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(54) Titre : PROTEINES PROTECTRICES DE S. AGALACTIA, LEURS COMBINAISONS ET LEURS PROCEDES D'UTILISATION
(54) Title: PROTECTIVE PROTEINS OF S. AGALACTIAE, COMBINATIONS THEREOF AND METHODS OF USING THE SAME

(57) Abrégé/Abstract:
The invention relates to a composition comprising at least two protective proteins against Streptococcus agalactiae (S. agalactiae) or functionally active variant thereof; a protective peptide against S. agalactiae; one or more nucleic acid(s) encoding the at least two proteins and/or the protective peptide; a method of producing the composition; a pharmaceutical composition, especially a vaccine, comprising the composition and/or at least one protective peptide; methods for producing antibodies; a mixture of antibodies against the at least two proteins of the composition; the use of the composition and/or at least one protective peptide and/or one or more nucleic acid(s) for the manufacture of a medicament for the immunization or treatment of a subject; methods of diagnosing a S. agalactiae infection; a method for identifying a ligand capable of binding the composition and/or at least one protective peptide; and the use of the composition and/or at least one protective peptide for the isolation and/or purification and/or identification of an interaction partner of the composition and/or peptide.

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(54) **Title:** PROTECTIVE PROTEINS OF S. AGALACTIAE, COMBINATIONS THEREOF AND METHODS OF USING THE SAME

(57) **Abstract:** The invention relates to a composition comprising at least two protective proteins against Streptococcus agalactiae (S. agalactiae) or functionally active variant thereof; a protective peptide against S. agalactiae; one or more nucleic acid(s) encoding the at least two proteins and/or the protective peptide; a method of producing the composition; a pharmaceutical composition, especially a vaccine, comprising the composition and/or at least one protective peptide; methods for producing antibodies; a mixture of antibodies against the at least two proteins of the composition; the use of the composition and/or at least one protective peptide and/or one or more nucleic acid(s) for the manufacture of a medicament for the immunization or treatment of a subject; methods of diagnosing a S. agalactiae infection; a method for identifying a ligand capable of binding the composition and/or at least one protective peptide; and the use of the composition and/or at least one protective peptide for the isolation and/or purification and/or identification of an interaction partner of the composition and/or peptide.

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Protective proteins of *S. agalactiae*, combinations thereof and methods of using the same

The invention relates to a composition comprising at least two protective proteins against *Streptococcus agalactiae* (*S. agalactiae*) or functionally active variants thereof; a protective peptide against *S. agalactiae*; one or more nucleic acid(s) encoding the at least two proteins and/or the protective peptide; a method of producing the composition; a pharmaceutical composition, especially a vaccine, comprising the composition and/or at least one protective peptide; methods for producing antibodies; a mixture of antibodies against the at least two proteins of the composition; the use of the composition and/or at least one protective peptide and/or one or more nucleic acid(s) for the manufacture of a medicament for the immunization or treatment of a subject; methods of diagnosing a *S. agalactiae* infection; a method for identifying a ligand capable of binding the composition and/or at least one protective peptide; and the use of the composition and/or at least one protective peptide for the isolation and/or purification and/or identification of an interaction partner of the composition and/or peptide.

S. agalactiae is an encapsulated gram-positive bacterium, which belongs to the Group B Streptococci (GBS) based on its haemolysis pattern on blood agar. Capsules form the basis for classifying GBS into nine distinct serotypes. Most of them have been shown to cause serious diseases, and the two most common serotypes - type III and V - are estimated to account for the majority (~80%) of invasive diseases worldwide. The ranking and serotype prevalence differs by age group and geographic area.

Streptococcus agalactiae is a frequent cause of infections in neonates, pregnant women and in chronically ill and elderly patients. In newborns Group B Streptococcus even represents the predominant pathogen in the United States causing life threatening diseases, such as sepsis, pneumonia and meningitis. GBS diseases are associated with a high mortality rate (~5%) and a large percentage (~20%) of children surviving GBS infections becomes permanently handicapped with hearing, learning and visual disabilities.

Newborns usually acquire the pathogen during delivery from their GBS-colonized mothers. Twenty-five to 40% of pregnant women are colonized with GBS, but are asymptomatic. Due to vertical transmission during birth, 50-70% of neonates born to colonized women - that is approximately 10-25% of all newborns - become colonized by GBS during delivery which is a prerequisite for infection and disease. In the United States, GBS infections affect 1-5 newborns/1,000 live births. Pre-term infants are at the highest risk for invasive disease due to their immature immune system and the low level of maternal antibody transfer before the 34th pregnancy week.

GBS disease occurs throughout the world. The highest prevalence of invasive disease in newborns occurs in Western countries, due to the elimination and reduction of other infectious agents and also due to the increased survival of very immature newborns. Before prevention by intrapartum antibiotic treatment was introduced, about 17,000 cases of invasive GBS diseases (sepsis, pneumonia and/or meningitis) were reported in the US annually. The rates of serious GBS infections are higher among newborns than among any other age group. Nonetheless, serious Group B streptococcal infections occur in other age groups in both men and women. Among non-pregnant adults, rates of serious disease range from 4.1 to 7.2 cases per 100,000 and increase with age. The average death rate for invasive infections is 8-10% for adults between ages 18-64 and 15-25% for adults > 65 years of age. Serious disease is most common among elderly, bedridden patients and people suffering from severe medical conditions including diabetes mellitus, liver disease, history of stroke, history of cancer or bedsores.

Currently, disease management fully relies on antibiotics, mainly Penicillin G. In order to prevent invasive disease in newborns, pregnant women are screened for carriage of GBS at 35th to 37th weeks of gestation. Colonized mothers are then treated with high dose antibiotics during delivery to prevent neonatal GBS disease.

Current standard treatment of GBS infections is also based on antibiotics. Route, dosage, schedule and duration of therapy depend on the severity of the illness. Ten days of treatment is recommended for bacteraemia, pneumonia and soft tissue infections, while 2-3 weeks is recommended for meningitis and 3-4 weeks for osteomyelitis.

Invasive GBS diseases are associated with 5% mortality and 20% permanent damage in spite of effective antibiotic therapy, due to a very rapid and dramatic clinical course. Before prevention direct medical costs of neonatal disease were ~$300 million annually in the US; and GBS still poses a considerable economic burden.

Although intrapartum prophylaxis has decreased the incidence of early-onset GBS disease, currently available strategies are not ideal as they can neither prevent late-onset infections nor disease in premature babies which are at highest risk for invasive disease.

Currently, no effective preventive vaccine is available. There are efforts focusing on using capsular polysaccharides (with or without protein-conjugation) as immunogens, but several arguments militate against that approach. Polysaccharides induce IgG2 antibodies, which cross the placenta less efficiently than IgG1 or IgG3 antibodies. This especially poses a problem for the most susceptible early-born neonates, since placental antibody transfer is low before the 34th pregnancy week and about 10% of deliveries occur before that time. An additional disadvantage of polysaccharide vaccines is the incomplete vaccine coverage among GBS serotypes. Given adequate ecological pressure, replacement disease by non-vaccine serotypes remains a real threat, particularly in areas with high disease burden.

Taking these insufficiencies into account, new generation immune interventions against GBS disease are needed. Given the very recent acceptance of the use of a cervical cancer-preventing vaccine in teenage girls, a new approach would be the use of combinations of proteins as a prophylactic GBS vaccine in order to provide protection against more than one *S. agalactiae* strain or serotype.

Accordingly, one problem underlying the present invention was to provide alternative means for the development of medicaments such as vaccines against *S. agalactiae* infection. More particularly, one problem was to provide combinations of protective proteins, particularly more effective combinations, derived from *S. agalactiae* that can be used for the manufacture of said medicaments.

Surprisingly, this object has been solved by combinations of protective proteins/peptides comprising or consisting of the amino acid sequences as defined in SEQ ID NOS: 1 to 6 or functionally active variants thereof.

Accordingly, a first subject of the present invention relates to a composition comprising at least two proteins selected from the group consisting of

i) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 1 (gbs0233p) or functionally active variant thereof;
ii) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 2 (gbs1087p) or functionally active variant thereof;
iii) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 3 (gbs1309p) or functionally active variant thereof;
iv) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 4 (gbs1477p) or functionally active variant thereof;
v) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 5 (gbs1478p) or functionally active variant thereof; and
vi) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 6 (gbs2018p) or functionally active variant thereof.

Surprisingly, it was found that combinations of the above protective proteins provide a better protection against *S. agalactiae* than a protective protein when used alone. A better protection in the context of the present invention may refer to a situation in which protection provided by the combination is improved quantitatively in comparison to the single components of the composition. For example, the combination may provide protection against at least one serotype of *S. agalactiae* against which at least one of the protective proteins present in the composition does not provide protection. Accordingly, the number of serotypes against which the combination provides protection is increased. Additionally or alternatively, protection provided by the combination is improved qualitatively in comparison to the single components of the composition. For example, the survival of mice challenged with GBS strains may be improved when a composition of protective proteins is used in comparison to the single components of the composition. Both, quantitatively and qualitatively sufficient protection, are important for successful prevention and/or treatment, since it is the goal striven for to provide protection which is as high as possible and which protects against as many serotypes as possible.

Additionally, combinations of different protective proteins are in general advantageous in comparison to single protective proteins, since in the case of vaccines employing different protective proteins/antibodies the probability of a serotype switch of the pathogen in question leading to reduced effectiveness of the vaccine is strongly diminished. This is due to the fact that more than one mutation in *S. agalactiae* proteins at defined sites would be required in order to render the respective *S. agalactiae* strain unsusceptible to the vaccine.

The protective protein consisting of the amino acid sequence of SEQ ID NO: 1 is derived from *S. agalactiae* strain 12403 and has been denoted by gbs0233p (partial gbs0233) in accordance with the genome of NEM316 (ATCC12403). The DNA sequence encoding the full length protein gbs0233 (consisting of 308 amino acids; SEQ ID NO: 229) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 1 is derived is disclosed at GenBank® accession number AL732656 (complete genome of *Streptococcus agalactiae* NEM316) and the amino acid sequence of the full length protein is disclosed in WO2004/099242 (see SEQ ID NO: 475). The amino acid sequence of SEQ ID NO: 1 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 1 or a functionally active variant thereof are referred to as (protective) proteins of subgroup i).

The protective protein consisting of the amino acid sequence of SEQ ID NO: 2 is derived from *S. agalactiae* strain 6313 and has been denoted by gbs1087p (partial gbs1087) in accordance with the genome of NEM316 (ATCC12403). The amino acid and encoding DNA sequences of the full length protein gbs1087 (also referred to as FbsA and consisting of 442 amino acids; SEQ ID NO: 230) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 2 is derived is disclosed in WO2004/035618 (see Fig. 1 and SEQ ID NO: 11). The amino acid sequence of SEQ ID NO: 2 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 2 or a functionally active variant thereof are referred to as (protective) proteins of subgroup ii).

The protective protein consisting of the amino acid sequence of SEQ ID NO: 3 is derived from *S. agalactiae* strain 12403 and has been denoted by gbs1309p (partial gbs1309) in accordance with the genome of NEM316 (ATCC12403). The DNA sequence encoding the full length protein gbs1309 (consisting of 403 amino acids; SEQ ID NO: 231) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 3 is derived is disclosed in GenBank® accession number AL732656 (complete genome of

Streptococcus agalactiae NEM316) and the amino acid sequence of the full length protein is disclosed in WO2004/099242 (see SEQ ID NO: 307). The amino acid sequence of SEQ ID NO: 3 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 3 or a functionally active variant thereof are referred to as (protective) proteins of subgroup iii).

The protective protein consisting of the amino acid sequence of SEQ ID NO: 4 is derived from *S. agalactiae* strain 6313 and has been denoted by gbs1477p (partial gbs1477) in accordance with the genome of NEM316 (ATCC12403). The amino acid and encoding DNA sequences of the full length protein gbs1477 (also referred to as PabB and consisting of 674 amino acids; SEQ ID NO: 232) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 4 is derived is disclosed in WO2004/035618 (see Fig. 16 and SEQ ID NO: 18). The amino acid sequence of SEQ ID NO: 4 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 4 or a functionally active variant thereof are referred to as (protective) proteins of subgroup iv).

The protective protein consisting of the amino acid sequence of SEQ ID NO: 5 is derived from *S. agalactiae* strain 6313 and has been denoted by gbs1478p (partial gbs1478) in accordance with the genome of NEM316 (ATCC12403). The amino acid and encoding DNA sequences of the full length protein gbs1478 (also referred to as PabA and consisting of 901 amino acids; SEQ ID NO: 233) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 5 is derived is disclosed in WO2004/035618 (see Fig. 16 and SEQ ID NO: 17). The amino acid sequence of SEQ ID NO: 5 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 5 or a functionally active variant thereof are referred to as (protective) proteins of subgroup v).

The protective protein consisting of the amino acid sequence of SEQ ID NO: 6 is derived from *S. agalactiae* strain 12403 and has been denoted by gbs2018p (partial gbs2018) in accordance with the genome of NEM316 (ATCC12403). The DNA sequence encoding the full length protein gbs2018 (also referred to as BibA (Santi *et al.,* 2007, Mol. Microbiol. 63:754-767) and consisting of 643 amino acids; SEQ ID NO: 234) from which the protective protein consisting of the amino acid sequence of the SEQ ID NO: 6 is derived is disclosed at GenBank® accession number AL732656 (complete genome of *Streptococcus agalactiae* NEM316) and the amino acid sequence of the full length protein is disclosed in WO2004/099242 (see SEQ ID NO: 364). The amino acid sequence of SEQ ID NO: 6 is disclosed in the Examples as well as in the attached Sequence listing. The protective protein comprising or consisting of the protective peptide of SEQ ID NO: 6 or a functionally active variant thereof are referred to as (protective) proteins of subgroup vi).

The combinations of the protective proteins of the sequences of SEQ ID NO: 1 to 6 have been shown to induce a protective immune response against different serotypes and/or to show increased protection against *S. agalactiae* in an animal model (see Examples). Functionally active variants may be obtained by changing the sequence of at least one of the protective proteins of SEQ ID NO: 1 to 6 and are characterized by having a biological activity similar to that displayed by the respective protective protein of the sequence of SEQ ID NO: 1 to 6 from which the variant is derived, including the ability to induce protective immune responses and/or to show protection against *S. agalactiae* e.g. in an animal model, wherein any variant may be tested in any of the tests described in the Examples. The functionally active variant of a protective protein may be obtained by sequence alterations in the protective protein, wherein the protein with the sequence alterations essentially retains a function of the unaltered protective protein, e.g. having a biological activity similar to that displayed by the unaltered protective protein (see above) including the ability to induce protective immune responses and/or to show protection against *S. agalactiae*. Such sequence alterations can include, but are not limited to, (conservative) substitutions, deletions, mutations and insertions.

In a preferred embodiment of the invention the composition comprises at least three proteins selected from the group consisting of subgroup i) to vi). In an even more preferred embodiment of the invention the composition comprises at least four proteins selected from the group consisting of subgroup i) to vi).

In a preferred embodiment of the invention the at least two, three or four proteins of the composition of the invention are selected from different subgroups i) to vi). Alternatively or additionally, at least two of the proteins of the composition of the invention are selected from one of the subgroups i) to vi).

Examples of combinations of the first alternative (selection of protective proteins from different groups) are compositions comprising:

- one protein of subgroup i) and one protein of subgroup ii);
- one protein of subgroup i) and one protein of subgroup iii);
- one protein of subgroup i) and one protein of subgroup iv);
- one protein of subgroup i) and one protein of subgroup v);
- one protein of subgroup i) and one protein of subgroup vi);
- one protein of subgroup ii) and one protein of subgroup iii);
- one protein of subgroup ii) and one protein of subgroup iv);
- one protein of subgroup ii) and one protein of subgroup v);
- one protein of subgroup ii) and one protein of subgroup vi);
- one protein of subgroup iii) and one protein of subgroup iv);
- one protein of subgroup iii) and one protein of subgroup v);
- one protein of subgroup iii) and one protein of subgroup vi);
- one protein of subgroup iv) and one protein of subgroup v);
- one protein of subgroup iv) and one protein of subgroup vi);
- one protein of subgroup v) and one protein of subgroup vi);
- one protein of subgroup i) and one protein of subgroup ii) and one protein selected from any of the subgroups iii) to vi);
- one protein of subgroup i) and one protein of subgroup iii) and one protein selected from any of the subgroups ii) or iv) to vi);
- one protein of subgroup i) and one protein of subgroup iv) and one protein selected from any of the subgroups ii), iii), v) or vi);
- one protein of subgroup i) and one protein of subgroup v) and one protein selected from any of the subgroups ii) to iv) or vi);
- one protein of subgroup i) and one protein of subgroup vi) and one protein selected from any of the subgroups ii) to v);
- one protein of subgroup ii) and one protein of subgroup iii) and one protein selected from any of the subgroups i) or iv) to vi);
- one protein of subgroup ii) and one protein of subgroup iv) and one protein selected from any of the subgroups i), iii), v) or vi);
- one protein of subgroup ii) and one protein of subgroup v) and one protein selected from any of the subgroups i), iii), iv) or vi);

- one protein of subgroup ii) and one protein of subgroup vi) and one protein selected from any of the subgroups i) or iii) to v);
- one protein of subgroup iii) and one protein of subgroup iv) and one protein selected from any of the subgroups i), ii), v) or vi);
- one protein of subgroup iii) and one protein of subgroup v) and one protein selected from any of the subgroups i), ii), iv) or vi);
- one protein of subgroup iii) and one protein of subgroup vi) and one protein selected from any of the subgroups i), ii), iv) or v);
- one protein of subgroup iv) and one protein of subgroup v) and one protein selected from any of the subgroups i) to iii) or vi);
- one protein of subgroup iv) and one protein of subgroup vi) and one protein selected from any of the subgroups i) to iii) or v); or
- one protein of subgroup v) and one protein of subgroup vi) and one protein selected from any of the subgroups i) to iv).

Preferred examples are:

- one protein of subgroup iv) and one protein of subgroup vi);
- one protein of subgroup iv), one protein of subgroup vi) and one protein of subgroup ii);
- one protein of subgroup iv), one protein of subgroup vi), one protein of subgroup ii) and one protein of subgroup v);
- one protein of subgroup iv), one protein of subgroup vi), one protein of subgroup ii) one protein of subgroup v) and one protein of subgroup i);
- one protein of subgroup iv), one protein of subgroup vi), one protein of subgroup ii), one protein of subgroup v) and one protein of subgroup iii); or
- one protein of subgroup iv), one protein of subgroup vi), one protein of subgroup ii), one protein of subgroup v), one protein of subgroup i) and one protein of subgroup iii).

