	Val	Phe	Asn	His	Ser	Cys	Ala
	690					695				700					
Ile	Glu	Tyr	Pro	Ser	Tyr	Arg	Phe	Leu	Phe	Pro	Ile	Lys	Ala	Leu	Gly
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Met	Tyr	Ser	Arg	Ala	Tyr	Glu	Thr	His	Thr	Leu					
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 <212> PRT
 <213> Homo sapiens

<400> 200

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Val	Arg	Phe	Arg	Ile	Gly	Gly	Lys	Arg	Lys	Val	Met	Pro	Lys	Met	Asp
			20					25					30		
Gln	Asp	Ser	Leu	Ser	Ser	Ser	Leu	Lys	Thr	Cys	Tyr	Lys	Tyr	Leu	Asn
		35					40					45			
Gln	Thr	Ser	Arg	Ser	Phe	Ala	Ala	Val	Ile	Gln	Ala	Leu	Asp	Gly	Glu
	50					55					60				
Met	Arg	Asn	Ala	Val	Cys	Ile	Phe	Tyr	Leu	Val	Leu	Arg	Ala	Leu	Asp
65					70					75					80
Thr	Leu	Glu	Asp	Asp	Met	Thr	Ile	Ser	Val	Glu	Lys	Lys	Val	Pro	Leu
				85					90					95	
Leu	His	Asn	Phe	His	Ser	Phe	Leu	Tyr	Gln	Pro	Asp	Trp	Arg	Phe	Met
			100					105					110		
Glu	Ser	Lys	Glu	Lys	Asp	Arg	Gln	Val	Leu	Glu	Asp	Phe	Pro	Thr	Ile
		115					120					125			
Ser	Leu	Glu	Phe	Arg	Asn	Leu	Ala	Glu	Lys	Tyr	Gln	Thr	Val	Ile	Ala