In an alternative preferred embodiment of the invention at least two of the proteins of the composition of the invention may be selected from one of the subgroups i) to vi). The at least two proteins may be selected in order to cover different strains or serotypes of *S. agalactiae* and, accordingly, to provide protection against e.g. different strains or serotypes of *S. agalactiae*. The complete genome of *Streptococcus agalactiae* NEM316 (strain

12403) is available at GenBank® accession number AL732656. Furthermore, the complete or incomplete genomic sequences of the following strains of *Streptococcus agalactiae* are available at GenBank® (NIH genetic sequence database; http://www.ncbi.nlm.nih.gov/) or NCBI (National Center for Biotechnology Information, Bethesda, MD, USA; http://www.ncbi.nlm.nih.gov/) using the indicated accession numbers:

Strain	**Serotype**	**Source**
515	Ia	NCBI: NZ_AAJP00000000 GenBank®: AAJP00000000
A909	Ia/c	NCBI: NC_007432 GenBank®: CP000114
H36B	Ib	NCBI: NZ_AAJS00000000 GenBank®: AAJS00000000
18RS21	II	NCBI NZ_AAJO00000000 GenBank®: AAJO00000000
COH1	III	NCBI: NZ_AAJR00000000 GenBank®: AAJR00000000
ATCC12403 (NEM316)	III	NCBI: NC_004368 GenBank®: AL732656
2603V/R	V	NCBI: NC_004116 GenBank®: AE009948
CJB111	V	NCBI: NZ_AAJQ00000000 GenBank®: AAJQ00000000

Using the sequences of SEQ ID NO: 1 to 6 as specified in the present description and knowing the sequences of other *S. agalactiae* strains (e.g. *vide supra*) the skilled person is able to identify the corresponding sequences of *S. agalactiae* strains other than 12403 (for SEQ ID NO: 1, 3 and 6) or 6313 (for SEQ ID NO: 2, 4 and 5) without undue burden. The corresponding sequences may be identified using e.g. the tools and sequences provided by "The Comprehensive Microbial Resource (CMR)" (see http://cmr.tigr.org/). However, it should be understood that the above strains are listed as examples of different *S. agalactiae* strains and that the present invention is not to be limited to those strains.

Additionally, examples of sequences of the proteins corresponding to SEQ ID NO: 1 to 6 and derived from other serotypes are published or disclosed in:

Protein or Analogue	NCBI Accession Number (strain [serotype]) or SEQ ID NO
gbs0233	Any sequence of SEQ ID NO: 55 to 60 (see Table 7), 229 and 235 to 286.
gbs1087	CAD12883 (6313); CAD27183 (706 S2 [Ia]); CAD27181 (SS1169 [V]); CAD27186 (O90R); CAD27182 (O176 H4A [II]) or any sequence of SEQ ID NO: 67 to 72 (see Table 8), 230 and 287 to 316.
gbs1309	Any sequence of SEQ ID NO: 79 to 84 (see Table 9), 231 and 317 to 359.
gbs1477	Any sequence of SEQ ID NO: 91 to 132 (see Table 10), 223 to 228 (see Fig. 5), 232 and 360 to 362.
gbs1478	Any sequence of SEQ ID NO: 185 to 203 (see Table 11), 233 and 363 to 378.
gbs2018	CAJ66802 (CCH57); CAJ66794 (CCH180); CAJ66788 (NEM1002); CAJ 66790 (NEM1560) or any sequence of SEQ ID NO: 175 to 179 (see Table 12), 234 and 379 to 425.

However, it should be understood that the present invention is not limited to the variants and corresponding proteins described above. Other naturally occurring proteins corresponding to those of SEQ ID NO: 1 to 6 may be identified as described above and used in order to carry out the present invention.

Examples of combinations of the second alternative (selection of protective proteins from one group only) are compositions comprising:

- at least two different proteins of subgroup i), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 1 or a naturally occurring variant thereof;

- at least two different proteins of subgroup ii), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 2 or a naturally occurring variant thereof;
- at least two different proteins of subgroup iii), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 3 or a naturally occurring variant thereof;
- at least two different proteins of subgroup iv), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 4 or a naturally occurring variant thereof;
- at least two different proteins of subgroup v), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 5 or a naturally occurring variant thereof;
- at least two different proteins of subgroup vi), preferably selected from the group consisting of proteins comprising or consisting of SEQ ID NO: 6 or a naturally occurring variant thereof;
- preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 55 to 60 (see Table 7), 235 to 286, and optionally 229;
- preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 67 to 72 (see Table 8), 287 to 316, and optionally 230;
- preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 79 to 84 (see Table 9), 317 to 359, and optionally 231;
- preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 185 to 203 (see Table 11), 363 to 378, and optionally 233;
- preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 175 to 179 (see Table 12), 379 to 425 and optionally 234; or
- more preferably at least two protective proteins each comprising or consisting of a sequence selected from SEQ ID NO: 91 to 132 (see Table 10), 360 to 362, or 223 to 228 (see Fig. 5) and optionally 232.

In a preferred embodiment the naturally occurring variants are those derived from *S. agalactiae* strains selected from the group consisting of IC97, IC98, IC105, IC108, IC216, IC244, IC245, IC246, IC247, IC250, IC251, IC252, IC253, IC254, IC255, IC287, IC288, IC289, IC290, IC291, IC304, IC305, IC306, IC361, IC363, IC364, IC365, IC366, IC367, IC368, IC377, IC379, IC432, IC434, IC455, IC457, IC458, IC459, IC460, IC461, IC462, IC463, IC469, IC470, 126H4A, 5095S2, 6313, 12351, 12403 (NEM316), 12401, COH1, BAA23, 0176H4A, A909, C388/90, BAA22, 2603V/R, 49447, BAA611, 515, H36B, 18RS21, CJB111, and those disclosed in Tables 7 to 13.

In another preferred embodiment of the present invention the composition of the invention comprises

- at least one protein of subgroup iv);
- at least one protein of subgroup vi);
- at least one protein of subgroup iv) and at least one protein of subgroup vi);
- at least one protein of subgroup iv), at least one protein of subgroup vi) and at least one protein of subgroup ii); or
- at least one protein of subgroup iv), at least one protein of subgroup vi), at least one protein of subgroup ii) and at least one protein of subgroup v).

In a preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 4 (gbs1477p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 4 (gbs1477p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 10, 13, and in the Sequence listing.

In another preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 6 (gbs2018p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 6 (gbs2018p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 12, 13, and in the Sequence listing.

In another preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 2 (gbs1087p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 2 (gbs1087p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 8, 13, and in the Sequence listing.

In another preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 5 (gbs1478p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 5 (gbs1478p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 11, 13, and in the Sequence listing.

In another preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 1 (gbs0233p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 1 (gbs0233p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 7, 13, and in the Sequence listing.

In another preferred embodiment of the invention one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 3 (gbs1309p) or a functionally active variant thereof, preferably protective peptide of SEQ ID NO: 3 (gbs1309p) or a naturally occurring functionally active variant thereof, more preferably a naturally occurring functionally active variant as listed in Tables 9, 13, and in the Sequence listing.

In a more referred embodiment of the invention the at least two proteins of the composition of the invention encompass:

- the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p);
- the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p); or

- the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p) and the protective peptide of SEQ ID NO: 5 (gbs1478p).

In a further preferred embodiment of the invention a naturally occurring functionally active variant of any of the protective peptides of SEQ ID NO: 1 to 6 of the above list of compositions may be used. Examples of the resulting combinations are:

I. the protective peptide of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p);
II. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p);
III. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p);
IV. the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and a naturally occurring functionally active variant of SEQ ID NO: 2 (gbs1087p);
V. the protective peptide of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p);
VI. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p);
VII. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p);
VIII. the protective peptide of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p) and a naturally occurring functionally active variant of SEQ ID NO: 2 (gbs1087p);
IX. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and a naturally occurring functionally active variant of SEQ ID NO: 2 (gbs1087p);

X. a naturally occurring functionally active variant of SEQ ID NO: 4 (gbs1477p) and a naturally occurring functionally active variant of SEQ ID NO: 6 (gbs2018p) and a naturally occurring functionally active variant of SEQ ID NO: 2 (gbs1087p);

XI. any of the compositions of I to X in combination with the protective peptide of SEQ ID NO: 5 (gbs1478p); or

XII. any of the compositions of I to X in combination with a naturally occurring functionally active variant of SEQ ID NO: 5 (gbs1478p).

wherein the naturally occurring functionally active variant is selected form those listed in Tables 7 to 13 and Fig. 5 and those of SEQ ID NO: 229 to 234 and 235 to 425.

Preferred *S. agalactiae* strains from which the naturally occurring functionally active variant may be derived include IC97, IC98, IC105, IC108, IC216, IC244, IC245, IC246, IC247, IC250, IC251, IC252, IC253, IC254, IC255, IC287, IC288, IC289, IC290, IC291, IC304, IC305, IC306, IC361, IC363, IC364, IC365, IC366, IC367, IC368, IC377, IC379, IC432, IC434, IC455, IC457, IC458, IC459, IC460, IC461, IC462, IC463, IC469, IC470, 126H4A, 5095S2, 6313, 12351, 12403 (NEM316), 12401, COH1, BAA23, 0176H4A, A909, C388/90, BAA22, 2603V/R, 49447, BAA611, 515, H36B, 18RS21, CJB111, and those disclosed in Tables 7 to 13.

In one embodiment of the invention two or more proteins of the at least two proteins of the composition of the invention may be combined into at least one fusion protein. The resulting fusion protein may encompass two or more of the proteins of subgroups i), ii), iii), iv), v) and/or vi) as defined above. Any of the specific combinations mentioned above may be combined into at least one fusion protein. The fusion protein may encompass e.g. the same protein components as described in the section "examples of combinations of the first alternative (selection of protective proteins from different groups)" for the components of the composition, wherein the proteins can be arranged in the fusion protein in any suitable manner.

The fusion protein may comprise or consist of two or more proteins as defined above. Additionally, the fusion protein may encompass a linker, such as a protein linker, to connect the two or more proteins or additional C- or N-terminal sequences, such as a tag in order to purify the fusion protein. Additional sequences may also result from genetic engineering and the use of suitable restriction sites when preparing the nucleic acid sequences underlying the fusion protein.

The proteins of subgroup i), ii), iii), iv), v) and/or vi) combined in a fusion protein may be directly joined to each other or may be combined over a linker. The linker may be e.g. a short amino acid sequence. The linker may result from the genetic engineering of a suitable fusion protein or may be introduced in order to allow the single proteins to operate effectively.

In a preferred embodiment the functionally active variant

a) is a functionally active fragment of the protective peptide, the functionally active fragment comprising at least 50% of the sequence of the protective peptide, preferably at least 70%, more preferably at least 80%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%;
b) is derived from the protective peptide by at least one amino acid substitution, addition and/or deletion, wherein the functionally active variant has a sequence identity to the protective peptide or to the functionally active fragment as defined in a) of at least 40%, preferably at least 60%, more preferably at least 75%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%; and/or
c) consists of the protective peptide or a functionally active variant thereof and additionally at least one amino acid heterologous to the protective peptide,

preferably wherein the functionally active variant is derived from or identical to any of the naturally occurring variants of any of the sequences of SEQ ID NO: 55 to 60, 67 to 72, 79 to 84, 91 to 132, 175 to 179, 185 to 203, 223 to 234, and 235 to 425.

The combinations of protective peptides of SEQ ID NO: 1 to 6 have been shown to induce a protective immune response against different serotypes and/or to show protection against *S. agalactiae* in a sepsis model (see Examples). Functionally active variants may be obtained by changing the sequence of the protective peptide as defined above and are characterized by having a biological activity similar to that displayed by the respective protective peptide of the sequence of SEQ ID NO: 1 to 6 from which the variant is derived, including the ability to induce protective immune responses and/or to show protection against *S. agalactiae* e.g. in a sepsis model, wherein any variant may be tested in any of the tests described in the Examples within a composition of at least two proteins as defined above. The functionally active variant of a protective peptide may be obtained by sequence alterations in the protective peptide, wherein the peptide with the sequence alterations retains a function of the unaltered protective peptide, e.g. having a biological activity similar to that displayed by the unaltered protective peptide (see above), when used in combination of the invention. Such sequence alterations can include, but are not limited to, (conservative) substitutions, additions, deletions, mutations and insertions.

The variant of the protective peptide is functionally active in the context of the present invention, if the activity of the composition of the invention including the variant (but not the original protein) amounts to at least 10%, preferably at least 25%, more preferably at least 50%, even more preferably at least 70%, still more preferably at least 80%, especially at least 90%, particularly at least 95%, most preferably at least 99% of the activity of the composition of the invention including the protective peptide without sequence alteration (i.e. the original protein). The activity of the composition including the variant may be determined or measured as described in the Examples and then compared to that obtained for the composition including the respective protective peptide of the amino acid sequence of SEQ ID NO: 1 to 6 instead of the variant.

The functionally active fragment of the protective peptide is characterized by being derived from the protective peptide of SEQ ID NO: 1 to 6 by one or more deletions resulting in a peptide comprising at least 50% of the sequence of the protective peptide, preferably at least 70%, more preferably at least 80%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%. Sequence identity may be determined as described below. The deletion(s) may be C-terminally, N-terminally and/or internally. Preferably the fragment is obtained by 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, more preferably 1, 2, 3, 4 or 5, even more preferably 1, 2 or 3, still more preferably 1 or 2, most preferably 1 deletion(s).

Alternatively or additionally, the variant may be obtained from the protective peptide by at least one amino acid substitution, addition and/or deletion, wherein the functionally active variant has a sequence identity to the protective peptide or to the functionally active fragment as defined in a) of at least 40%, preferably at least 60%, more preferably at least

75%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%. Sequence identity may be determined as described below. The substitution(s), addition(s) and/or deletion(s) may be C-terminally, N-terminally and/or internally. Preferably, the functionally active variant is obtained from the protective peptide or the fragment, preferably the protective peptide, by 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, more preferably 1, 2, 3, 4 or 5, even more preferably 1, 2 or 3, still more preferably 1 or 2, most preferably 1 amino acid substitution(s), addition(s) and/or deletion(s).

Furthermore, the variant may consist of the protective peptide or the functionally active variant thereof, preferably the variant of a) and/or b), and at least one amino acid residue heterologous to the protective peptide or variant thereof, such as a marker protein. The feature “heterologous amino acid” or “amino acid heterologous to the protective peptide or variant thereof” refers to any amino acid which is different from that amino acid located adjacent to the protective protein in any naturally occurring protein of *S. agalactiae*, particularly from that of strain 12403 (for SEQ ID NO: 1, 3 and 6) or 6313 (for SEQ ID NO: 2, 4 and 5), especially the sequence made reference to above. The one or more additional amino acids may be C-terminally, N-terminally or C- and N-terminally to the protective peptide or variant thereof.

The substituted or additional sequence or amino acid residue(s) as defined above consists of (an) amino acid residue(s), which may be any amino acid, which may be either an L- and/or a D-amino acid, naturally occurring and otherwise. Preferably the amino acid is any naturally occurring amino acid such as alanine, cysteine, aspartic acid, glutamic acid, phenylalanine, glycine, histidine, isoleucine, lysine, leucine, methionine, asparagine, proline, glutamine, arginine, serine, threonine, valine, tryptophan or tyrosine.

However, the amino acid may also be a modified or an unusual amino acid. Examples of those are 2-aminoadipic acid, 3-aminoadipic acid, beta-alanine, 2-aminobutyric acid, 4-aminobutyric acid, 6-aminocaproic acid, 2-aminoheptanoic acid, 2-aminoisobutyric acid, 3-aminoisobutyric acid, 2-aminopimelic acid, 2,4-diaminobutyric acid, desmosine, 2,2’-diaminopimelic acid, 2,3-diaminopropionic acid, N-ethylglycine, N-ethylasparagine, hydroxylysine, allo-hydroxylysine, 3-hydroxyproline, 4-hydroxyproline, isodesmosine, allo-isoleucine, N-methylglycine, N-methylisoleucine, 6-N-methyllysine, N-methylvaline, norvaline, norleucine or ornithine. Additionally, the amino acid may be subject to modifications such as posttranslational modifications. Examples of modifications include acetylation, amidation, blocking, formylation, gamma-carboxyglutamic acid hydroxylation, glycosylation, methylation, phosphorylation and sulfatation. If more than one substituted or additional heterologous amino acid residue is present in the peptide, the amino acid residues may be the same or different from one another.

In one preferred embodiment of the invention, the functionally active variant of the peptide of the invention is essentially identical to the protective peptide of subgroups i) to vi), but differs from the peptide of the SEQ ID NO: 1 to 6, respectively, in that it is derived from a homologous sequence of a different strain or even serotype of *S. agalactiae*. As detailed above different strains and serotypes of *S. agalactiae* have been identified so far. Accordingly, any of these serotypes may be the basis for the functionally active variant. These are referred to as naturally occurring variants (see also above). Preferably, these naturally occurring variants are derived from *S. agalactiae* strains selected from the group consisting of IC97, IC98, IC105, IC108, IC216, IC244, IC245, IC246, IC247, IC250, IC251, IC252, IC253, IC254, IC255, IC287, IC288, IC289, IC290, IC291, IC304, IC305, IC306, IC361, IC363, IC364, IC365, IC366, IC367, IC368, IC377, IC379, IC432, IC434, IC455, IC457, IC458, IC459, IC460, IC461, IC462, IC463, IC469, IC470, 126H4A, 5095S2, 6313, 12351, 12403 (NEM316), 12401, COH1, BAA23, 0176H4A, A909, C388/90, BAA22, 2603V/R, 49447, BAA611, 515, H36B, 18RS21, CJB111, and those disclosed in Tables 7 to 13.

However, the term “functionally active variant” includes naturally occurring allelic variants, as well as mutants or any other non-naturally occurring variants. As is known in the art, an allelic variant is an alternate form of a (poly)peptide that is characterized as having a substitution, deletion, or addition of one or more amino acids that does essentially not alter the biological function of the polypeptide. By "biological function" is meant a function of the peptide in the cell it naturally occurs in, even if the function is not necessary for the growth or survival of the cells. For example, the biological function of a porin is to allow the entry into cells of compounds present in the extracellular medium. The biological function is distinct from the antigenic function. A polypeptide can have more than one biological function.

Accordingly, the present invention also relates to compositions comprising protective peptides including functionally active variants thereof of different *S. agalactiae* isolates. Such homologues may easily be identified and isolated based on the nucleic acid and amino acid sequences disclosed herein as discussed above. A homologous protective peptide of a different strain or even serotype may be identified by e.g. sequence alignment. The homologous sequence may vary from any of the protective peptides of subgroups i) to vi), by one or more amino acid substitutions, deletions and/or additions.

Percentage of sequence identity can be determined e.g. by sequence alignment. Methods of alignment of sequences for comparison are well known in the art. Various programs and alignment algorithms have been described e.g. in Smith and Waterman, Adv. Appl. Math. 2: 482, 1981 or Pearson and Lipman, Proc. Natl. Acad. Sci. U.S.A. 85: 2444-2448, 1988.

The NCBI Basic Local Alignment Search Tool (NCBI BLAST) (Altschul et al., J. Mol. Biol. 215: 403-410, 1990) is available from several sources, including the National Center for Biotechnology Information (NCBI, Bethesda, MD) and on the Internet, for use in connection with the sequence analysis programs blastp, blastn, blastx, tblastn and tblastx. Variants, e.g. of any protective peptide of the sequences of SEQ ID NO: 1 to 6, are typically characterized using the NCBI Blast 2.0, gapped blastp set to default parameters. For comparisons of amino acid sequences of e.g. at least 85 amino acids, the “Blast 2 sequences” function may be employed using the default BLOSUM62 matrix set to default parameters, (gap existence cost of 11, and a per residue gap cost of 1).

In a preferred embodiment, the functionally active variant derived from the peptide as defined above by amino acid exchanges, deletions or insertions may also conserve, or more preferably improve, the activity (as defined above). Furthermore, these peptides may also cover epitopes, which trigger the same or preferably an improved T cell response. These epitopes are referred to as ”heteroclitic”. They have a similar or preferably greater affinity to MHC/HLA molecules, and the ability to stimulate the T cell receptors (TCR) directed to the original epitope in a similar or preferably stronger manner. Heteroclitic epitopes can be obtained by rational design i. e. taking into account the contribution of individual residues to binding to MHC/HLA as for instance described by (Rammensee, H. et al., 1999, Immunogenetics. 50: 213-219), combined with a systematic exchange of residues potentially interacting with the TCR and testing the resulting sequences with T cells directed against the original epitope. Such a design is possible for a skilled man in the art without much experimentation.

Conservative substitutions are those that take place within a family of amino acids that are related in their side chains and chemical properties. Examples of such families are amino acids with basic side chains, with acidic side chains, with non-polar aliphatic side chains, with non-polar aromatic side chains, with uncharged polar side chains, with small side chains, with large side chains etc.. In one embodiment, one conservative substitution is included in the peptide. In another embodiment, two conservative substitutions or less are included in the peptide. In a further embodiment, three conservative substitutions or less are included in the peptide.

Examples of conservative amino acid substitutions include, but are not limited to, those listed below:

Original Residue	Conservative Substitutions
Ala	Ser
Arg	Lys
Asn	Gln; His
Asp	Glu
Cys	Ser
Gln	Asn
Glu	Asp
His	Asn; Gln
Ile	Leu; Val
Leu	Ile; Val
Lys	Arg; Gln; Asn
Met	Leu; Ile
Phe	Met; Leu; Tyr
Ser	Thr
Thr	Ser
Trp	Tyr
Tyr	Trp; Phe
Val	Ile; Leu

In another embodiment of the invention the peptide as defined above may be modified by a variety of chemical techniques to produce derivatives having essentially the same activity (as defined above for fragments and variants) as the modified peptides, and optionally having other desirable properties. For example, carboxylic acid groups of the protein, whether C-terminal or side chain, may be provided in the form of a salt of a pharmaceutically-acceptable cation or esterified to form an ester, or converted to an amide. Amino groups of the peptide, whether amino-terminal or side chain, may be in the form of a pharmaceutically-acceptable acid addition salt, such as the HCl, HBr, acetic, benzoic, toluene sulfonic, maleic, tartaric and other organic salts, or may be converted to an amide. Hydroxyl groups of the peptide side chains may be converted to alkoxy or to an ester using well recognized techniques. Phenyl and phenolic rings of the peptide side chains may be substituted with one or more halogen atoms, such as fluorine, chlorine, bromine or iodine, or with alkyl, alkoxy, carboxylic acids and esters thereof, or amides of such carboxylic acids. Thiols can be protected with any one of a number of well recognized protecting groups, such as acetamide groups.

Peptides of this invention may be in combination with outer surface proteins or other proteins or antigens of other proteins. In such combination, the peptide may be in the form of a fusion protein. The peptides/proteins of the composition of the invention may be optionally fused to a selected peptide or protein derived from other microorganisms. For example, a peptide or protein may be fused at its N-terminus or C-terminus to a polypeptide from another pathogen or to more than one polypeptide in sequence. Peptides which may be useful for this purpose include polypeptides identified by the prior art.

In a preferred embodiment of the invention a protein/peptide of the composition of the invention is fused to an epitope tag which provides an epitope to which an anti-tag substance can selectively bind. The epitope tag is generally placed at the N- or C-terminus of the peptide but may be incorporated as an internal insertion or substitution as the biological activity permits. The presence of such epitope-tagged forms of a peptide can be detected using a substance such as an antibody against the tagged peptide. Also, provision of the epitope tag enables the peptide to be readily purified by affinity purification using an anti-tag antibody or another type of affinity matrix that binds to the epitope tag. Various tag polypeptides and their respective antibodies are well known in the art. Examples include a poly-histidine (poly-his) tag, e.g. a hexa-histidine tag as described in the Examples, a poly-histidine-glycine (poly-his-gly) tag, the HA tag polypeptide, the c-myc tag, the Strep tag and the FLAG tag.

Fusions also may include the peptides/proteins of the composition of this invention fused or coupled to moieties other than amino acids, including lipids and carbohydrates. Further, peptides/proteins/compositions of this invention may be employed in combination with other vaccinal agents described by the prior art, as well as with other types of vaccinal agents derived from other microorganisms. Such peptides/proteins are useful in the prevention, treatment and diagnosis of diseases caused by a wide spectrum of *Streptococcus* isolates.

These fusion proteins are constructed for use in the methods and compositions of this invention. These fusion proteins or multimeric proteins may be produced recombinantly, or may be synthesized chemically.

The peptides and proteins described herein may be prepared by any of a number of conventional techniques. Desired peptides may be chemically synthesized. An alternative approach involves generating the fragments of known peptides by enzymatic digestion, e.g., by treating the protein with an enzyme known to cleave proteins at sites defined by particular amino acid residues, or by digesting the DNA with suitable restriction enzymes, expressing the digested DNA and isolating the desired fragment. Yet another suitable technique involves isolating and amplifying a DNA fragment encoding a desired peptide fragment, by polymerase chain reaction (PCR). Oligonucleotides that define the desired termini of the DNA fragment are employed as the 5' and 3' primers in the PCR. Techniques for making mutations, such as deletions, insertions and substitutions, at predetermined sites in DNA, and therefore in proteins having a known sequence are well known. One of skill in the art using conventional techniques, such as PCR, may readily use the peptides, proteins and compositions provided herein to identify and isolate other similar proteins. Such methods are routine and not considered to require undue experimentation, given the information provided herein. For example, variations can be made using oligonucleotide-mediated site-directed mutagenesis (Carter et al., Nucl. Acids Res., 13:4431 (1985); Zoller et al., Nucl. Acids Res. 10:6487 (1987)), cassette mutagenesis (Wells et al., Gene, 34:315 (1985)), restriction selection mutagenesis (Wells et al., Philos. Trans. R. Soc. London

SerA, 317:415 (1986)), PCR mutagenesis, or other known techniques can be performed on the cloned DNA to produce the peptide or composition of the invention.

Another subject of the invention relates to a protective peptide consisting of the amino acid sequence selected from the group consisting of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 55 to 57, 59, 60, 68, 69, 71, 72, 79 to 84, 91 to 132, 175 to 179, 185 to 203, 223 to 234, and 235 to 425 which have been shown to provide protection against *S. agalactiae* (see Examples).

Another subject of the invention relates to one or more nucleic acid(s) encoding the at least two proteins comprised in the composition according to the invention and/or any of the protective peptides according to the invention.

Nucleic acid molecules of the present invention may be in the form of RNA, such as mRNA or cRNA, or in the form of DNA, including, for instance, cDNA and genomic DNA e.g. obtained by cloning or produced by chemical synthetic techniques or by a combination thereof. The DNA may be triple-stranded, double-stranded or single-stranded. Single-stranded DNA may be the coding strand, also known as the sense strand, or it may be the non-coding strand, also referred to as the anti-sense strand. Nucleic acid molecule as used herein also refers to, among others, single- and double-stranded DNA, DNA that is a mixture of single- and double-stranded RNA, and RNA that is a mixture of single- and double-stranded regions, hybrid molecules comprising DNA and RNA that may be single-stranded or, more typically, double-stranded, or triple-stranded, or a mixture of single- and double-stranded regions. In addition, nucleic acid molecule as used herein refers to triple-stranded regions comprising RNA or DNA or both RNA and DNA.

The nucleic acid may be a fragment of a nucleic acid occurring naturally in *S. agalactiae*. The nucleic acid also includes sequences that are a result of the degeneration of the genetic code. There are 20 natural amino acids, most of which are specified by more than one codon. Therefore, all nucleotide sequences are included in the invention which result in the peptide as defined above.

Preferred examples of the nucleic acid(s) encoding the at least two proteins comprised in the composition according to the invention and/or any of the protective peptides according to the invention are those comprising or consisting of at least one nucleic acid sequence selected from the group consisting of SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 10, SEQ ID NO: 11, SEQ ID NO: 12, SEQ ID NO: 61 to 66, SEQ ID NO: 73 to 78, SEQ ID NO: 85 to 90, SEQ ID NO: 133 to 174, SEQ ID NO: 180 to 184 and SEQ ID NO: 204 to 222. The above sequences are indicated in the Examples, Tables 7 to 12 and the attached Sequence listing.

Additionally, the nucleic acid may contain one or more modified bases. Such nucleic acids may also contain modifications e.g. in the ribose-phosphate backbone to increase stability and half life of such molecules in physiological environments. Thus, DNAs or RNAs with backbones modified for stability or for other reasons are "nucleic acid molecules" as that feature is intended herein. Moreover, DNAs or RNAs comprising unusual bases, such as inosine, or modified bases, such as tritylated bases, to name just two examples, are nucleic acid molecules within the context of the present invention. It will be appreciated that a great variety of modifications have been made to DNA and RNA that serve many useful purposes known to those of skill in the art. The term nucleic acid molecule as it is employed herein embraces such chemically, enzymatically or metabolically modified forms of nucleic acid molecule, as well as the chemical forms of DNA and RNA characteristic of viruses and cells, including simple and complex cells, *inter alia*. For example, nucleotide substitutions can be made which do not affect the peptide or protein or composition of the invention encoded by the nucleic acid, and thus any nucleic acid molecule which encodes an antigenic peptide or functionally active variant thereof or a composition of the invention as defined above is encompassed by the present invention.

Furthermore, any of the nucleic acid molecules encoding a peptide or composition of the invention can be functionally linked, using standard techniques such as standard cloning techniques, to any desired regulatory sequences, whether a *S. agalactiae* regulatory sequence or a heterologous regulatory sequence, heterologous leader sequence, heterologous marker sequence or a heterologous coding sequence to create a fusion protein.

The nucleic acid of the invention may be originally formed *in vitro* or in a cell in culture, in general, by the manipulation of nucleic acids by endonucleases and/or exonucleases and/or polymerases and/or ligases and/or recombinases or other methods known to the skilled practitioner to produce the nucleic acids.

In one embodiment of the invention, the nucleic acid(s) according to the invention is/are located in a vector or a cell other than *S. agalactiae*.

A vector may further include nucleic acid sequences that permit it to replicate in the host cell, such as an origin of replication, one or more therapeutic genes and/or selectable marker genes and other genetic elements known in the art such as regulatory elements directing transcription, translation and/or secretion of the encoded peptide or protein. The vector may be used to transduce, transform or infect a cell, thereby causing the cell to express nucleic acids and/or proteins other than those native to the cell. The vector optionally includes materials to aid in achieving entry of the nucleic acid into the cell, such as a viral particle, liposome, protein coating or the like. Numerous types of appropriate expression vectors for protein expression are known in the art, which may be used in standard molecular biology techniques. Such vectors are selected from among conventional vector types including insects, e.g., baculovirus expression, or yeast, fungal, bacterial or viral expression systems. Other appropriate expression vectors, of which numerous types are known in the art, can also be used for this purpose. Methods for obtaining such expression vectors are well-known (see, e.g. Sambrook et al., Molecular Cloning. A Laboratory Manual, 2nd edition, Cold Spring Harbor Laboratory, New York (1989)). In one embodiment, the vector is a viral vector. Viral vectors include, but are not limited to, retroviral and adenoviral vectors.

Suitable host cells or cell lines for transfection by this method include bacterial cells. For example, the various strains of *E. coli* are well-known as host cells in the field of biotechnology. Various strains of *B. subtilis*, *Pseudomonas*, *Streptomyces*, and other bacilli and the like may also be employed in this method. Many strains of yeast cells known to those skilled in the art are also available as host cells for expression of the peptides of the present invention. Other fungal cells or insect cells such as *Spodoptera frugipedera* (Sf9) cells may also be employed as expression systems. Alternatively, mammalian cells, such as human 293 cells, Chinese hamster ovary cells (CHO), the monkey COS-1 cell line or murine 3T3 cells derived from Swiss, BALB/c or NIH mice may be used. Still other suitable host cells, as well as methods for transfection, culture, amplification, screening, production, and purification are known in the art.

A further subject of the invention relates to a method of producing the composition according to the invention or the protective peptide according to the invention, comprising

(a) introducing the one or more nucleic acids into a host cell;

(b) expressing the protein(s) and/or peptide(s) encoded by the nucleic acid by culturing the host cell under conditions conducive to the expression of the protein(s) and/or peptide(s); and

(c) collecting and/or isolating the expressed protein(s) and/or peptide(s) of step (b).

A peptide or composition of the invention or component thereof may be produced by expressing a nucleic acid of the invention in a suitable host cell. The nucleic acid encoding the peptide/protein can be introduced into a host cell by any conventional technique. The host cells can e.g. be transfected, e.g. by conventional means such as electroporation with at least one expression vector containing a nucleic acid of the invention under the control of a transcriptional regulatory sequence. The transfected or transformed host cell is then cultured under conditions that allow expression of the protein. The expressed protein is recovered, isolated, and optionally purified from the cell (or from the culture medium, if expressed extracellularly) by appropriate means known to one of skill in the art. For example, the proteins are isolated in soluble form following cell lysis, or extracted using known techniques, e.g. in guanidine chloride. If desired, the peptides or fragments of the invention are produced as a fusion protein. Such fusion proteins are those described above. Alternatively, for example, it may be desirable to produce fusion proteins to enhance expression of the protein in a selected host cell or to improve purification. The molecules comprising the peptides and compositions of this invention may be further purified using any of a variety of conventional methods including, but not limited to: liquid chromatography such as normal or reversed phase, using HPLC, FPLC and the like; affinity chromatography (such as with inorganic ligands or monoclonal antibodies); size exclusion chromatography; immobilized metal chelate chromatography; gel electrophoresis; and the like. One of skill in the art may select the most appropriate isolation and purification techniques without departing from the scope of this invention. Such purification provides the peptide/protein/composition in a form substantially free from other proteinaceous and non-proteinaceous materials of the microorganism.

Still another subject of the invention relates to a pharmaceutical composition, especially a vaccine, comprising

(i) the composition according to the invention and/or at least one protective peptide according to the invention; and

(ii) optionally a pharmaceutically acceptable carrier or excipient.

A peptide or composition of the invention may be used for methods for immunizing or treating humans and/or animals with the disease caused by infection with *S. agalactiae*. Therefore, the peptide or composition may be used within a pharmaceutical composition. The pharmaceutical composition of the present invention may further encompass pharmaceutically acceptable carriers and/or excipients. The pharmaceutically acceptable carriers and/or excipients useful in this invention are conventional and may include buffers, stabilizers, diluents, preservatives, and solubilizers. Remington's Pharmaceutical Sciences, by E. W. Martin, Mack Publishing Co., Easton, PA, 15th Edition (1975), describes compositions and formulations suitable for pharmaceutical delivery of the (poly)peptides/proteins herein disclosed.

If the pharmaceutical composition comprises at least two protective proteins as defined above, the proteins of subgroup i) to vi) may be formulated into one or more pharmaceutical composition(s). Additionally, the two or more pharmaceutical compositions may be administered together, simultaneously or consecutively.

In general, the nature of the carrier or excipients will depend on the particular mode of administration being employed. For instance, parenteral formulations usually comprise injectable fluids that include pharmaceutically and physiologically acceptable fluids such as water, physiological saline, balanced salt solutions, aqueous dextrose, glycerol or the like as a vehicle. For solid compositions (e. g. powder, pill, tablet, or capsule forms), conventional non-toxic solid carriers can include, for example, pharmaceutical grades of mannitol, lactose, starch, or magnesium stearate. In addition to biologically neutral carriers, pharmaceutical compositions to be administered can contain minor amounts of non-toxic auxiliary substances, such as wetting or emulsifying agents, preservatives, and pH buffering agents and the like, for example sodium acetate or sorbitan monolaurate.

In a preferred embodiment the pharmaceutical composition further comprises an immunostimulatory substance such as an adjuvant. The adjuvant can be selected based on the method of administration and may include mineral oil-based adjuvants such as Freund's complete and incomplete adjuvant, Montanide incomplete Seppic adjuvant such as ISA or ISA206 (SEPPIC, Paris, France), oil in water emulsion adjuvants such as the Ribi adjuvant system, syntax adjuvant formulation containing muramyl dipeptide, IC31® (Intercell; a synthetic adjuvant comprising the peptide motif KLK [WO 02/32451] and an oligonucleotide [WO 01/93905]), or aluminum salt adjuvants, preferably aluminum hydroxide or aluminum phosphate.

In a more preferred embodiment the immunostimulatory substance is selected from the group comprising polycationic polymers, especially polycationic peptides such as polyarginine, immunostimulatory deoxynucleotides (ODNs), especially Oligo$(dIdC)_{13}$, peptides containing at least two LysLeuLys motifs, especially KLKLLLLLKLK, neuroactive compounds, especially human growth hormone, alum, adjuvants and combinations thereof. Preferably the combination is either a polycationic polymer and immunostimulatory deoxynucleotides or of a peptide containing at least two LysLeuLys motifs and immunostimulatory deoxynucleotides. In a still more preferred embodiment the polycationic polymer is a polycationic peptide.

The term "Oligo$(dIdC)_{13}$" as used in the present invention means a phosphodiester backboned single-stranded DNA molecule containing 13 deoxy (inosine-cytosine) motifs, also defined by the term [oligo-d$(IC)_{13}$]. The exact sequence is 5'-dIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdCdIdC-3'. Oligo$(dIdC)_{13}$ can also be defined by the terms (oligo-dIC_{26}); oligo-$dIC_{26\text{-mer}}$; oligo-deoxy IC, 26-mer; or oligo-dIC, 26-mer, as specified for example in WO 01/93903 and WO 01/93905.

In an even more preferred embodiment of the invention the immunostimulatory substance is at least one immunostimulatory nucleic acid. Immunostimulatory nucleic acids are e.g. natural or artificial CpG containing nucleic acids, short stretches of nucleic acids derived from non-vertebrates or in form of short oligonucleotides (ODNs) containing non-methylated cytosine-guanine dinucleotides (CpG) in a defined base context (e.g. as described in WO 96/02555). Alternatively, also nucleic acids based on inosine and cytidine as e.g. described in WO 01/93903, or deoxynucleic acids containing deoxy-inosine and/or deoxyuridine residues (described in WO 01/93905 and WO 02/095027) may preferably be used as immunostimulatory nucleic acids in the present invention. Preferably, mixtures of different immunostimulatory nucleic acids are used in the present invention. Additionally, the aforementioned polycationic compounds may be combined with any of the immunostimulatory nucleic acids as aforementioned. Preferably, such combinations are according to the ones described in WO 01/93905, WO 02/32451, WO 01/54720, WO 01/93903, WO 02/13857, WO 02/095027 and WO 03/047602.

In addition or alternatively, such a vaccine composition may comprise a neuroactive compound. Preferably, the neuroactive compound is human growth factor, e.g. described in WO 01/24822. Also preferably, the neuroactive compound is combined with any of the polycationic compounds and/or immunostimulatory nucleic acids as defined above.

In a highly preferred embodiment of the invention, the adjuvants are those used in the Examples, e.g. Complete Freund's adjuvant, aluminum hydroxide or/and an adjuvant comprising the KLKLLLLLKLK peptide and $[dIdC]_{13}$ phosphodiester ssDNA, such as IC31® (Intercell AG, Vienna, Austria; described above).

The composition may be used e.g. for immunization or treatment of a subject. The pharmaceutical composition encompasses at least one peptide or composition of the invention; however, it may also contain a cocktail (i.e., a simple mixture) containing different peptides and/or compositions of the invention, optionally mixed with different antigenic peptides or proteins of other pathogens. Such mixtures of these peptides, polypeptides, proteins or fragments or variants thereof are useful e.g. in the generation of desired antibodies to a wide spectrum of *S. agalactiae* isolates. The (poly)peptide(s)/composition(s) of the present invention may also be used in the form of a pharmaceutically acceptable salt. Suitable acids and bases which are capable of forming salts with the peptides of the present invention are well known to those of skill in the art, and include inorganic and organic acids and bases.