	SeqLst															
130	135	140														
Asp 145	Ile 130	Cys 145	Arg 145	Arg 145	Met 150	Gly 135	Ile 145	Gly 145	Met 155	Ala 140	Glu 140	Phe 140	Leu 140	Asp 140	Lys 160	
His 145	Val 145	Thr 145	Ser 165	Glu 165	Gln 150	Glu 135	Trp 145	Asp 170	Lys 155	Tyr 140	Cys 140	His 140	Tyr 140	Val 175	Ala 160	
Gly 145	Leu 145	Val 145	Gly 180	Ile 165	Gly 150	Leu 135	Ser 145	Arg 185	Leu 170	Phe 140	Ser 140	Ala 140	Ser 140	Glu 190	Phe 175	
Glu 145	Asp 145	Pro 195	Leu 180	Val 165	Gly 150	Glu 135	Asp 200	Thr 185	Glu 170	Arg 140	Ala 140	Asn 205	Ser 140	Met 190	Gly 175	
Leu 145	Phe 210	Leu 195	Gln 180	Lys 165	Thr 150	Asn 200	Ile 135	Ile 145	Arg 170	Asp 220	Tyr 140	Leu 205	Glu 140	Asp 190	Gln 175	
Gln 145	Gly 225	Gly 210	Arg 180	Glu 165	Phe 230	Trp 215	Pro 135	Gln 145	Glu 235	Val 220	Trp 140	Ser 205	Arg 140	Tyr 190	Val 240	
Lys 145	Lys 225	Leu 210	Gly 245	Asp 230	Phe 245	Ala 230	Lys 135	Pro 145	Glu 250	Asn 235	Ile 140	Asp 205	Leu 140	Ala 255	Val 240	
Gln 145	Cys 260	Leu 245	Asn 260	Glu 245	Leu 260	Ile 230	Thr 135	Asn 265	Ala 250	Leu 235	His 140	His 205	Ile 270	Pro 255	Asp 240	
Val 145	Ile 275	Thr 260	Tyr 275	Leu 245	Ser 260	Arg 230	Leu 135	Arg 280	Asn 265	Gln 250	Ser 140	Val 205	Phe 270	Asn 255	Phe 240	
Cys 145	Ala 290	Ile 275	Pro 260	Gln 245	Val 260	Met 295	Ala 135	Ile 280	Ala 300	Thr 265	Leu 205	Ala 270	Ala 255	Cys 240	Tyr 240	
Asn 145	Asn 305	Gln 290	Gln 275	Val 260	Phe 310	Lys 295	Gly 135	Ala 280	Val 300	Lys 315	Ile 205	Arg 270	Lys 255	Gly 240	Gln 320	
Ala 145	Val 305	Thr 290	Leu 275	Met 325	Met 310	Asp 295	Ala 135	Thr 280	Asn 330	Met 315	Pro 205	Ala 270	Val 255	Lys 335	Ala 320	
Ile 145	Ile 335	Tyr 305	Gln 340	Tyr 325	Met 310	Glu 295	Glu 135	Ile 345	Tyr 330	His 315	Arg 205	Ile 270	Pro 255	Asp 335	Ser 320	
Asp 145	Pro 355	Ser 340	Ser 325	Ser 340	Lys 310	Thr 295	Arg 345	Gln 330	Ile 315	Ile 330	Ser 205	Thr 270	Ile 255	Arg 335	Thr 320	
Gln 145	Asn 370	Leu 355	Pro 340	Asn 325	Cys 310	Gln 295	Leu 135	Ile 375	Ser 360	Arg 345	Ser 205	His 270	Tyr 255	Ser 335	Pro 320	
Ile 145	Tyr 385	Leu 370	Ser 355	Phe 340	Val 325	Met 310	Leu 135	Leu 375	Ala 395	Ala 360	Leu 205	Ser 270	Trp 255	Gln 335	Tyr 320	
Leu 145	Thr 385	Thr 370	Leu 355	Ser 405	Gln 325	Val 310	Thr 135	Glu 375	Asp 410	Tyr 395	Val 205	Gln 270	Thr 255	Gly 415	Glu 400	
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Gln 1	Asp 1	Ser 1	Leu 35	Ser 1	Ser 1	Ser 1	Leu 40	Lys 1	Thr 1	Cys 1	Tyr 1	Lys 45	Tyr 1	Leu 1	Asn 1	
Gln 1	Thr 50	Ser 1	Arg 1	Ser 1	Phe 1	Ala 55	Ala 1	Val 1	Ile 1	Gln 1	Ala 60	Leu 1	Asp 1	Gly 1	Asp 1	
Ile 1	Arg 65	His 1	Ala 1	Ile 1	Cys 70	Val 1	Phe 1	Tyr 1	Leu 75	Val 1	Leu 1	Arg 1	Ala 1	Leu 1	Asp 80	
Thr 1	Val 1	Glu 1	Asp 1	Asp 85	Met 1	Ser 1	Ile 1	Ser 1	Val 90	Glu 1	Lys 1	Lys 1	Ile 1	Pro 95	Leu 1	
Leu 1	Cys 1	Asn 1	Phe 100	His 1	Thr 1	Phe 1	Leu 1	Tyr 105	Asp 1	Pro 1	Glu 1	Trp 1	Arg 110	Phe 1	Thr 1	
Glu 1	Ser 1	Lys 115	Glu 1	Lys 1	Asp 1	Arg 1	Gln 120	Val 1	Leu 1	Glu 1	Asp 1	Phe 125	Pro 1	Thr 1	Ile 1	
Ser 1	Leu 130	Glu 1	Phe 1	Arg 1	Asn 1	Leu 135	Ala 1	Glu 1	Lys 1	Tyr 1	Gln 140	Thr 1	Val 1	Ile 1	Asp 1	