Still another subject of the invention relates to a pharmaceutical composition comprising
(i) the one or more nucleic acid(s) according to the invention or one or more nucleic acid(s) complementary thereto, and
(ii) optionally a pharmaceutically acceptable carrier or excipient.

The nucleic acid sequences, alone or in combination with other nucleic acid sequences encoding peptides/proteins/compositions or antibodies or directed to other pathogenic microorganisms, may further be used as components of a pharmaceutical composition. The composition may be used for immunizing or treating humans and/or animals with the disease caused by infection with *S. agalactiae*.

The pharmaceutically acceptable carrier or excipient may be as defined above.

In another embodiment, the nucleic acid sequences of this invention, alone or in combination with nucleic acid sequences encoding other antigens or antibodies from other pathogenic microorganisms, may further be used in compositions directed to actively induce a protective immune response in a subject to the pathogen. These components of the present invention are useful in methods for inducing a protective immune response in humans and/or animals against infection with *S. agalactiae*.

For use in the preparation of the therapeutic or vaccine compositions, nucleic acid delivery compositions and methods are useful, which are known to those of skill in the art. The nucleic acids of the present invention or one or more nucleic acid(s) complementary thereto may be employed in the methods of this invention or in the compositions described herein as DNA sequences, either administered as naked DNA, or associated with a pharmaceutically acceptable carrier and provide for *in vivo* expression of the antigen, peptide or polypeptide. So-called “naked DNA” may be used to express the peptide or composition of the invention *in vivo* in a patient. (See, e.g., J. Cohen, Science, 259:1691-1692, which describes similar uses of “naked DNA”). For example, “naked DNA” associated with regulatory sequences may be administered therapeutically or as part of the vaccine composition e.g., by injection.

Alternatively, a nucleic acid encoding a peptide or composition of the invention or a nucleic acid complementary thereto may be used within a pharmaceutical composition, e.g. in order to express the peptide or composition of the invention *in vivo*, e.g., to induce antibodies.

A preferred embodiment of the invention relates to a pharmaceutical composition, wherein the nucleic acid is comprised in a vector and/or a cell other than *S. agalactiae*. Vectors and cells suitable in the context of the present invention are described above. Vectors are particularly employed for a DNA vaccine. An appropriate vector for delivery may be readily selected by one of skill in the art. Exemplary vectors for *in vivo* gene delivery are readily available from a variety of academic and commercial sources, and include, e.g., adeno-associated virus (International patent application No. PCT/US91/03440), adenovirus vectors (M. Kay et al., Proc. Natl. Acad. Sci. USA, 91:2353 (1994); S. Ishibashi et al., J. Clin. Invest., 92:883 (1993)), or other viral vectors, e.g., various poxviruses, vaccinia, etc.. Recombinant viral vectors, such as retroviruses or adenoviruses, are preferred for integrating the exogenous DNA into the chromosome of the cell.

Another subject of the invention relates to a method for producing antibodies, characterized by the following steps:

(a) administering an effective amount of the composition according to the invention and/or at least one protective peptide according to the invention to an animal; and
(b) isolating the antibodies produced by the animal in response to the administration of step (a) from the animal.

A further subject of the invention relates to a method for producing antibodies, characterized by the following steps:

(a) contacting a B cell with an effective amount of the composition according to the invention and/or at least one protective peptide according to the invention;
(b) fusing the B cell of step (a) with a myeloma cell to obtain a hybridoma cell; and
(c) isolating the antibodies produced by the cultivated hybridoma cell.

Also included in the scope of the invention is the production of antibodies against a peptide or composition according to the invention. This includes, for example, monoclonal and polyclonal antibodies, chimeric, single chain, and humanized antibodies, as well as Fab fragments, or the product of a Fab expression library, which are able to specifically bind to the peptide or composition according to the invention.

In a preferred embodiment the antibody is a monoclonal, polyclonal, chimeric or humanized antibody or functionally active fragment thereof. In another preferred embodiment the functionally active fragment comprises a Fab fragment.

Antibodies generated against the peptide or composition according to the invention can be obtained by direct injection of the peptide or composition according to the invention into an animal or administering of the peptide or composition according to the invention to an animal, preferably a non-human. The antibody so obtained will then bind the peptide or composition according to the invention. Such antibodies can then be used to isolate reactive antigens, peptide or proteins from a tissue expressing those.

For preparation of monoclonal antibodies, any technique known in the art, which provides antibodies produced by continuous cell line cultures, e.g. a hybridoma cell line, can be used.

Techniques described for the production of single chain antibodies (U. S. Patent No. 4,946,778) can be adapted to produce single chain antibodies to the antigenic peptides or compositions according to the invention. Also, transgenic mice or other organisms such as other mammals may be used to express humanized antibodies to the antigenic peptides or compositions according to the invention.

Antibodies may be also produced using a hybridoma cell line. Hybridoma cell lines expressing desirable monoclonal antibodies are generated by well-known conventional techniques. The hybridoma cell can be generated by fusing a normal-activated, antibody-producing B cell with a myeloma cell. In the context of the present invention the hybridoma cell is able to produce an antibody specifically binding to the antigenic peptide or composition according to the invention.

Similarly, desirable high titer antibodies are generated by applying known recombinant techniques to the monoclonal or polyclonal antibodies developed to these peptides/proteins/compositions (see, e.g., PCT Patent Application No. PCT/GB85/00392; British Patent Application Publication No. GB2188638A; Amit et al., Science, 233:747-753 (1986); Queen et al., Proc. Natl. Acad. Sci. USA, 86:10029-10033 (1989); PCT Patent Application No. WO90/07861; Riechmann et al., Nature, 332:323-327 (1988); Huse et al., Science, 246:1275-1281 (1988)).

Particularly, the antibody may be produced by initiating an immune response in a non-human animal by administrating a peptide or composition of the invention to an animal, removing an antibody-containing body fluid from said animal, and producing the antibodies by subjecting said antibodies containing body fluid to further purification steps.

Alternatively, the antibody may be produced by initiating an immune response in a non-human animal by administrating a peptide or composition, as defined in the present invention, to said animal, removing the spleen or spleen cells from said animal and/or producing hybridoma cells of said spleen or spleen cells, selecting and cloning hybridoma cells specific for the peptide or composition according to the invention and producing the antibody by cultivation of said cloned hybridoma cells.

Alternatively, the antibody may be produced employing a phage display antibody library. The method is based on the selective binding of one or more members of a phage display antibody library to a surface-bound antigen. The method may e.g. be carried out as follows: an antigen of choice is immobilized to a solid surface, such as nitrocellulose, magnetic beads, a column matrix or, the most widely used, plastic surfaces as polystyrole tubes or 96-well plates. The antibody phages are incubated with the surface-bound antigen, followed by thorough washing to remove the excess nonbinders. The bound antibody phage can subsequently be eluted and e.g. amplified by infection of *Escherichia coli*. This method allows the detection of a single antibody phage and as it can be selected by e.g. its resistance marker, it can give rise to a bacterial colony after elution. The isolation of antibodies using phage display antibody libraries has been described in more details by Mancini et al., New Microbiol. 2004 Oct;27(4):315-328 and Pini et al., Curr Protein Pept Sci. 2004 Dec;5(6):487-496.

In a preferred embodiment the antibodies produced according to a method of the invention are additionally purified. Methods of purification are known to the skilled artisan.

The antibody may be used in methods for treating an infection. Accordingly, still another subject of the invention relates to a pharmaceutical composition, especially a vaccine, comprising the antibody produced according to the invention. The pharmaceutical composition may encompass further components as detailed above. The composition may further encompass substances increasing their capacity to stimulate T cells. These include T helper cell epitopes, lipids or liposomes or preferred modifications as described in WO01/78767. Another way to increase the T cell stimulating capacity of epitopes is their formulation with immune stimulating substances for instance cytokines or chemokines like interleukin-2, -7, -12, -18, class I and II interferons (IFN), especially IFN-gamma, GM-CSF, TNF-alpha, flt3-ligand and others.

Another subject of the invention relates to a mixture of antibodies against the at least two proteins of the composition according to the invention and/or against the at least one protective peptide according to the invention. The mixture of antibodies may be further characterized and produced as described above.

Methods of producing antibodies, mixtures of antibodies, as well as the use of antibodies are also described in Examples 4 and 5, and Figures 4, 8, and 10 to 13.

Another subject of the invention relates to the use of the composition according to the invention and/or at least one protective peptide according to the invention and/or one or more of the nucleic acid(s) according to the invention for the manufacture of a medicament for the immunization or treatment of a subject, preferably against *S. agalactiae*, more preferably against pneumonia, septicemia, meningitis, fever, vomiting, poor feeding, irritability, urinary tract infection and/or vaginal infection caused by *S. agalactiae*.

The peptides, proteins, compositions or the nucleic acids of the invention are generally useful for inducing an immune response in a subject. The vaccine used for immunization may be administered to a subject susceptible to infection by *S. agalactiae*, preferably mammals, and still more preferably humans, in any conventional manner, including oral, topical, intranasal, intramuscular, intra-lymph node, intradermal, intraperitoneal, subcutaneous, and combinations thereof, but most preferably through intramuscular injection. The volume of the dose for intramuscular administration is preferably up to about 5 ml, still more preferably between 0.5 ml and 3 ml, and most preferably about 1 to 2 ml. The volume of the dose when subcutaneous injection is the selected administration route is preferably up to about 5 ml, still more preferably between 0.5 ml and 3 ml, and most preferably about 1 to 2 ml. The amount of substance in each dose should be enough to confer effective immunity against and decrease the risk of developing clinical signs resulting from *S. agalactiae* infection to a subject receiving a vaccination therewith. Preferably, the unit dose of protein should be up to about 5 µg protein/kg body weight, more preferably between about 0.2 to 3 µg, still more preferably between about 0.3 to 1.5 µg, more preferably between about 0.4 to 0.8 µg, and still more preferably about 0.6 µg.

Alternative preferred unit doses of protein could be up to about 6 μg protein/kg body weight, more preferably between about 0.05 to 5 μg, still more preferably between about 0.1 to 4 μg. The dose is preferably administered 1 to 3 times, e.g. with an interval of 1 to 4 weeks. Preferred amounts of protein per dose are from approximately 1 μg to approximately 1 mg, more preferably from approximately 5 μg to approximately 500 μg, still more preferably from approximately 10 μg to approximately 250 μg and most preferably from approximately 25 μg to approximately 100 μg.

In still another aspect of the invention the mixture of antibodies or the antibody produced according to the invention or functional fragment thereof is used for the manufacture of a medicament for the treatment of an infection, preferably a *S. agalactiae* infection. The treatment involves administering an effective amount of the antibody to a subject, preferably a mammal, more preferably a human. Thus, antibodies against the peptides or the composition of the present invention may be employed to inhibit and/or treat infections, particularly bacterial infections and especially infections arising from *S. agalactiae*.

An "effective amount" of peptides, proteins, compositions or the nucleic acids of the invention or an antibody produced according to the invention may be calculated as that amount capable of exhibiting an *in vivo* effect, e.g. preventing or ameliorating a sign or symptom of infection, particularly *S. agalactiae* infection. Such amounts may be determined by one of skill in the art. Such a substance may be administered in any conventional manner, including oral, topical, intranasal, intramuscular, intra-lymph node, intradermal, intraperitoneal, subcutaneous, and combinations thereof, but preferably intramuscularly or subcutaneously. However, it may also be formulated to be administered by any other suitable route, including orally or topically. The selection of the route of delivery and dosage of such therapeutic compositions is within the skill of the art.

Treatment in the context of the present invention refers to both therapeutic treatment and prophylactic or preventive measures, wherein the object is to prevent or slow down (lessen) the targeted pathologic condition or disorder. Those in need of treatment include those already with the disorder as well as those prone to have the disorder or those in whom the disorder is to be prevented.

Another subject of the invention relates to a method of diagnosing a *S. agalactiae* infection comprising the steps of:

(a) contacting a sample obtained from a subject with the composition according to the invention and/or at least one protective peptide according to the invention; and
(b) detecting the presence of an antibody against the protective peptide, the functionally active variant and/or the composition in the sample,

wherein the presence of the antibody is indicative for the *S. agalactiae* infection.

Another subject of the invention relates to a method of diagnosing a *S. agalactiae* infection comprising the steps of:

(a) contacting a sample obtained from a subject with the mixture of antibodies according to the invention; and
(b) detecting the presence of the at least two proteins of the composition according to the invention and/or of the at least one protective peptide according to the invention in the sample,

wherein the presence of the at least two proteins and/or of the at least one protective peptide is indicative for the *S. agalactiae* infection.

The protective peptides or compositions of the invention or alternatively a mixture of antibodies may be used for the detection of *S. agalactiae*. Preferably such detection is for diagnosis, more preferably for the diagnosis of a disease, most preferably for the diagnosis of a *S. agalactiae* infection. The protective peptides or compositions may be used to detect the presence of a *S. agalactiae*-specific antibody or fragment thereof e.g. in a sample obtained from a subject. Alternatively, the mixture of antibodies may be used to detect the presence of *S. agalactiae* proteins, e.g. in a sample obtained from a subject. The sample may be e.g. a blood sample.

The present invention also relates to diagnostic assays such as quantitative and diagnostic assays for detecting levels of the proteins, compositions and/or mixtures of antibodies of the present invention in cells and tissues or body fluids, including determination of normal and abnormal levels. Assay techniques that can be used to determine levels of a peptide, a composition or an antibody, in a sample derived from a host are well known to those of skill in the art. Such assay methods include radioimmunoassays, competitive-binding assays, Western Blot analysis and ELISAs. Among these, ELISAs frequently are preferred.

An ELISA initially comprises preparing an antibody or antibodies specific to the peptide or composition, preferably a monoclonal antibody. In addition, a reporter antibody generally is prepared which binds to the monoclonal antibody. The reporter antibody is attached to a detectable reagent such as radioactive, fluorescent or enzymatic reagent, such as horseradish peroxidase enzyme.

The peptides or compositions of the present invention may also be used for the purpose of or in connection with an array. More particularly, at least one of the peptides or compositions of the present invention may be immobilized on a support. Said support typically comprises a variety of peptides/proteins whereby the variety may be created by using one or several of the peptides or compositions of the present invention. The characterizing feature of such array as well as of any array in general is the fact that at a distinct or predefined region or position on said support or a surface thereof, a distinct polypeptide is immobilized. Because of this any activity at a distinct position or region of an array can be correlated with a specific polypeptide. The number of different peptides or antibodies of the present invention immobilized on a support may range from as little as 10 to several 1000 different peptides or compositions of the present invention. Alternatively, antibodies produced according to the present invention may be used to detect peptides or compositions of the invention.

The manufacture of such arrays is known to the one skilled in the art and, for example, described in US patent 5,744,309. The array preferably comprises a planar, porous or non-porous solid support having at least a first surface. Preferred support materials are, among others, glass or cellulose. It is also within the present invention that the array is used for any of the diagnostic applications described herein. Apart from the peptides or antibodies of the present invention also the nucleic acid molecules according to the present invention may be used for the generation of an array as described above.

Another subject of the invention relates to a method for diagnosing an infection with *S. agalactiae* comprising the steps of:

(a) contacting a sample obtained from a subject with a primer and/or a probe specific for the one or more nucleic acid(s) according to the invention; and
(b) detecting the presence of one or more nucleic acid(s) according to the invention in the sample,

wherein the presence of the one or more nucleic acid(s) is indicative for the *S. agalactiae* infection.

A series of methods for detecting nucleic acids in samples by using specific primers and/or probes is known in the art. In general, these methods are based on the specific binding of a primer or probe to the nucleic acid in question. The methods may involve amplification of the nucleic acid, e.g. RNA or DNA, before the actual detection step. Therefore, primers may be used to specifically induce transcription and/or amplification of RNA or DNA in order to generate a detectable amount of nucleic acid. Suitable well known techniques may be PCR and RT-PCR. Suitable primers and probes for the method of the invention may be produced based on sequence information provided in the present application. Guidelines and computer-assisted programs (e.g Primer Express®, Applied Biosystems, Foster City, CA, USA) for designing primers and probes to a specific nucleic acid are known to the person skilled in the art.

After the amplification step the amplified nucleic acid, in general DNA, may be detected e.g. by its size (e.g. involving agarose gel electrophoresis) or using labeled probes which specifically bind to the amplified nucleic acid. The probes may be labeled with a dye, radioactive marker, a fluorescent marker, an enzyme-linked marker or any other marker.

For example, FRET (Förster resonance energy transfer) may be used for the detection of the nucleic acid of the invention. In FRET, a donor fluorophore molecule absorbs excitation energy and delivers this via dipole-dipole interaction to a nearby acceptor fluorophore molecule. This process only occurs when the donor and acceptor molecules are sufficiently close to one another. Several different strategies for determining the optimal physical arrangement of the donor and acceptor moieties are known to the skilled practitioner. For this, a fluorescent donor is excited at its specific fluorescence excitation wavelength. By a long-range dipole-dipole coupling mechanism, this excited state is then nonradiatively transferred to a second molecule, the acceptor. The donor returns to the electronic ground state. The described energy transfer mechanism is termed “Förster resonance energy transfer” (FRET). The process involves measuring fluorescence as FRET donor and acceptor moieties are brought together as a result of DNA hybridization. For examples two probes each labeled with a suitable marker hybridize to the nucleic acid of the invention within a distance which allows FRET to occur. Suitable markers include

Cyan 500, Cy5, Cy3, SYBR Green I, fluorescein, HEX, Red 610 and Red 640, wherein the two marker involved have to be selected based on there excitation and emission spectrums as known by the skilled person. A suitable system for the detection of nucleic acids is the LightCycler® (Roche Diagnostics).

Another subject of the invention relates to a method for identifying a ligand capable of binding the composition according to the invention and/or at least one protective peptide according to the invention comprising:

(a) providing a test system comprising the peptide and/or composition,
(b) contacting the test system with a test compound, and
(c) detecting a signal generated in response to the binding of the test compound to the peptide and/or composition.

More particularly, the method may be carried out by contacting an isolated or immobilized protective peptide or composition according to the invention with a candidate ligand under conditions to permit binding of the candidate ligand to the peptide, wherein the test system comprises a component capable of providing a detectable signal in response to the binding of the candidate ligand to said peptide; and detecting the presence or absence of a signal generated in response to the binding of the ligand to the peptide. The ligand may be an agonist or an antagonist.

Test systems for detection binding of a ligand are known to the skilled artisan and include e.g. binding assays with labeled ligand such as radioligands, fluorescence-labeled ligands or enzyme-labeled ligands.

The test compound can be any test compound either naturally occurring or chemically synthesized. Naturally occurring test compounds include in particular antibodies, preferably those showing similarity to the antibodies of the invention. In one preferred embodiment of the invention the test compound is provided in the form of a chemical compound library. Chemical compound libraries include a plurality of chemical compounds and have been assembled from any of multiple sources, including chemically synthesized molecules and natural products, or have been generated by combinatorial chemistry techniques. They are especially suitable for high throughput screening. They may be comprised of chemical compounds of a particular structure or compounds of a particular creature such as a plant.

A further subject of the invention relates to the use of the composition according to the invention and/or at least one protective peptide according to the invention for the isolation and/or purification and/or identification of an interaction partner of the composition and/or peptide. The isolation and/or purification and/or identification of the ligand may be carried out as detailed above or as known to the person skilled in the art. In a preferred embodiment of the invention an affinity device may be used. The affinity device may comprise at least a support material and any antigenic peptide or composition according to the present invention, which is attached to the support material. Because of the specificity of the protective peptides and/or compositions according to the present invention for their target cells or target molecules or their interaction partners, the peptides and/or compositions allow a selective removal of their interaction partner(s) from any kind of sample applied to the support material provided that the conditions for binding are met. The sample may be a biological or medical sample, including but not limited to, fermentation broth, cell debris, cell preparation, tissue preparation, organ preparation, blood, urine, lymph liquid, liquor and the like. The peptide or composition may be attached to the matrix in a covalent or non-covalent manner. Suitable support material is known to the one skilled in the art and can be selected from the group comprising cellulose, silicon, glass, aluminium, paramagnetic beads, starch and dextrane.

The present invention is further illustrated by the following Figures, Examples and the Sequence listing, from which further features, embodiments and advantages may be taken. It is to be understood that the present examples are given by way of illustration only and not by way of limitation of the disclosure.

FIGURE LEGENDS

Figure 1 shows the protection achieved by passive immunization with selected hyper-immune rabbit sera generated by immunization of rabbits with *S. agalactiae* antigens in a mouse lethality model. CD-1 mice (10 mice per group) were immunized intraperitoneally with 150 µl hyper-immune rabbit sera 1 – 3 hours before they were intraperitoneally challenged. **(A)** gbs1309p, gbs1478p, gbs2018p, Sip and PBS-induced hyperimmune sera, challenge with 1 x 10^7 cfu C388/90 (serotype Ia/c). **(B)** gbs1478p, gbs2018p, Sip and PBS-induced hyperimmune sera, challenge with 5 x 10^6 cfu ATCC12401 (serotype Ib). **(C)** gbs0233p, gbs1087p, gbs1477p, Sip and PBS-induced hyperimmune sera, challenge with 1 x 10^8 cfu ATCC12403 (serotype III). **(D)** gbs0233p, gbs1087p, gbs2018p, Sip and PBS-induced hyperimmune sera, challenge with 1 x 10^8 cfu ATCC49447 (serotype V). Survival was monitored for 14 days post-challenge. Numbers of surviving mice are plotted as percentage of total mice.

Figure 2 shows the protection achieved with a combination of *S. agalactiae* antigen-specific hyperimmune rabbit sera in a mouse lethality model. CD-1 mice (10 mice per group) were immunized intraperitoneally with different combinations of hyperimmune rabbit sera (150 µl per hyper-immune rabbit sera) 1 – 3 hours before an intraperitoneal challenge. Sip- and PBS-induced sera were used as positive and negative controls, respectively. Mice were immunized with combinations of sera induced by gbs1087p, gbs1477p, gbs1478p and gbs2018p; challenge with **(A)** 5 x 10^6 cfu ATCC12401 (serotype Ib); **(B)** 1 x 10^8 cfu ATCC12403 (serotype III) and **(C)** 1 x 10^8 cfu ATCC49447 (serotype V). Survival was monitored for 11 days post-challenge. Numbers of surviving mice are plotted as percentage of total mice.

Figure 3 shows the surface staining of the serotype III GBS strain ATCC12403. The results for the hyperimmune rabbit sera (black) are shown in comparison to those for the respective preimmune sera (white).

Figure 4 shows an opsonophagocytic killing assay with hyperimmune rabbit sera and different GBS strains. **(A)** Serotype II GBS strain AC3912, not suitable for animal testing. **(B)** Serotype V GBS strain BAA23, used for animal testing. PI, preimmune sera; HI, hyperimmune sera. GBS cells in the exponential phase were opsonised with 200-fold diluted sera in the presence of 5% guinea pig complement for 60 minutes. Phagocytic cells (RAW264.7) were added to opsonised bacteria and incubated for an additional 60 minutes at 37°C. Surviving bacteria were counted on agar plates after overnight incubation at 37°C. Percentage of killing was calculated based on CFU obtained after incubation with the different hyperimmune sera relative to CFU obtained with preimmune sera at 0 min and after 60 min of incubation as described under experimental procedure.

Figure 5 A-D show the sequence alignment of protein sequences homologous to gbs1477 from genomic and sequenced strains. Alignment of sequences was performed using the software from Vector NTI (Suite 7.1; Invitrogen, Austria). The name on the left of the sequence indicates the strain name. Amino acids in bold, residue identical in at least 50% of sequences. *, indicates position of STOP codon.

Figure 6 shows active protection of adult mice by immunizing with a combination of GBS antigens. CD-1 mice (10 mice per group) were immunized with different combinations of the recombinant proteins (gbs1087p, gbs1477p, gbs1478p and gbs2018p; 25 µg each). As positive control 25 µg Sip protein (open circle) was used. For the negative control, PBS (open square) was used with ALUM 1%. One week after the last booster immunization, mice were challenged with **(A)** 3.5 x 10^6 cfu 12401; **(B)** 8.8 x 10^7 cfu 12403 or with **(C)** 1.1 x 10^8 cfu 49447. Numbers of surviving mice are plotted as a percentage of the total number of mice.

Figure 7 shows active protection of adult mice by immunizing with single GBS antigens. CD-1 mice (10 mice per group) were immunized with different recombinant proteins (gbs0233p, gbs1087p, gbs1309p, gbs1477p, gbs1478p and gbs2018p; 50 µg each). As positive control 50 µg Sip protein (open circle) was used. For the negative control, PBS (open square) was used with ALUM 1%. One week after the last booster immunization, mice were challenged with **(A)** 3.5 x 10^6 cfu 12401; **(B)** 8.8 x 10^7 cfu 12403 or with **(C)** 1.1 x 10^8 cfu 49447. Numbers of surviving mice are plotted as a percentage of the total number of mice.

Figure 8 shows the protection of neonatal mice by immunization of mothers passively with rabbit sera generated with a combination of recombinant GBS antigens. Pregnant CD-1 mice were immunized at day 18 post gestation with 500 µl of combinations of gbs1087p, gbs1477p, gbs1478p and gbs2018p-induced sera or PBS-induced control sera. Neonates were challenged within 24 – 38 hours after birth with lethal challenge doses of **(A)** 1.2 x 10^7 cfu C388/90; **(B)** 1.3 x 10^6 cfu 12403; **(C)** 5.7 x 10^6 cfu BAA23 or **(D)** 1.8 x 10^8 cfu 2603V/R. Numbers of surviving neonates are plotted as a percentage of the total number of challenged neonates.

Figure 9 shows active protection of adult mice by immunizing with different clade gbs1477p proteins. CD-1 mice (10 mice per group) were immunized with different clade proteins of gbs1477p (gbs1477p-2603V/R, gbs1477p-49447, gbs1477p-C388/90, gbs1477p-126H4A and gbs1477p-NEM316; 50 µg each). As negative control, PBS (open square) was used with ALUM 1%. One week after the last booster immunization, mice were challenged with **(A)** 1.4 x 10^7 cfu C388/90; **(B)** 1.2 x 10^8 cfu 12403 or with **(C)** 1.6 x 10^8 cfu BAA23. Numbers of surviving mice are plotted as a percentage of the total number of mice.

Figure 10 shows the protection of adult mice by immunization with mouse mAbs against different recombinant GBS antigens. CD-1 mice were immunized intraperitoneally with 50 µg of the respective mouse mAb. 1 to 3 hours later, mice were challenged intraperitoneally with **(A)** 1.2 x 10^8 cfu 12403; **(B)** 1.5 x 10^8 cfu 12403 or **(C)** 1.1 x 10^8 cfu 49447. Numbers of surviving mice are plotted as a percentage of the total number of challenged mice.

Figure 11 shows the protection of adult mice by immunization with a combination of five mouse mAbs against different recombinant GBS antigens. CD-1 mice were immunized intraperitoneally with 25 µg of each mouse mAb. 1 to 3 hours later, mice were challenged intraperitoneally with **(A)** 1.2 x 10^7 cfu C388/90; **(B)** 9.6 x 10^7 cfu 12403 or **(C)** 1.7 x 10^8 cfu BAA23. Numbers of surviving mice are plotted as a percentage of the total number of challenged mice.

Figure 12 shows surface staining of the serotype III GBS strain ATCC12403. The results for the monoclonal antibodies (black) are shown with the buffer control (white).

Figure 13 shows opsonophagocytic killing assay with hyperimmune rabbit sera and different GBS strains. Rabbit sera were tested in the opsonophagocytic killing assay at a serum dilution of 1:1,000, % killing was calculated in relation to the respective pre-immune sera. The mouse monoclonal antibodies were tested with two different amounts added to the opsonophagocytic killing assay, 1.0 and 0.1 µg. The % killing for the monoclonal antibodies was calculated in relation to the complement control.

EXAMPLES

Example 1: Group B streptococcal antigens and combinations thereof inducing protective immune responses against lethal sepsis in an i.p. challenge model.

Experimental procedures

Cloning and expression of recombinant Group B streptococcal proteins

Cloning of genes: The gene of interest was amplified from genomic DNA of *S. agalactiae* ATCC12403 (serotype III) by PCR using gene specific primers. Apart from the gene specific part, the primers had restriction sites that aided in a directional cloning of the amplified PCR product. The gene annealing (specific) part of the primer ranged between 15-30 bases in length. The PCR products obtained were digested with the appropriate restriction enzymes and cloned into the pET28b (+) vector (Novagen) for His-tagged proteins. Once the recombinant plasmid was confirmed to contain the gene of interest, *E. coli* BL21 star® cells (Invitrogen) that served as expression host were transformed. Cloning of the gbs1087, gbs1477 and gbs1478 genes has been performed using genomic DNA from strain *S. agalactiae* 6313 (serotype III) in the vector pET28a (+).The origin of the gene and position within the full length gene of the selected antigens are listed in Table 1. The amino acid and nucleic acid sequences are as follows:

Amino acid sequences:

SEQ ID NO: 1
Construct 1: gbs0233p
LCLALLTISGCQLTDTKKPGHTTIKVAAQSSTESSIMANIVTELIHHELGYNTTLISNLGS
STVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDTKEASKIVKTEFQKRYNQTWYPTYG
FSDTYAFMVTKEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSH
IYPMQIGLVYDAVESNKMQSVLGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKK
DPKLKKLLHRLDGKINLKTMQNLNYMVDDKLLEPSVVAKQFLEKNHYFRGD

SEQ ID NO: 2
Construct 2: gbs1087p
MDSVGNQSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDAENKSQGNVL
ERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQG
NVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDAENKSQGNVLERRQRDAENR
SQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDA
ENRSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQ
RDAENKSQVGQLIG

SEQ ID NO: 3

Construct 3: gbs1309p

SVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATM
MPYRQVCKVIDSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGD
GVMIKSTDSREERRYLDLTHFVIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYN
NYEVDDDTILITNSDMGKGYTSRVFKELGKALKVKKHEHFWDIYHVKEKLSSYLRKYPIEL
TDFALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKVLNNFKYIKPAHLRNLSNR
GIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIILERANGLRELFFGSWRKVYSEYKEG
SFSAGRLFKKTDELDKFSKPLLKNGRKWSITGIK

SEQ ID NO: 4
Construct 4: gbs1477p

DDVTTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDLKSYFGSTDAKEIKGAFFV
FKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDTGFAFNTAKLKGTYQIVELKEKSN
YDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRK
DKGVVSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGKDFPVLNYK
LVTDDQGFRLALNATGLAAVAAAAKDKDVEIKITYSATVNGSTTVEVPETNDVKLDYGNNP
TEESEPQEGTPANQEIKVIKDWAVDGTITDVNVAVKAIFTLQEKQTDGTWVNVASHEATKP
SRFEHTFTGLDNTKTYRVVERVSGYTPEYVSFKNGVVTIKNNKNSNDPTPINPSEPKVVTY
GRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAKLALDEAVKAYNDL
TKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEITG
LDKGTYSLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVT
IPQTGGIGT

SEQ ID NO: 5
Construct 5: gbs1478p

ESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIEKVTAELTGEATFDNLIPG
DYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNHEELDKQYPPTGIYED
TKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIEL
TVSGKTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANS
DNRVALVTYGSDIFDGRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRI
PTEAPRAKWGSTTNGLTPEQQKQYYLSKVGETFTMKAFMEADDILSQVDRNSQKIIVHITD
GVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFLLTDKPEDIKGNGESYFLFPLDSYQ
TQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQKNYDIFNFGIDISA
FRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNEIL
SKIQQQFEKVLTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIAT
GGPNNDGGILKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTL
NPKSEDPNTLRDFPIPKIRDVREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQE
FNEDYKLYLPIKNNNSKVVTGENGKISYKDLKDGKYQLIEAVSPKDYQKITNKPILTFEVV
KGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGGK

SEQ ID NO: 6
Construct 6: gbs2018p

DTSSGISASIPHKKQVNLGAVTLKNLISKYRGNDKAIAILLSRVNDFNRASQDTLPQLINS
TEAEIRNILYQGQIGKQNKPSVTTHAKVSDQELGKQSRRSQDIIKSLGFLSSDQKDILVKS
ISSSKDSQLILKFVTQATQLNNAESTKAKQMAQNDVALIKNISPEVLEEYKEKIQRASTKS
QVDEFVAEAKKVVNSNKETLVNQANGKKQEIAKLENLSNDEMLRYNTAIDNVVKQYNEGKL
NITAAMNALNSIKQAAQEVAQKNLQKQYAKKIERISSKGLALSKKAKEIYEKHKSILPTPG
YYADSVGTYLNRFRDKQTFGNRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKP
DVKPEAKPEAKPNIQVPKQAPTEAAKPALSPEALTRLTTWYNQAKDLLKDDQVKDKYVDIL
AVQKAVDQAYDHVEEGKFITTDQANQLANKLRDALQSLELKDKKVAKPEAKPEAKPEAKPE
AKPEAKPEAKPEAKPEAKPDVKPEAKPDVKPEAKPEAKPEAKSEAKPEAKLEAKPEAKPAT

KKSVNTSGNLAAKKAIENKKYSKKLPST

Nucleic acid sequences:

SEQ ID NO: 7
Construct 1: gbs0233p
CTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAATTAACCGATACTAAAAAACCTGGTC
ATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATCATGGCAAATATTGT
CACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGTTCC
TCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATA
CAGGAACAGACATCACAGGAACTCTTGGCTTAAAAGCTGTTAAAGACACTAAAGAAGCTTC
TAAGATTGTAAAAACTGAATTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGT
TTTTCTGATACTTATGCATTCATGGTTACTAAAGAGTTTGCCAGACAGAATAAAATCACCA
AGATCTCTGATCTCAAAAAGTTATCAACAACTATGAAGGCAGGGGTTGATAGTTCATGGAT
GAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAATTTTCACAT
ATTTACCCTATGCAAATTGGCTTAGTCTATGATGCAGTTGAAAGTAACAAAATGCAATCTG
TATTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGA
TAAAAAATTCTTTCCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAA
GATCCTAAACTAAAAAAATTACTCCATCGACTCGATGGTAAAATCAATTTAAAAACGATGC
AAAACCTTAATTATATGGTAGATGATAAACTTTTAGAACCTTCAGTTGTTGCCAAACAATT
TTTAGAAAAAAACCATTATTTTAGAGGAGAT

SEQ ID NO: 8
Construct 2: gbs1087p
ATGGATAGTGTTGGAAATCAAAGTCAGGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAG
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AGGCAATGTTTTAGAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGGCAATGTTTTA
GAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTCTAGAGCGTCGTCAAC
GTGATGCAGAAAACAGAAGCCAAGGCAATGTTCTAGAGCGTCGTCAACGCGATGCAGAAAA
CAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGT
AATGTTCTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGTAATGTTCTAGAGC
GTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGA
TGCGGAAAACAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGA
AGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATG
TTCTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTCTAGAGCGTCG
TCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTCTAGAGCGTCGTCAACGCGATGCA
GAAAACAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCC
AAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTTT
AGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTTTAGAGCGTCGTCAA
CGTGATGCGGAAAACAAGAGCCAAGTAGGTCAACTTATAGGG

SEQ ID NO: 9
Construct 3: gbs1309p
AGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTA
GTAGGAGTCGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCT
TGAAAAATATAAGAGATATTCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATG
ATGCCTTATCGTCAAGTTTGCAAAGTAATAGATAGCACTTTGCAAACAATCATAACAAAAG
ACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTAAAAGAAAAAGAACGCTATCG
TTTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTTGAGGGTGAT
GGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATT
TTGTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCA

CGAAATATTACAGCTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAAT
AACTATGAAGTAGATGACGATACTATTTTAATCACTAACTCTGATATGGGTAAAGGCTATA
CTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTTAAGGTAAAGAAACATGAGCATTTTTG
GGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAATATCCAATTGAATTA
ACCGATTTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTTTTTG
ATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAA
AAAAGTATTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGT
GGTATTGGTATCATGGAATCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCA
TGTATTGGTCAAAGTGGGGAATCTCCACAATGGCAAATATGATTATACTTGAAAGAGCTAA
CGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTATACAGTGAGTATAAAGAAGGT
TCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTTTCTAAGCCCC
TTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAA

SEQ ID NO: 10
Construct 4: gbs1477p
GACGACGTAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCATTTG
ATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAA
TGACCTTAAATCTTATTTTGGCTCAACCGATGCTAAAGAAATTAAGGGTGCTTTCTTTGTT
TTCAAAAATGAAACTGGTACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGG
AAGCTAAAGATGCTGAAGGTGGTGCTGTTCTTTCAGGGTTAACAAAAGACACTGGTTTTGC
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CATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAAC
AAAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAA
GACAAAGGTGTTGTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAA
TTCTTAAAGGCTCAGACTATAAGAAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGAC
GTTCAACAACAACGTTAAAGTAACATTGGATGGTAAAGATTTTCCTGTTTTAAACTACAAA
CTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACAGGTCTTGCAGCAGTAG
CAGCTGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTGAACGG
CTCCACTACTGTTGAAGTTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCA
ACGGAAGAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAG
ACTGGGCAGTAGATGGTACAATTACTGATGTTAATGTTGCAGTTAAAGCTATCTTTACCTT
GCAAGAAAAACAAACGGATGGTACATGGGTGAACGTTGCTTCACACGAAGCAACAAAACCA
TCACGCTTTGAACATACTTTCACAGGTTTGGATAATACTAAAACTTACCGCGTTGTCGAAC
GTGTTAGCGGCTACACTCCAGAATATGTATCATTTAAAAATGGTGTTGTGACTATCAAGAA
CAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCC
TTGTTAAGAAAGAAGGAAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAA
GGCAGCTGTAAAAACTGCTAAACTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTG
ACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAAACAGCATTGGCTACTGTTGATCAAAAAC
AAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATATGAATGGGTTGCAGATAA
AAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATTACTGGT
TTGGATAAAGGCACTTATAGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGT
CAGGTGATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACAT
CGCATATGATAAAGGATCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACC
ATCCCACAAACAGGTGGTATTGGTACA

SEQ ID NO: 11
Construct 5: gbs1478p
GAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGATGACC
AGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAA

AATAGAAAAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGA
GATTATACTTTATCAGAAGAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGC
AAGTTAAGGTTGAGAGTAATGGAAAAACTACGATACAAAATAGTGGTGATAAAAATTCCAC
AATTGGACAAAATCACGAAGAACTAGATAAGCAGTATCCCCCCACAGGAATTTATGAAGAT
ACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGAAAGTCAGAGG
CAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAAC
ATTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTA
ACTGTCAGTGGAAAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCT
TCGTACTCGATAATTCTAACTCAATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAA
AGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCAGTAAAAGATATTTTAGGAGCAAACAGT
GATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGATGGTAGGAGTGTAGATG
TCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACAATTCA
GACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATT
CCTACAGAAGCTCCTAGAGCTAAATGGGGATCAACTACAAACGGACTTACTCCAGAGCAAC
AAAAGCAGTACTATCTTAGTAAAGTAGGGGAAACATTTACTATGAAAGCCTTCATGGAGGC
AGATGATATTTTGAGTCAAGTAGATCGAAATAGTCAAAAAATTATTGTTCATATAACTGAT
GGTGTTCCAACAAGATCATATGCTATTAATAATTTTAAATTGGGTGCATCATATGAAAGCC
AATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTACTTACTGATAA
GCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACC
CTAAAGGTACAATTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTA
TATAAATAGTTTAAAACAGAAAAATTATGACATCTTTAATTTTGGTATAGATATATCTGCT
TTTAGACAAGTTTATAATGAGGATTATAAGAAAAATCAAGATGGTACTTTTCAAAAATTGA
AAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTAATGAAGTCATTCTCTTC
TAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAAATTTTA
TCTAAAATTCAGCAACAATTTGAAAAGGTTTTAACAAAAGAAAACTCAATTGTTAATGGAA
CTATAGAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCA
ACCAAGTGATTATACTTTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACT
GGTGGGCCTAATAATGATGGTGGAATACTTAAAGGGGTTAAATTAGAATACATCAAAAATA
AACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAAAAAGTAACACTCACATATGATGT
GAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGTAGAACAACATTG
AATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGATG
TGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTAC
AAAAGTTGATAAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAA
TTTAATGAAGATTATAAACTTTATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGG
GAGAAAACGGCAAAATTTCTTACAAAGATTTGAAAGATGGCAAATATCAGTTAATAGAAGC
AGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATTTTAACTTTTGAAGTTGTT
AAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCATGAGGAAG
GTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGG
TGGGAAA

SEQ ID NO: 12

Construct 6: gbs2018p

GATACTAGTTCAGGAATATCGGCTTCAATTCCTCATAAGAAACAAGTTAATTTAGGGGCGG
TTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATTGCTATACTTTT
AAGTAGAGTAAATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT
ACTGAAGCAGAAATTAGAAATATTTTATATCAAGGACAAATTGGTAAGCAAAATAAACCAA
GTGTAACTACACATGCTAAAGTTAGTGATCAAGAACTAGGTAAGCAGTCAAGACGTTCTCA
AGATATCATTAAGTCATTAGGTTTCCTTTCATCAGACCAAAAAGATATTTTAGTTAAATCT
ATTAGCTCTTCAAAAGATTCGCAACTTATTCTTAAATTTGTAACTCAAGCCACGCAACTGA
ATAATGCTGAATCAACAAAAGCTAAGCAAATGGCTCAAAATGACGTGGCCTTAATAAAAAA

TATAAGCCCCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACTAAGAGT
CAAGTTGATGAGTTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACGTTGG
TAAATCAGGCCAATGGTAAAAAGCAAGAAATTGCTAAGTTAGAAAATTTATCTAACGATGA
AATGTTGAGATATAATACTGCAATTGATAATGTAGTGAAACAGTATAATGAAGGTAAGCTC
AATATTACTGCTGCAATGAATGCTTTAAATAGTATTAAGCAAGCAGCACAGGAAGTTGCCC
AGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAAAGAATAAGTTCAAAAGGATTAGC
GTTATCTAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTGCCTACACCTGGA
TATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACAAACTTTCGGAA
ATAGGAGTGTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGT
CAAAAAGCTTTTAAAAGAACTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCA
GACGTTAAGCCAGAAGCCAAACCAGAGGCCAAACCAAATATTCAAGTACCTAAACAAGCAC
CTACAGAAGCTGCAAAACCAGCTTTGTCACCAGAAGCCTTGACAAGATTGACTACATGGTA
TAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGACAAATACGTAGATATACTT
GCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTTATTACCA
CTGATCAAGCAAATCAATTAGCTAACAAGCTACGTGATGCTTTACAAAGTTTAGAATTAAA
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GCTAAGCCAGAAGCTAAGCCAGAAGCTAAGCCAGAGGCCAAACCAGAAGCTAAGCCAGACG
TTAAGCCAGAAGCTAAACCAGACGTTAAACCAGAGGCTAAGCCAGAAGCTAAACCAGAGGC
TAAGTCAGAAGCTAAACCAGAGGCTAAGCTAGAAGCTAAACCAGAGGCCAAACCAGCAACC
AAAAAATCGGTTAATACTAGCGGAAACTTGGCGGCTAAAAAAGCTATTGAAAACAAAAAGT
ATAGTAAAAAATTACCATCAACG

<u>Expression and purification of proteins:</u> *E. coli* BL21 star® cells harboring the recombinant plasmid were grown into log phase in the required culture volume. Once an OD_{600nm} of 0.6 was reached the culture was induced with 0.5 mM IPTG for 3 hours at 37°C. The cells were harvested by centrifugation, lysed by a combination of the freeze-thaw method followed by disruption of cells with 'Bug-buster®', (Novagen). The lysate was separated by centrifugation into soluble (supernatant) and insoluble (pellet) fractions. Depending on the location of the protein different purification strategies were applied. A) If the His-tagged protein was in the soluble fraction, protein purification was done by binding the supernatant to Ni-Sepharose beads (Ni-Sepharose™ 6 Fast Flow, GE Healthcare). Due to the presence of the hexa Histidine (6xHIS) at the C terminus of the expressed protein, it bound to the Ni-Sepharose while the other contaminating proteins were washed from the column by wash buffer. The protein was eluted by 500 mM Imidazole in 20 mM NaH_2PO_4, 0.5 mM NaCl buffer at pH 7.4. The eluate was concentrated, assayed by Bradford for protein concentration and checked by SDS-PAGE and Western blot. B) If the protein was present in the insoluble fraction, the pellet was solubilized in suitable buffer containing 8 M urea and applied onto the Ni-NTA column under denaturing conditions (in buffer containing 8 M urea) using the same materials and procedure as mentioned above. Contaminating proteins were washed from the column by wash buffer without urea.

Refolding of the His-tagged protein was performed while the protein was immobilized on the Ni-NTA matrix. After renaturation, proteins were eluted by the addition of 500 mM Imidazole. The eluate was dialyzed to remove traces of urea and concentrated if the volume was large, checked by SDS-PAGE and measured by the Bradford method.

Animal protection studies

Animals: CD-1 female mice (6-8 weeks) were used for these studies.
Active immunization, generation of hyper-immune mouse sera: 50 µg of recombinant protein was injected subcutaneously into CD-1 mice, adjuvanted with Complete Freund's adjuvant (CFA). Animals were boosted twice with the same amount of protein and Incomplete Freund's adjuvant (IFA) at days 14 and 28. The published protective Sip (gbs0031) protein antigen (Brodeur et al., Infect Immun. 68(10):5610-5618 (2000)) was used as a positive control, while mice immunized with adjuvant only served as negative controls. Antibody titres were measured at day 35 by ELISA using the respective recombinant proteins. In case of hyper-immune sera generation mice were terminally bled at day 35.

Generation of hyperimmune rabbit sera: Polyclonal rabbit sera were generated for gbs0031, gbs0233p, gbs1087p, gbs1309p, gbs1477p, gbs1478p and gbs2018p at Charles River Laboratories, Kislegg, Germany. 250 µg of recombinant protein was injected into New Zealand White rabbits, adjuvanted with Complete Freund's adjuvant (CFA). Animals were boosted three times with the same amount of protein, but with Incomplete Freund's adjuvant (IFA) at days 28, 42 and 56. Antibody titers were measured at day 38 and 52 by ELISA using the respective recombinant proteins. Rabbits were terminally bled at day 70.

Passive immunization: CD-1 mice were immunized intraperitoneally 1 to 3 hours before the bacterial challenge with 150 µl mouse or rabbit hyperimmune sera.

Bacterial challenge: Freshly grown *S. agalactiae* strains C388/90 (serotype Ia/c), A909 (serotype Ia/c), ATCC12401 (serotype Ib), ATCC12403 (serotype III), COH1 (serotype III), BAA22 (serotype III), 2603V/R (serotype V), ATCC49447 (serotype V), BAA23 (serotype V) were used for animal challenge studies. In order to determine the viable cell numbers present in the bacterial inoculum, cfus were determined via plating on blood agar plates. 10^6 - 10^8 cfus were applied intraperitoneally into mice. Protection by immunization was measured by a lethal sepsis model, where survival rates were followed for 1 to 2 weeks post-challenge and survival was expressed as percentage of the total number of animals (10 mice / group).

Results

By using a genomic scale antigen identification method we selected Group B streptococcal antigens based on immunogenicity in humans (WO2004/099242) and pre-selected vaccine candidates based on *in vitro* assays. Here we show immune protection by six Group B streptococcal antigens in animal models. The first screening model was set up using adult mice and the mouse-adapted *S. agalactiae* ATCC12403 serotype III strain that was also used for the genomic library construction and cloning of some of the vaccine candidates. We set up the method with CD-1 mice and defined the LD_{90} - LD_{100} dose. The model set up was further optimized by using positive and negative control sera. Protection was estimated by reduced lethality of mice immunized with Sip or anti-Sip immune sera relative to animals immunized with adjuvant alone or treated with control sera. Based on these data, CD-1 mice and a challenge dose between 5 x 10^7 to 1 x 10^8 cfu was used for further studies. Mice were immunized first with the recombinant antigens adjuvanted with CFA/IFA and in subsequent experiments with hyper-immune mouse sera transferred to naïve animals before challenge with *S. agalactiae* ATCC12403 (serotype III). In the active, as well as in the passive model, several protective antigens were identified that showed variable protection levels, ranging from higher, equal or lower survival relative to Sip. Since several different Group B Streptococcus serotypes are able to cause severe disease in humans, it is important to test cross-protection of vaccine candidates against all major serotypes in animal experiments. Moreover, it has been firmly demonstrated that protective antigens show strain-dependent variations not only in their primary sequences and expression, but also in their protective capacity. For that reason, we have set up the screening model with several different *S. agalactiae* strains representing the major serotypes, Ia, Ib, III and V. Strain-dependent protection within one serotype was also addressed by using 2-3 different strains of the most common serotypes Ia, III and V. In order to perform this large number of experiments with the minimal animal sacrifice and good comparability, we generated hyper-immune rabbit sera for all *in vitro* selected recombinant antigens. Three rabbits were immunized with each individual antigen adjuvanted with CFA/IFA using a standard protocol. Animals were pre-screened for pre-existing GBS-specific antibodies by testing their sera with ELISA and only animals without a significant reaction were included in immunization studies. The individual hyper-immune sera were then analyzed for antigen-specific antibody levels and used in pools for further analyses. Thus, the very same immune sera were used for passive protection studies with nine different GBS strains that we found useful for animal studies. As a result of these experiments we could identify six novel vaccine candidates – gbs0233p, gbs1087p, gbs1309p, gbs1477p, gbs1478p and gbs2018p – that showed protection against at least one serotype when used as a sole antigen (Figure 1).

In order to examine benefits of combinations of different antigenic components, we performed passive protection studies by combining rabbit sera with different antigen specificities. With different combinations using these six protective vaccine candidates, we could demonstrate increased protection compared to the single proteins against all the tested GBS serotypes. The combination of gbs1477p + gbs2018p provided a significantly increased level of protection against many serotypes. The best protection seen so far was achieved with a combination of gbs1087p + gbs1477p + gbs1478p + gbs2018p that protected most of the mice against all nine tested GBS strains (Figure 2).

Example 2: Surface exposure and induction of functional antibodies by Group B streptococcal antigens.

Experimental procedures

FACS analysis:

The *S. agalactiae* strain to be tested was inoculated from a glycerol stock into 5 ml THB medium and incubated over night at 37°C. The overnight culture was reinoculated by adding 200 µl into 10 ml fresh THB medium and incubated until an OD_{600nm} of approximately 1 was reached (~5 x 10^8 cells/ml). The bacterial cells were pelleted by centrifugation at 4,000 rpm for 5 min and washed twice with 2 ml HBSS. The final pellet was resuspended in HBSS with 1% BSA to give a cell density of 5 x 10^6 cells/ml. To 100 µl bacterial suspension 1 µl serum was added and incubated for 45 min on ice. Bacteria were pelleted by centrifugation at 1,000 g for 4 min and washed once with 150 µl HBSS with 1% BSA and resuspended in 100 µl HBSS with 1% BSA. To the opsonised bacteria 1 µl of the secondary antibody (goat F(ab)2 fragment anti rabbit IgG coupled with PE) was added and incubated for 45 min on ice in the dark. The cells were washed twice with 150 µl HBSS as described above and dissolved in 250 µl HBSS, the cells were fixed by the addition of 250 µl 4% para-formaldehyde. The fluorescent staining of the bacteria was measured by FACS analysis.

Opsonophagocytic killing assay

Preparation of bacterial cells: The *S. agalactiae* strain to be tested was inoculated from a glycerol stock into 5 ml THB medium and incubated overnight at 37°C. The over night culture was reinoculated by adding 200 µl into 10 ml fresh THB medium and incubated until an OD_{600nm} of approximately 1 was reached. The bacteria were pelleted by centrifugation at 4,000 rpm for 5 min and washed twice with 2 ml HBSS. The final pellet was resuspended in HBSS with 0.125% BSA to give a final concentration of 5×10^4 cells/85 µl.

Preparation of RAW264.7 cells: Cells were cultivated in T175 flasks with 25 ml DMEM high glucose medium at 37°C with 5% CO_2. Cells were detached from the flasks by scraping and collected by low speed centrifugation at 1,000 rpm for 10 min and washed twice with 50 ml HBSS with 10 mM glucose and resuspended in HBSS with 10 mM glucose to give a cell concentration of 1×10^7 cells/ml.

Opsonophagocytic killing assay: Bacteria (85 µl) were mixed with 10 µl guinea pig complement and 5 µl prediluted serum and incubated for 60 min at 6°C with shaking (500 rpm). To the opsonised bacteria 100 µl (1×10^6 cells) RAW264.7 cells were added. Three aliquots of 10 µl were taken and each added to 1.5 ml water after 5 min incubation, 100 µl were plated on blood agar plates to determine the initial bacterial count, T_0. The suspensions with opsonised bacteria and RAW264.7 cells were incubated for one hour at 37°C with shaking (500 rpm). After 60 min incubation three aliquots of 10 µl were removed and each diluted in 1.5 ml, after 5 min incubation, 100 µl were plated on blood agar plates to determine T_{60}. After overnight cultivation cfus were determined with a colony counter.

Evaluation: For each sample the relationship between the cfu at T_0 and T_{60} was determined. The percentage killing of each test serum was related to the respective preimmune serum using the relationship between T_0 and T_{60} with the formula 100-100x(test serum/preimmune serum).

Results

The analyses of surface expression of gbs0233, gbs1087, gbs1309, gbs1477, gbs1478 and gbs2018 have been performed by FACS analysis using the very same pooled rabbit hyperimmune sera that were tested for protection in animal studies. These six protective antigens were detected on the surface of Group B streptococcal strains. Four of the antigens (gbs1087, gbs1477, gbs1478, gbs2018) were most consistently detected (Figure 3), gbs0233 was not expressed *in vitro* by all strains and gbs1309 was mainly detected in the bacterial supernatant. The *in vitro* expression experiments have been performed with nine different strains from the serotypes Ia, Ib, II, III, IV and V; the most comprehensive studies have been performed with the serotype III strain ATCC12403.

Based on the passive protection data, it is firmly established that protection by the selected six vaccine candidates is mainly mediated by antibodies. The ability to measure functional antibodies in *in vitro* assays is essential for the development of both a prophylactic vaccine and an antibody-based therapy or prevention. Nine different *S. agalactiae* strains representing six serotypes (Ia, Ib, II, III, IV and V) were used to evaluate gbs0233p, gbs1087p, gbs1309p, gbs1477p, gbs1478p and gbs2018p for induction of functional antibodies. Included in the opsonophagocytic killing assays were two GBS strains representing serotypes II and IV that were not suitable for animal testing. As an example of the *in vitro* assays, results with two strains are presented in Figure 4, the serotype II strain AC3912 (Figure 4A) and the serotype V strain BAA23 (Figure 4B). Simultaneously with the opsonophagocytic killing assay cells were tested for *in vitro* expression of the tested antigens by Western blot and FACS analysis. At a serum dilution of 1:200, only gbs1478p showed more than 50% killing of the serotype II strain AC3912 (Figure 4A), both gbs1477p and gbs1478p showed more than 50% killing of the serotype V strain BAA23 (Figure 4B). The remaining antigens showed less than 50% killing of the strains tested in

Figure 4, which in most cases can be explained by poor *in vitro* expression of the antigens in these strains.

Example 3: Sequence conservation of protective Group B streptococcal antigens

Experimental procedures

<u>*Sequence analyses of S. agalactiae genes:*</u> In order to determine the sequence of an antigen from diverse *S. agalactiae* strains, PCR was performed with primers specific for the gene of interest. *S. agalactiae* strains used for these analyses are shown in Tables 2 and 13. Oligonucleotide sequences as primers for PCR were designed for the selected antigens in order to be able to amplify the full gene. Sequencing was performed with dedicated primers using the PCR products as templates. The sequences of the oligonucleotides are listed in Table 3. Genomic DNA of all *S. agalactiae* strains was prepared as described in WO2004/099242. PCR was performed in a reaction volume of 25 µl using Taq polymerase (1 U), 200 nM dNTPs, 10 pMol of each oligonucleotide and the kit according to the manufacturer's instructions (Invitrogen, The Netherlands). As standard, 30 cycles (1x: 5 min. 95°C, 30x: 30 sec. 95°C, 30 sec. 56°C, 30 sec. 72°C, 1x: 4 min. 72°C) were performed, unless conditions had to be adapted for individual primer pairs. PCR samples were sequenced with the oligonucleotides as listed in Table 3.