SeqLst

Gly	Leu	Val	Gly	165	Ile	Gly	Leu	Ser	Arg	170	Leu	Phe	Ser	Ala	Ser	175	Glu	Phe
Glu	Asp	Pro	180	Ile	Val	Gly	Glu	Asp	185	Thr	Glu	Cys	Ala	Asn	190	Ser	Met	Gly
Leu	Phe	195	Leu	Gln	Lys	Thr	Asn	200	Ile	Ile	Arg	Asp	Tyr	220	Leu	Glu	Asp	Gln
Gln	Glu	Gly	Arg	Gln	Phe	230	Trp	Pro	Gln	Glu	Val	Trp	Gly	Lys	Tyr	240	Val	
225	Lys	Lys	Leu	Glu	Asp	245	Phe	Val	Lys	Pro	Glu	Asn	Val	Asp	Val	255	Ala	Val
Lys	Cys	Leu	Asn	260	Glu	Leu	Ile	Thr	Asn	265	Ala	Leu	Gln	His	Ile	270	Pro	Asp
Val	Ile	Thr	Tyr	Leu	Ser	Arg	Leu	Arg	Asn	Gln	Ser	Val	Phe	Asn	Phe			
Cys	Ala	290	Ile	Pro	Gln	Val	Met	295	Ala	Ile	Ala	Thr	Leu	Ala	Ala	Cys	Tyr	
Asn	Asn	His	Gln	Val	Phe	310	Lys	Gly	Val	Val	Lys	Ile	Arg	Lys	Gly	Gln	320	
Ala	Val	Thr	Leu	Met	325	Met	Asp	Ala	Thr	Asn	Met	Pro	Ala	Val	Lys	Ala	335	
Ile	Ile	Tyr	Gln	Tyr	Ile	Glu	Glu	Ile	Tyr	His	Arg	Val	Pro	Asn	Ser			
Asp	Pro	Ser	Ala	Ser	Lys	Ala	Lys	360	Gln	Leu	Ile	Ser	Asn	Ile	Arg	Thr		
Gln	Ser	Leu	Pro	Asn	Cys	Gln	Leu	Ile	Ser	Arg	Ser	His	Tyr	Ser	Pro			
Ile	Tyr	Leu	Ser	Phe	Ile	Met	Leu	Leu	Ala	Ala	Leu	Ser	Trp	Gln	Tyr	400		
385	Leu	Ser	Thr	Leu	Ser	405	Gln	Val	Thr	Glu	Asp	Tyr	Val	Gln	Arg	Glu	415	His

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<400> 203

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

SeqLst

Leu	His	Arg	Gly	Gln	Gly	Met	Asp	Leu	Phe	Trp	Arg	Asp	Thr	Leu	Thr
		195					200					205			
Cys	Pro	Ser	Glu	Asp	Glu	Tyr	Leu	Glu	Met	Val	Gly	Asn	Lys	Thr	Gly
	210					215					220				
Gly	Leu	Phe	Arg	Leu	Ala	Val	Lys	Leu	Met	Gln	Ala	Glu	Ser	Ser	Thr
225					230					235					240
Gly	Lys	Asp	Cys	Val	Ala	Leu	Val	Asn	Val	Leu	Gly	Leu	Val	Phe	Gln
			245						250					255	
Ile	Cys	Asp	Asp	Tyr	Leu	Asn	Leu	Ser	Asp	Thr	Thr	Tyr	Thr	Gln	Asn
			260					265						270	
Lys	Gly	Leu	Cys	Glu	Asp	Leu	Thr	Glu	Gly	Lys	Phe	Ser	Phe	Pro	Ile
		275					280					285			
Ile	His	Ser	Ile	Arg	Ser	Asn	Pro	Gly	Asn	His	Gln	Leu	Ile	Asn	Ile
	290					295					300				
Leu	Arg	Gln	Arg	Thr	Lys	Asp	Glu	Glu	Val	Lys	Arg	Tyr	Ala	Leu	Gln
305					310					315					320
Tyr	Met	Glu	Ser	Thr	Gly	Ser	Phe	Lys	His	Thr	Gln	Asp	Val	Val	Arg
				325					330					335	
Gln	Leu	Arg	Ala	Arg	Ala	Leu	Gln	Leu	Ile	Glu	Glu	Ile	Glu	Asn	Ser
			340					345					350		
Glu	Asn	Gly	Glu	Gln	Pro	Glu	Glu	His	Asn	Asp	Gly	Thr	Met	Val	Arg
		355					360					365			
Ala	Ile	Leu	Asp	Lys	Ile	Thr	Glu	Ser	Thr	Leu	Ala	Asp	Thr	Asn	Thr
	370					375					380				
Thr	Thr	Arg	Asp	Ile	Asn	Gly	Asn	Cys	Ala	Thr	Arg				
385					390					395					

Claims

1. A method for producing a target steviol glycoside or a target steviol glycoside composition, comprising contacting a starting composition comprising a steviol, a precursor steviol glycoside having a 13-*O*-glucose, a 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose, and/or a mixture thereof with a first polypeptide capable of beta 1,2 glycosylation of a C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152; and one or more of:
 - (a) a second polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5;
 - (b) a polypeptide capable of rhamnosylation of a steviol 13-*O*-monoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:150;
 - (c) a polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising a UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1;
 - (d) a polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising a UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3; and/or
 - (e) a polypeptide capable of beta 1,3 glycosylation of a C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7;wherein at least one of the polypeptides is a recombinant polypeptide;

and one or more UDP-sugars, under suitable reaction conditions for the transfer of one or more sugar moieties from the one or more UDP-sugars to the steviol, the precursor steviol glycoside, and/or the mixture thereof,

thereby producing the target steviol glycoside or the target steviol glycoside composition.

2. The method of claim 1, wherein the one or more UDP-sugar comprises UDP-glucose, UDP-rhamnose, fructose, and/or UDP-xylose.
3. The method of claim 1, wherein the target steviol glycoside comprises steviol-1,2-bioside, stevioside, rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, or dulcoside A.
4. The method of claim 1, wherein the target steviol glycoside composition comprises steviol-1,2-bioside, stevioside, rebaudioside A, rebaudioside B, rebaudioside C, rebaudioside D, rebaudioside E, rebaudioside F, dulcoside A and a combination thereof.
5. The method of claim 1, wherein:
 - (a) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, steviol-1,2-bioside, stevioside, or rebaudioside B and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose, the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19

carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

rebaudioside A is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (b) the precursor steviol glycoside is steviol-13-*O*-glucoside or steviol-1,2-bioside and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90%

sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

rebaudioside B is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (c) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, steviol-1,2-bioside, or stevioside and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

rebaudioside E is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (d) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, steviol-1,2-bioside, stevioside, rebaudioside A, rebaudioside B, or rebaudioside E and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

rebaudioside D is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (e) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, or steviol-1,2-rhamnobioside and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose and UDP-rhamnose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of rhamnosylation of the steviol 13-*O*-monoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:150; and

- dulcoside A is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose and UDP-rhamnose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or
- (f) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, steviol-1,2-rhamnobioside, or dulcoside A and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose and UDP-rhamnose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set

forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; the polypeptide capable of rhamnosylation of the steviol 13-*O*-monoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:150; and the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

rebaudioside C is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose and UDP-rhamnose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (g) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, rubusoside, 1,2-steviolxyloside, or steviol-1,2-xylobioside, and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose and UDP-xylose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-

diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7, a UDP-glucose dehydrogenase (UGD1) polypeptide, and/or a UDP-glucuronic decarboxylase (UXS3) polypeptide; and

rebaudioside F is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose and UDP-xylose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (h) the precursor steviol glycoside is steviol-13-*O*-glucoside, the one or more UDP-sugar is UDP-glucose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID

NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; and the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and

steviol-1,2-bioside is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof; or

- (i) the precursor steviol glycoside is steviol-13-*O*-glucoside, steviol-19-*O*-glucoside, steviol-1,2-bioside, or rubusoside, and/or a mixture thereof, the one or more UDP-sugar is UDP-glucose,

the steviol, the precursor steviol glycoside and/or the mixture thereof is contacted with the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152 and one or more of: the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT85 family, comprising the UGT85C2 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:3, the polypeptide of uridine 5'-diphospho (UDP) glycosyl transferase (UGT) UGT74 family, comprising the UGT74G1 polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-19 carboxyl group and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:1; the polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:5; and the polypeptide capable of beta

1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:7; and

stevioside is produced upon transfer of the one or more sugar moieties from the one or more UDP-glucose to steviol, the precursor steviol glycoside, and/or the mixture thereof.

6. The method of claim 1, wherein the target steviol glycoside or the target steviol glycoside composition is produced in a recombinant host cell which has been transformed with a gene encoding the first polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside and having at least 90% sequence identity to the amino acid sequence set forth in SEQ ID NO:152.
7. The method of claim 1, wherein the method is an *in vitro* method, further comprising supplying the one or more UDP-sugars or supplying a cell-free system for regeneration of the one or more UDP-sugars.
8. The method of claim 7, wherein the *in vitro* method is an enzymatic *in vitro* method or a whole cell *in vitro* method.
9. The method of claim 8, wherein the whole cell *in vitro* method comprises feeding raw materials comprising Stevia extracts, comprising the one or more UDP-sugars and one or more of the steviol, the precursor steviol glycoside and/or the mixture thereof to a whole cell.
10. The method of claim 9, wherein the whole cell used in the whole cell *in vitro* method has a reduced ability to degrade external sucrose.
11. The method of claim 9, wherein an endogenous sucrose invertase of the whole cell comprising the *in vitro* method is disrupted.