Results

The genomic sequence of eight individual strains of *S. agalactiae* (Tables 2 and 4) has been published and was compared for the six antigens shown to be protective under Example 1. The comparison showed that the proteins gbs0233 and gbs1087 are highly conserved (more than 99 and 91% identity, respectively; Tables 2 and 4), although gbs1087 displayed various numbers of repeats in the different GBS strains (see also WO2004/035618). This high degree of protein sequence identity (gbs0233: >99%; gbs1087: >86%) could also be observed for the strains that were subjected to DNA sequence analyses as listed in Tables 5, 7, 8, and Table 13 and in the Sequence listing. The gbs0233 protein from any of the analyzed strains showed at least 98.7% amino acid sequence identity to gbs0233 from *S. agalactiae* NEM316, with only 6 amino acid position showing a change. The sequences of the gbs1087 proteins from the analyzed strains were also highly conserved, yet the different strains harboured between a single and up to 29 repeats of a highly conserved 17 amino acid long sequence. The sequences of proteins gbs1309 and gbs2018 showed high sequence conservation in 7 genomic strains (more than 87 and 77% identity, respectively), while protein sequences diverged more significantly in strain COH1 (69.9 and 47.7%, respectively; Table 4). The gbs1309 protein showed a similar high degree of amino acid sequence identity (89.6%) in the sequenced GBS strains (Table 5, 9, 13 and Sequence listing), while the gbs2018 protein can be classified in two clades, with 95% of strains belonging to one clade with at least 60.8% sequence identity and 3 strains COH1(III), BAA22(III) and 49447(V) belonging to the second clade. The protein gbs1478 is highly conserved in 6 genomic strains (more than 87% identity), yet the strains COH1 and A909 show a lower amino acid sequence identity of approximately 43% (Table 4). Protein gbs1478 is conserved in most analyzed GBS strains as shown in Table 5, 11, 13 and the Sequence listing, but exists as 2 distinct clades with an amino acid sequence identity of more than 80% in the dominant clade (approx. 80% of analyzed strains) and more than 99% in the second clade. The protein gbs1477 shows the highest degree of amino acid sequence variability, with six distinct clades that can be characterized. Strains COH1 and A909 do not encode a homologous protein with significant amino acid sequence identity (Table 4). The sequence analyses of the gbs1477 gene from further distinct GBS strains revealed that all selected strains encode a protein homologous to gbs1477 and that all six clades were covered by these sequences (Table 5, 6, 10, 13, Sequence listing and Figure 5). The prototype sequences for the 6 clades of gbs1477 are: strain 12401 (clade 1; SEQ ID NO: 93), strain IC254 (clade 2; SEQ ID NO: 110), strain 126H4A (clade 3; SEQ ID NO: 94), strain 49447 (clade 4; SEQ ID NO: 95), strain C388/90 (clade 5; SEQ ID NO: 100) and strain NEM316 (clade 6; SEQ ID NO: 223 and SEQ ID NO: 361); (for all sequences, see Sequence listing). Within any single clade the level of amino acid sequence identity reaches at least 98%.

Example 4: Group B streptococcal antigens and combinations thereof as well as mouse monoclonal antibodies, generated against these antigens, induce protective immune responses against lethal sepsis in an i.p. challenge model.

Experimental procedures

Cloning and expression of recombinant Group B streptococcal proteins

Cloning of genes: The gene of interest was amplified from genomic DNA of *S. agalactiae* ATCC12403 (serotype III) by PCR using gene specific primers. Apart from the gene specific part, the primers had restriction sites that aided in a directional cloning of the amplified PCR product. The gene annealing (specific) part of the primer ranged between 15-30 bases in length. The PCR products obtained were digested with the appropriate restriction enzymes and cloned into the pET28b (+) vector (Novagen) for His-tagged proteins. Once the recombinant plasmid was confirmed to contain the gene of interest, *E. coli* BL21 star® cells (Invitrogen) that served as expression host were transformed. Cloning of the gbs1087, gbs1477 and gbs1478 genes has been performed using genomic DNA from strain *S. agalactiae* 6313 (serotype III) in the vector pET28a (+). The constructs of the selected antigens are listed in Table 1.

Expression and purification of proteins:

E coli BL21 star® cells harboring the recombinant plasmid were grown into log phase in the required culture volume. Once an OD_{600nm} of 0.6 was reached the culture was induced with 0.5 mM IPTG for 3 hours at 37°C. The cells were harvested by centrifugation, lysed by a combination of the freeze-thaw method followed by disruption of cells with 'Bug-buster®' (Novagen). The lysate was separated by centrifugation into soluble (supernatant) and insoluble (pellet) fractions. Depending on the location of the protein different purification strategies were applied. A) If the His-tagged protein was in the soluble fraction, protein purification was done by binding the supernatant to Ni-Sepharose beads (Ni-Sepharose™ 6 Fast Flow, GE Healthcare). Due to the presence of the hexa Histidine (6xHIS) at the C terminus of the expressed protein, it bound to the Ni-Sepharose while the other contaminating proteins were washed from the column by wash buffer. The protein was eluted by 500 mM Imidazole in 20 mM NaH_2PO_4, 0.5 mM NaCl buffer at pH 7.4. The eluate was concentrated, assayed by Bradford for protein concentration and checked by SDS-PAGE and Western blot. B) If the protein was present in the insoluble fraction, the pellet was solubilized in suitable buffer containing 8 M Urea and applied onto the Ni-NTA column under denaturing conditions (in buffer containing 8 M Urea) using the same materials and procedure as mentioned above. Contaminating proteins were washed from the column by wash buffer without urea. Refolding of the His-tagged protein was performed while the protein was immobilized on the Ni-NTA matrix. After renaturation, proteins were eluted by the addition of 500 mM Imidazole. The eluate was dialyzed to remove traces of urea and concentrated if the volume was large, checked by SDS-PAGE and measured by the Bradford method.

Animal protection studies

Animals: CD-1 female mice (6-8 weeks) were used for these studies.

Active immunization: 25 µg of recombinant protein was injected subcutaneously into CD-1 mice, adjuvanted with ALUM 1%. Animals were boosted twice with the same amount of protein and ALUM 1% at days 14 and 28. The published protective Sip (gbs0031) protein antigen was used as a positive control, while mice immunized with adjuvant only served as negative controls. Antibody titres were measured at day 35 by ELISA using the respective recombinant proteins.

Generation of hyperimmune rabbit sera: Polyclonal rabbit sera were generated for gbs0031, gbs0233p, gbs1087p, gbs1309p, gbs1477p, gbs1478p and gbs2018p at Charles River Laboratories, Kislegg, Germany. 250 µg of recombinant protein was injected into New Zealand White rabbits, adjuvanted with Complete Freund adjuvant (CFA). Animals were boosted three times with the same amount of protein, but with Incomplete Freund adjuvant (IFA) at days 28, 42 and 56. Antibody titers were measured at day 38 and 52 by ELISA using the respective recombinant proteins. Rabbits were terminally bled at day 70.

Generation of mouse monoclonal antibodies: Monoclonal mouse antibodies were generated against gbs0233p, gbs1087p, gbs1477p, gbs1478p and gbs2018p at Abgent, San Diego, USA. 100 µg of recombinant protein was injected into Balb/c mice, adjuvanted with Complete Freund adjuvant (CFA). Animals were boosted with 50 µg protein and CFA at week 2; at week 3 animals were boosted with the same amount of protein, but with Incomplete Freund adjuvant (IFA) and at week 4 and 5 animals were boosted with 50 µg protein in PBS (without adjuvant). Antibody titers were measured in week 5 by ELISA and Western blotting using the respective recombinant proteins. Spleen cells from mouse with the best titer were fused with myeloma cell F0 using PEG protocol. Subsequently growing fused hybridoma clones were screened against the respective antigen for test of their specificity and sensitivity. ELISA positive clones were tested also by Western blot. Selected clones from this test were subcloned at least two times and antibodies were purified by protein G affinity chromatography from culture medium.

Passive immunization (neonates): Pregnant CD-1 mice were given 0.5 ml undiluted rabbit hyper-immune sera by intraperitoneal injection 2 to 4 days before delivery. Within 48h after birth, pups were challenged intraperitoneally.

Bacterial challenge: Freshly grown *S. agalactiae* strains C388/90 (serotype Ia/c), A909 (serotype Ia/c), ATCC12401 (serotype Ib), ATCC12403 (serotype III), COH1 (serotype III), ATCCBAA22 (serotype III), 2603V/R (serotype V), ATCC49447 (serotype V), ATCCBAA23 (serotype V) were used for animal challenge studies. In order to determine the viable cell numbers present in the bacterial inoculum, cfus were determined via plating on blood agar plates. 10^6 - 10^8 cfus were applied intraperitoneally into mice. Protection by immunization was measured by a lethal sepsis model, where survival rates were followed for 1 to 2 weeks post-challenge and survival was expressed as percentage of the total number of animals (10 mice / group for active immunization; for neonatal challenge number of animals depends on the litter size).

Results

By using a genomic scale antigen identification method we selected Group B antigens based on immunogenicity in humans (WO04/099242) and pre-selected vaccine candidates based on *in vitro* assays. We have shown previously immune protection by six Group B streptococcal antigens in animal models. Additionally, with different combinations using these six protective vaccine candidates, we demonstrated increased protection compared to the single proteins against all the tested GBS serotypes. The combination of gbs1477p + gbs2018p provided a significantly increased level of protection against many serotypes. The best protection seen so far was achieved with a combination of gbs1087p + gbs1477p + gbs1478p + gbs2018p that protected most of the mice against all nine tested GBS strains (see Example 1 and Figure 2). So far these experiments were obtained in serum transfer experiments. We now further substantiated these results by active immunization of mice with two, three or four recombinant proteins using ALUM as adjuvant (Figure 6). Immunization with single proteins verified the data already obtained with the hyper-immune rabbit sera (Figure 7).

Since GBS sepsis affects mainly newborns, we have also developed a model that can demonstrate protection in neonatal mice. We established a murine model with passive immunization of pregnant mice with hyperimmune rabbit sera (500 µl i.p.) 2-4 days before delivery and challenging their babies with *S. agalactiae* 24-48h after birth. We observed excellent protection of newborn mice born to mothers immunized with the combination of gbs1087p + gbs1477p + gbs1478p + gbs2018p specific immune sera (4 x 125 µl) (Figure 8). Hyperimmune sera against the individuals antigens were also effective in this, but overall was lower than that obtained with the combination of four (data not shown). These findings are very significant, since the models with the different GBS strains were very stringent, resulting in death of infected pups within 24 hours.

Since the protein gbs1477 has the highest sequence variability and exists in different clades (Table 5 & 6, Figure 5) the protection was analyzed using the adult sepsis/lethality model. Mice were immunized with fragments (corresponding to gbs1477p of strain 6313) of six different gbs1477 proteins, originated from distinct clades. Protection was measured against the homologous as well as against the heterologous clade (Figure 9). The best protection was always obtained when immunization and challenge is done with the homologous clade. The more variable the sequences of the different clades are the lower the protection obtained in the sepsis model.

This invention includes also protection data by mouse monoclonal antibodies. mAbs were generated against gbs0233p, gbs1087p, gbs1477p, gbs1478p and gbs2018p. Selection of hybridoma supernatants were performed using antigen-specific ELISA and/or FACS analysis. Per antigen two mAbs were selected and tested in the passive transfer model using 50 µg purified mAb. We demonstrate in this invention that we obtain protection with a single mAb against at least one serotype (Figure 10). In order to examine benefits of combinations of different mAb components, we performed passive protection studies by combining mAbs with different antigen specificities. We could demonstrate increased protection compared to the single mAbs against all the tested GBS serotypes. The best protection seen so far was achieved with a combination of mAbs against gbs0233p + gbs1087p + gbs1477p + gbs1478p + gbs2018p that protected most of the mice against all nine tested GBS strains (Figure 11).

Example 5: Group B streptococcal antigens and mouse monoclonal antibodies, generated against these antigens, induce functional antibodies against group B streptococcus.

Experimental procedures

FACS analysis

The *Streptococcus agalactiae* strain to be tested was inoculated from a glycerol stock into 5 ml THY medium and incubated over night at 37°C. The overnight culture was re-inoculated by adding 200 µl into 10 ml fresh THY medium and incubated until an OD_{600nm} of approximately 1 was reach (~5 x 10^8 cells/ml). The bacteria were pelleted by centrifugation at 4,000 rpm for 5 min and washed twice with 2 ml HBSS. The final pellet was resuspended in HBSS with 1% BSA to give a cell density of 5 x 10^6 cells/ml. To 100 µl bacteria, 1 µl immune serum was added and incubated for 45 min on ice. Bacteria were pelleted by centrifugation at 1,000 g for 4 min and washed once with 150 µl HBSS with 1% BSA and resuspended in 100 µl HBSS with 1% BSA. To the opsonised bacteria, 1 µl of the secondary antibody (goat F(ab)2 fragment anti rabbit IgG coupled with PE) was added and incubated for 45 min on ice in dark. The cells were washed twice with 150 µl HBSS as described above and dissolved in 250 µl HBSS, the cells were fixed by addition of 250 µl 4% para-formaldehyde. The fluorescent staining of the bacteria was measured by flow cytometry.

Opsonophagocytic killing assay

Preparation of bacterial cells: The *Streptococcus agalactiae* strain to be tested was inoculated from a glycerol stock into 5 ml THY medium and incubated overnight at 37°C. The over night culture was re-inoculated by adding 200 µl into 10 ml fresh THY medium and incubated until an OD_{600nm} of approximately 1 was reached. The bacteria were pelleted by centrifugation at 4,000 rpm for 5 min and washed twice with 2 ml HBSS. The final pellet was re-suspended in HBSS with 0.125% BSA to give a final concentration of 5 x 10^4 cells/85 µl.

Preparation of RAW264.7 cells: Cells were cultivated in T175 flasks with 25 ml DMEM high glucose medium at 37°C with 5% CO_2. Cells were detached from the plates by scraping and collected by low speed centrifugation at 1,000 rpm for 10 min and washed twice with 50 ml HBSS with 10 mM glucose and re-suspended in HBSS with 10 mM glucose to give a cell concentration of 1 x 10^7 cells/ml.

Opsonophagocytic killing assay conditions: Bacterial cells (85 µl) were mixed with 10 µl guinea pig complement and 5 µl pre-diluted serum and incubated for 60 min at 6°C with shaking (500 rpm). To the opsonised bacteria, 100 µl (1 x 10^6 cells) of RAW264.7 cells were added. Three aliquots of 10 µl were taken out and added to 1.5 ml water after 5 min incubation, 100 µl were plated out on blood agar plates. This CFU determination served as the initial bacterial count, T_0. The suspension of opsonised bacteria and RAW264.7 cells was further incubated at 37°C with shaking (500 rpm) for 60 min and then the T60 was determined as described for the T_0. Blood agar plates were incubated overnight and the CFUs determined on the next day using a colony counter.

Evaluation: For each serum, the relationship between the CFUs at T_0 and T_{60} was determined for the pre-immune and the immune serum. The percentage of killing of each immune serum was determined by the following formula: 100-100x(immune serum/preimmune serum). A reaction without sera was included in each assay as negative (complement) control.

Results

Based on the passive protection data, it is firmly established that protection by the selected six vaccine candidates is mainly mediated by antibodies. The ability to measure functional antibodies in *in vitro* assays is essential for the development of both a prophylactic vaccine and an antibody-based therapy or prevention. The same opsonophagocytic killing assay that was developed for the *in vitro* validation and used for selection of vaccine candidates was employed to analyze the hyperimmune rabbit sera for the presence of functional antibodies. Seven mouse monoclonal antibodies and four rabbit sera representing four antigens were tested in the opsonophagocytic killing assay for functional antibodies and staining in flow cytometry of the serotype III GBS strain ATCC12403 (Figure 12 and 13). All monoclonal antibodies bound to the serotype III GBS strain ATCC12403 as measured by flow cytometry (Figure 12). The opsonophagocytic killing assay with the rabbit and mouse monoclonal antibodies are shown in Figure 13. At a 1:1,000 dilution of the rabbit sera only gbs1477#28 and gbs1478#4 showed a high killing activity and gbs1087#12 showed low killing activity. The mouse monoclonal antibodies generated against gbs1477p and gbs1478p showed high killing activity and those against gbs1087p and gbs2018p showed only a killing activity at the higher concentration.

Table 1: List of genes selected for expression.

The nomenclature of the proteins is derived from the genome of NEM316 (ATCC12403). The strain and position (start/stop) of the amplicon within the full length gene/protein are indicated.

Const-ruct	Gene	Full length	Strain	Vector	nt (start/stop)	SEQ ID NO	aa (start/stop)	SEQ ID NO
1	gbs0233	308	12403	pET28b	37-921	7	13-307	1
2	gbs1087	442	6313	pET28a	106-1062	8	36-354	2
3	gbs1309	403	12403	pET28b	4-1203	9	2-401	3
4	gbs1477	674	6313	pET28a	88-1944	10	30-648	4
5	gbs1478	901	6313	pET28a	88-2595	11	30-865	5
6	gbs2018	643	12403	pET28b	106-1836	12	36-612	6

Table 2: List of *S. agalactiae* strains which were used for the first run of sequencing of the most of the genes of interest, and for which the genome has been published. (A complete list of strains used for the first and second run can be found in Table 13.)

GBS strains used for sequencing	
***S. agalactiae* strain**	**Serotype**
IC105	IV
IC458	Ia
0176H4A	II
ATCC12401	Ib
BAA23	V
COH1	III
ATCC12403	III
6313	III
Published genomic GBS strains (Maione *et al.,* 2005, Science 309(5731): 148-50)	
***S. agalactiae* strain**	**Serotype**
H36B	Ib
COH1	III
CJB111	V
A909	Ia/c
515	Ia
2603V/R	V
NEM316 (ATCC12403)	III
18RS21	II

Table 3: Oligonucleotides used for PCR and sequencing

ORF-protein	PCR	Sequencing Primer	Name	SEQ ID NO:
gbs0233	ICC5455 & ICC5456	GGGGGCACAATTCCTGTTAT	ICC 5455	13
		AAAAAGTGGTGGATAAATTGTTCT	ICC 5456	14
gbs1087	ICC5489 & ICC5494	CATTGTAAATCTTAATGTTAGTATGA	ICC 5489	15
		TGACTTTGATTTCCAACACTATCC	ICC 5490	16
		GGTTTTAGAACTTGGAAATCAGGA	ICC 5491	17
		GGTCTATTAGCTACATTAGTAACCTG	ICC 5492	18
		AGAGAAAATAATCACTCTAGTCAAGG	ICC 5493	19
		AAAAAGTCACCCTAACCAACC	ICC 5494	20
gbs1309	ICC5465 & ICC5468	AATCATCGGTGAAGTGACGA	ICC 5465	21
		CGGTTAATTCAATTGGATATTTTCT	ICC 5466	22
		ACTCTGATATGGGTAAAGGCTAT	ICC 5467	23
		CTTGAATTATTCTTAAAAAGACCAAAA	ICC 5468	24
	ICC5469 & ICC5470	CCAGTAGATGAGTGGTTAGGTCTTG	ICC 5469	25
		AAGATGAGCTGGTTTTATATATTTG	ICC 5470	26
gbs1477	ICC5471 & ICC5479	TTGCAGGTGGAATTTATATTTGG	ICC 5471	27
		TTCTTATCTACTTGTGGTTTTGTTTCA	ICC 5477	28
		TCTTGGCTGATTCAAAAGCA	ICC 5478	29
		GGTTCTGATGGGTTGATTGG	ICC 5479	30
	ICC5480 & ICC5472	AATGGCTCTTGCTTATGATCT	ICC 5472	31
		TGTTAGCGGCTACACTCCAG	ICC 5480	32
	ICC5471 & ICC5475	TTGCAGGTGGAATTTATATTTGG	ICC 5471	33
		CAACTTTTGGTTCAGTTGG	ICC 5475	34
		CCCATTGTCAAACCATTT	ICC 5473	35
		GCTACTGCTGAAATCGGTMA	ICC 5474	36
	ICC5476 & ICC5472	CATACATGATCTCAGAACGT	ICC 5476	37
		AATGGCTCTTGCTTATGATCT	ICC 5472	38
gbs1478	ICC5481 & ICC5484	TCTAGGATATTCTGTATCTGATCTTAG	ICC 5481	39
		CCATCAAAAATATCTGAACCA	ICC 5482	40
		GAGGGAACATTATCTAAACGTATTTCA	ICC 5483	41

		TTCAATTTTTGAAAAGTACCATCTTG	ICC 5484	42
	ICC5485 & ICC5488	GAACATGGAACACCAACCAA	ICC 5485	43
		TCAATTTCACCTAACTTCTTCTCG	ICC 5486	44
		TTTTCCAATCCCTAAAATTCG	ICC 5487	45
		TTTTCATTTCTATCTCCTTCTTATTC	ICC 5488	46
gbs2018	ICC5457 & ICC5460	AAAAGGCAAAGTTCTGATGAGG	ICC 5457	47
		AAAAATGCTTGATGAAGTCAAAA	ICC 5458	48
		GTTTGGCTTCTGGCTTAACG	ICC 5459	49
		TGATCAAGAACTAGGTAAGCAGTCA	ICC 5460	50
	ICC5461 & ICC5462	CAAATTTAAGAATAAGTTGCGAATC	ICC 5461	51
		AGAGTAAATGATTTTAATAGAGCATCA	ICC 5462	52
	ICC5463 & ICC5464	AAAATATTTCTAATTTCTGCTTCAGT	ICC 5463	53
		AATTAAAATAAACGTGGTCCTATCC	ICC 5464	54

Table 4: Sequence identity of proteins in published genomes of 8 GBS strains.