12. The method of claim 9, further comprising feeding raw materials during or after cell growth.
13. The method of claim 9, wherein the whole cell used in the whole cell *in vitro* method is:
 - (a) in suspension or immobilized;
 - (b) entrapped in a calcium or sodium alginate bead;
 - (c) linked to a hollow fiber tube reactor system;
 - (d) concentrated and entrapped within a membrane reactor system; or
 - (e) in fermentation broth or in a reaction buffer.
14. The method of claim 9, further comprising permeabilizing the whole cell by using a permeabilizing agent, wherein the permeabilizing agent is a solvent, a detergent, or a surfactant, by a mechanical shock, an electroporation, or an osmotic shock.
15. The method of claim 9, wherein the whole cell used in the whole cell *in vitro* method is a plant cell, a mammalian cell, an insect cell, a fungal cell from *Aspergillus* genus or a yeast cell from *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, *Yarrowia lipolytica*, *Candida glabrata*, *Ashbya gossypii*, *Cyberlindnera jadinii*, *Pichia pastoris*, *Kluyveromyces lactis*, *Hansenula polymorpha*, *Candida boidinii*, *Arxula adeninivorans*, *Xanthophyllomyces dendrorhous*, or *Candida albicans* species, an algal cell or a bacterial cell from *Escherichia coli* species or *Bacillus* genus.
16. The method of claim 1, wherein:
 - (a) the second polypeptide capable of beta 1,2 glycosylation of the C2' of the 13-O-glucose, the 19-O-glucose, or both the 13-O-glucose and the 19-O-glucose of the precursor steviol glycoside comprises:
 - (i) a polypeptide having an arginine at residue 206, a cysteine at residue 207, and an arginine at residue 343 of SEQ ID NO:5;
 - (ii) a polypeptide having a tyrosine or phenylalanine at residue 30, a proline or glutamine at residue 93, a serine or valine at residue 99, a tyrosine or a phenylalanine at residue 122, a histidine or tyrosine at residue 140, a serine or cysteine at residue 142, an alanine or threonine at residue 148, a

methionine at residue 152, an alanine at residue 153, an alanine or serine at residue 156, a glycine at residue 162, a leucine or methionine at residue 195, a glutamic acid at residue 196, a lysine or glutamic acid at residue 199, a leucine or methionine at residue 211, a leucine at residue 213, a serine or phenylalanine at residue 221, a valine or isoleucine at residue 253, a valine or alanine at residue 286, a lysine or asparagine at residue 427, an alanine at residue 438, and either an alanine or threonine at residue 462 of SEQ ID NO:5;

- (iii) a polypeptide having a methionine at residue 211 and an alanine at residue 286 of SEQ ID NO:5; or
- (iv) a polypeptide having at least 90% sequence identity to any one of the amino acid sequences set forth in SEQ ID NOs:10, 12, or 95; and

- (b) the polypeptide capable of glycosylating the steviol or the precursor steviol glycoside at its C-13 hydroxyl group comprises a polypeptide having one or more amino acid substitutions at residues K9E, K10R, V13F, F15L, Q21H, M27V, H60D, A65S, E71Q, I87F, L91P, K220T, R243W, T270M, T270R, Q289H, Y298C, L334S, K350T, H368R, A389V, I394V, P397S, E418V, G420R, L431P, G440D, H441N, R444G, and M471T of SEQ ID NO:3;

and/or

- (c) the polypeptide capable of beta 1,3 glycosylation of the C3' of the 13-*O*-glucose, the 19-*O*-glucose, or both the 13-*O*-glucose and the 19-*O*-glucose of the precursor steviol glycoside comprises a polypeptide having one or more amino acid substitutions at residues M29I, V74E, V87G, L91P, G116E, A123T, Q125A, I126L, T130A, V145M, C192S, S193A, F194Y, M196N, K198Q, K199I, Y200L, Y203I, F204L, E205G, N206K, I207M, T208I, P266Q, S273P, R274S, G284T, T285S, L330V, G331A, and L346I of SEQ ID NO:7.