ORF indicates the name of the respective gene/protein in the genomic GBS strain. % Id, amino acid sequence identity in percentage. All comparisons are performed to the respective protein of GBS strain NEM316.

	S. agalactiae H36B		*S. agalactiae* COH1		*S. agalactiae* CJB111		*S. agalactiae* A909		*S. agalactiae* 515		*S. agalactiae* 2603V/R		*S. agalactiae* 18RS21	
ORF name (NEM316)	**ORF**	**% Id**	**ORF**	**% Id**	**ORF**	**% Id**	**ORF**	**% Id**	**ORF**	**% Id**	**ORF**	**% Id**	**ORF**	**% Id**
gbs0233	SAI_0243	99.0	SAN_0021	99.7	SAM_0244	99.0	SAK_0301	99.0	SAL_0280	99.7	SAG0242	99.0	SAJ_0320	99.0
gbs1087	SAI_2325	93.9	SAN_1174	93.3	SAM_1069	91.5	SAK_1142	92.8	SAL_1159	92.0	SAG1052	100.0	SAJ_1090	100.0
gbs1309	SAI_1330	99.4	SAN_1370	69.9	SAM_1259	100.0	SAK_1321	99.7	SAL_1364	87.7	SAG1237	99.7	SAJ_2108	90.1
gbs1477	SAI_1511	47.0	none		SAM_1372	98.4	none		SAL_1486	75.9	SAG1407	47.3	SAJ_1416	47.3
gbs1478	SAI_1512	87.7	SAN_0702	43.2	SAM_1373	99.1	SAK_0780	43.3	SAL_1487	97.0	SAG1408	97.3	SAJ_1417	97.3
gbs2018	SAI_2103	78.8	SAN_2207	47.7	SAM_1974	77.6	SAK_1999	92.3	SAL_2118	100.0	SAG2063	87.5	SAJ_1966	87.5

Table 5: Sequence identity of proteins as determined by the first run of sequencing. % Id, amino acid sequence identity of the respective protein in percentage as determined by DNA sequencing. All comparisons are performed to the respective protein of GBS strain NEM316.

	S. agalactiae IC105	*S. agalactiae* IC458	*S. agalactiae* 12401	*S. agalactiae* BAA23	*S. agalactiae* COH1	*S. agalactiae* 0176H4A
ORF name (NEM316)	**% Id**	**% Id**	**% Id**	**% Id**	**% Id**	**% Id**
gbs0233	99.0	100	99.0	99.0	99.7	99.7
gbs1087	86.0	95.2	93.9	91.5	92.7	98.6
gbs1309	100	100	99.3	100	99.5	99.5
gbs1477	48.9	49.3	48.8	98.4	Not determined	67.8
gbs1478	88.2	88.1	87.7	99.1	Not determined	Not determined
gbs2018	77.6	99.7	77.2	78.5	Not determined	80.2

Table 6: Sequence identity of gbs1477 proteins as determined by the first run of sequencing. % Id, amino acid sequence identity of the respective protein in percentage as determined by DNA sequencing. Pairwise comparisons are performed for the gbs1477 protein among the sequenced GBS strains.

	S. agalactiae IC105	*S. agalactiae* IC458	*S. agalactiae* 12401	*S. agalactiae* BAA23	*S. agalactiae* 0176H4A
gbs1477	**% Id**	**% Id**	**% Id**	**% Id**	**% Id**
S. agalactiae NEM316	48.9	49.3	48.8	98.4	67.8
***S. agalactiae* IC105**	100	58.6	99.9	49.4	48.0
***S. agalactiae* IC458**		100	58.6	49.5	53.2
***S. agalactiae* 12401**			100	49.4	47.9
***S. agalactiae* BAA23**				100	68.5
***S. agalactiae* 0176H4A**					100

Table 7: Amino acid and encoding DNA sequences of gbs0233 proteins derived from different strains of *S. agalactiae*

Strain 0176H4A

ORF DNA sequence (SEQ ID NO: 61)

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAACCTGGTCATACCACAATTAAGGTTGCTGCACAAAGTTCTACAGAGTCTAGTATC
ATGGCAAATATTGTCACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCACAGGAACTCTTGGCTTAAAAGCTGTTAAAGACCCTAAAGAAGCTTCTAAGATTGTAAAAACTGAA
TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAGAGTTTGCCAGACAGAATAAAATCACCAAGATCTCTGATCTCAAAAAATTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCGGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC
CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 55):

MLKKSHFLQIFTLCLALLTISGCQLTDTKKPGHTTIKVAAQSSTESSIMANIVTELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDPKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Strain 12401

ORF DNA sequence (SEQ ID NO: 62):

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAGTCTGGTCATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATT
ATGGCAAATATTATCACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCACAGGGACTCTTGGTTTAAAAGCTGTTAAAGACCCTAAAGAAGCTTCTAAGATTGTAAAAACTGAA
TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAGAGTTTGCCAGACAgAATAAAATCACTAAGATCTCTGATCTTAAAAAATTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCGGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC
CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 56):

MLKKSHFLQIFTLCLALLTISGCQLTDTKKSGHTTIKVAAQSSTESSIMANIITELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDPKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Strain BAA23

ORF DNA sequence (SEQ ID NO: 63):

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAGTCTGGTCATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATT
ATGGCAAATATTATCACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCACAGGGACTCTTGGTTTAAAAGCTGTTAAAGACCCTAAAGAAGCTTCTAAGATTGTAAAAACTGAA
TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAGAGTTTGCCAGACAGAATAAAATCACTAAGATCTCTGATCTTAAAAAATTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCGGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAgGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC

CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 57):

MLKKSHFLQIFTLCLALLTISGCQLTDTKKSGHTTIKVAAQSSTESSIMANIITELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDPKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Strain COH1

ORF DNA sequence (SEQ ID NO: 64):

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAACCTGGTCATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATC
ATGGCAAATATTGTCACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCACAGGAACTCTTGGCTTAAAAGCTGTTAAAGACCCTAAAGAAGCTTCTAAGATTGTAAAAACTGAA
TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAGAGTTTGCCAGACAGAATAAAATCACCAAGATCTCTGATCTCAAAAAGTTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCGGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC
CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 58):

MLKKSHFLQIFTLCLALLTISGCQLTDTKKPGHTTIKVAAQSSTESSIMANIVTELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDPKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Strain IC105

ORF DNA sequence (SEQ ID NO: 65):

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAGTCTGGTCATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATT
ATGGCAAATATTATCACCGAATTAATTCATCACGAATTAGGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCACAGGGACTCTTGGTTTAAAAGCTGTTAAAGACCCTAAAGAAGCTTCTAAGATTGTAAAAACTGAA
TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAGAGTTTGCCAGACAGAATAAAATCACTAAGATCTCTGATCTTAAAAAATTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCGGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC
CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 59):

MLKKSHFLQIFTLCLALLTISGCQLTDTKKSGHTTIKVAAQSSTESSIMANIITELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDPKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Strain IC458

ORF DNA sequence (SEQ ID NO: 66):

ATGCTTAAAAAATCGCACTTTTTACAGATATTTACACTTTGCTTAGCCCTCTTAACGATTTCTGGTTGTCAA
TTAACCGATACTAAAAAACCTGGTCATACCACAATTAAGGTTGCTGCCCAAAGTTCTACAGAGTCTAGTATC
ATGGCAAATATTGTCACCGAATTAATTCATCACGAATTAgGATACAACACAACTTTAATAAGCAATCTTGGT
TCCTCTACGGTTACTCACCAAGCTTTGCTCCGTGGTGATGCTGACATTGCTGCCACACGTTATACAGGAACA
GACATCAcAGGAACTCTTGGCTTAAAAGCTGTTAAAGACACTAAAGAAGCTTCTAAGATTGTAAAAACTGAA

TTCCAAAAACGCTACAATCAAACTTGGTATCCTACTTATGGTTTTTCTGATACTTATGCATTCATGGTTACT
AAAgAGTTTGCCAGACAGAAtAAAATCACCAAGATCTCTGAtCTCAAAAAgTTATCAACAACTATGAAGGCA
GGGGTTGATAGTTCATGGATGAATCGCGAGGGAGATGGATACACTGATTTCGCTAAAACATACGGTTTTGAA
TTTTCACATATTTACCCTATGCAAATTGGCTTAGTCTATGATGCAGTTGAAAGTAACAAAATGCAATCTGTA
TTAGGCTACTCCACTGACGGTCGTATTTCGAGCTATGATTTAGAAATTTTAAGGGATGATAAAAAATTCTTT
CCTCCTTATGAAGCCTCTATGGTTGTCAACAATTCTATCATCAAAAAAGATCCTAAACTAAAAAAATTACTC
CATCGACTCGATGGTAAAATCAATTTAAAAACGATGCAAAACCTTAATTATATGGTAGATGATAAACTTTTA
GAACCTTCAGTTGTTGCCAAACAATTTTTAGAAAAAAACCATTATTTTAGAGGAGATAAATAA

ORF amino acid sequence (SEQ ID NO: 60):
MLKKSHFLQIFTLCLALLTISGCQLTDTKKPGHTTIKVAAQSSTESSIMANIVTELIHHELGYNTTLISNLG
SSTVTHQALLRGDADIAATRYTGTDITGTLGLKAVKDTKEASKIVKTEFQKRYNQTWYPTYGFSDTYAFMVT
KEFARQNKITKISDLKKLSTTMKAGVDSSWMNREGDGYTDFAKTYGFEFSHIYPMQIGLVYDAVESNKMQSV
LGYSTDGRISSYDLEILRDDKKFFPPYEASMVVNNSIIKKDPKLKKLLHRLDGKINLKTMQNLNYMVDDKLL
EPSVVAKQFLEKNHYFRGDK

Table 8: Amino acid and encoding DNA sequences of gbs1087 proteins derived from different strains of *S. agalactiae*

Strain 0176H4A

ORF DNA sequence (SEQ ID NO: 73):
TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCA
ACTATTATTTTAGGATCAAGTCCTGTATCTGCTATGGATAGTGTTGGAAATCAAAGTCAGGGCAATGTTTTA
GAGCGTCGTCAACGCGATGCAGAAAACAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGCGATGCAGAA
AACAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGTAGGTCAACTT
ATAGGGAAAAATCCACTTCTTTCAAAGTCAATTATATCTAGAGAAAATAATCACTCTAGTCAAGGTGACTCT
AACAAACAGTCATTCTCTAAAAAAGTATCTCAGGTTACTAATGTAGCTAATAGACCGATGTTAACTAATAAT
TCTAGAACAATTTCAGTGATAAATAAATTACCTAAAACAGGTGATGATCAAAATGTCATTTTTAAACTTGTA
GGTTTTGGTTTAATTTTGTTAACAAGTCGCTGCGGTTTGAGACGCAATGAAAATTAA

ORF amino acid sequence (SEQ ID NO: 67):
LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSVGNQSQGNVLERRQRDAENRSQGNVLERRQRDAE
NRSQGNVLERRQRDAENKSQVGQLIGKNPLLSKSIISRENNHSSQGDSNKQSFSKKVSQVTNVANRPMLTNN
SRTISVINKLPKTGDDQNVIFKLVGFGLILLTSRCGLRRNEN

Strain 12401

ORF DNA sequence (SEQ ID NO: 74):
TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCA
ACTATTATTTTAGGATCAAGTCCTGTATCTGCTATGGATAGTGTTGGAAATCAAAGTCAAGGTAATGTTCTA
GAGCGTCGTCAACGTGATGCGGATAACAAGAGCCAAGGTAATGTTCTAGAACGTCGTCAACGCGATGTGGAA
AACAAAAGTCAGGGCAATGTTCTAGAACGTCGTCAACGTGATGTTGAGAATAAGAGCCAAGGCAATGTTCTA
GAGCGTCGCCAACGTGATGCAGAAAACAAAAGTCAGGGTAATGTTCTAGAGCGTCGTCAACGCGATGCAGAT
AACAAGAGCCAAGGTAATGTTCTAGAACGTCGTCAACGCGATGTGGAAAACAAAAGTCAGGGCAATGTTCTA
GAGCGTCGCCAACGTGATGTTGAGAACAAGAGCCAAGTAGGTCAACTTATAGGGAAAAATCCACTTCTTTCA
AAGTCAACTATATCTAGAGAAAATAATCACTCTAGTCAAGGTGACTCTAACAAACAGTCATTCTCTAAAAAA
GTATCTCAGGTTACTAATGTAGCTAATAGACCAATGTTAACTAATAATTCTAGAACAATTTCAGTGATAAAT
AAATTACCTAAAACAGGTGATGATCAAAATGTCATTTTTAAACTTGTAGGTTTTGGTTTAATTTTGTTAACA
AGTCGCTGCGGTTTGAGACGCAATGAAAATTAA

ORF amino acid sequence (SEQ ID NO: 68):
LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSVGNQSQGNVLERRQRDADNKSQGNVLERRQRDVE
NKSQGNVLERRQRDVENKSQGNVLERRQRDAENKSQGNVLERRQRDADNKSQGNVLERRQRDVENKSQGNVL
ERRQRDVENKSQVGQLIGKNPLLSKSTISRENNHSSQGDSNKQSFSKKVSQVTNVANRPMLTNNSRTISVIN
KLPKTGDDQNVIFKLVGFGLILLTSRCGLRRNEN

Strain BAA23

ORF DNA sequence (SEQ ID NO: 75):
TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCA
ACTATTATTTTAGGATCAAGTCCTGTATCTGCTATGGATAGTGTTGGAAATCAAAGTCAGGGCAATGTTTTA
GAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCAGAA

AACAGAAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGCGATGCAGAAAACAGAAGCCAAGGTAATGTTCTA
GAGCGTCGTCAACGTGATGTTGAGAATAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGCGATGTTGAG
AATAAGAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGGCAATGTTCTA
GAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGGCAATGTTCTAGAGCGTCGTCAACGCGATGCAGAA
AACAGAAGCCAAGGTAATGTTTTAGAACGTCGTCAACGCGATGTTGAGAACAAGAGCCAAGGTAACGTTCTA
GAGCGTCGCCAACGTGACGTTGAGAACAAGAGCCAAGGTAATGTTTTAGAGCGTCGCCAACGCGATGCGGAT
AACAAAAGTCAGGGCAATGTTTTAGAGCGTCGCCAACGTGATGTTGAGAACAAGAGCCAAGGTAATGTTCTA
GAGCGTCGCCAAAATAATGTCCTTATTAAGAGTCAAGATAATGTTCTAGAGCGCCGCCAACGTGATGCGGAT
AACAAGAGCCAGGGTAACGTTCTAGAGCGTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGTAATGTTTTA
GAGCGTCGCCAACATGATGTTGAGAATAAGAGTCAAGTAGGTCAACTTATAGGGAAAAATCCACTTTTTTCA
AAGTCAACTGTATCTAGAGAAAATAATCACTCTAGTCAAGGTGACTCTAACAAACAGTCATTCTCTAAAAAA
GTATCTCAGGTTACTAATGTAGCTAATAGACCGATGTTAACTAATAATTCTAGAACAATTTCAGTGATAAAT
AAATTACCTAAAACAGGTGATGATCAAAATGTCATTTTTAAACTTGTAGGTTTTGGTTTAATTTTATTAACA
AGTCTCTGCGGTTTGAGACGCAATGAAAATTAA

ORF amino acid sequence (SEQ ID NO: 69):

LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSVGNQSQGNVLERRQRDAENRSQGNVLERRQRDAE
NRSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDVENKSQGNVLERRQRDAENKSQGNVL
ERRQRDAENKSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDVENKSQGNVLERRQRDAD
NKSQGNVLERRQRDVENKSQGNVLERRQNNVLIKSQDNVLERRQRDADNKSQGNVLERRQRDVENKSQGNVL
ERRQHDVENKSQVGQLIGKNPLFSKSTVSRENNHSSQGDSNKQSFSKKVSQVTNVANRPMLTNNSRTISVIN
KLPKTGDDQNVIFKLVGFGLILLTSLCGLRRNEN

Strain COH1

ORF DNA sequence (SEQ ID NO: 76):

TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCA
ACTATTATTTTAGGATCAAGTCCTGTATCTGCTATGGATAGTGTTGGAAATCAAAGTCAAGGTAATGTTTTA
GAGCGTCGCCAACGTGATGCGGAAAACAAAAGTCAGGGTAATGTTTTAGAGCGTCGCCAACGTGATGCGGAA
AACAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGCAATGTTTTA
GAGCGTCGTCAACGTGATGCGGAAAACAAAAGTCAGGGCAATGTTCTAGAGCGCCGCCAACGTGATGCGGAT
AACAAGAGCCAAGTAGGTCAACTTATAGGGAAAAATCCACTTTTTTCAAAGCCAACTGTATCTAGAGAAAAT
AATCACTCTAGTCAAGGTGACTCTAACAAACAGTCATTCTCTAAAAAAGTATCTCAGGTTACTAATGTAGCT
AATAGACCGATGTTAACTAATAATTCTAGAACAATTTCAGTGATAAATAAATTACCTAAAACAGGTGGTGAT
CAAAATGTCATTTTTAAACTTGTAGGTTTTGGTTTAATTTTGTTAACAAGTCGCTGCGGTTTGAGACGCAAT
GAAAATTAA

ORF amino acid sequence (SEQ ID NO: 70):

LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSVGNQSQGNVLERRQRDAENKSQGNVLERRQRDAE
NKSQGNVLERRQRDVENKSQGNVLERRQRDAENKSQGNVLERRQRDADNKSQVGQLIGKNPLFSKPTVSREN
NHSSQGDSNKQSFSKKVSQVTNVANRPMLTNNSRTISVINKLPKTGGDQNVIFKLVGFGLILLTSRCGLRRN
EN

Strain IC105

ORF DNA sequence (SEQ ID NO: 77):

TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCa
actattattttaggatcaagtcctgtttctgCTATGGATAGTGATGGAAATCAAAGTCAGGGCAATGTTTTA
GAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGGCAATGTTCTAGAGCGTCGTCAACGCGATGCAGAA
AACAGAAGCCAAGGTAATGATCTAGAGCGTCGCCAACGTGACGTTGAGAACAAGAGCCAAGGTAACGTTCTA
GAGCGTCGTCAACGTGATGCAGATAACAAGAGCCAGGGCAATGTTTTAGAGCGTCGCCAACGTGATGTTGAG
AACAAGAGCCAAGGTAATGTTCTAGAGCGTCGCCAAAATAATGTCCTTATTAAGAGTCAAGATAATGATCTA
GAGCGCCGCCAACGTGATGCGGATAACAAGAGCCAGGGTAACGTTCTAGAGCGTCGCCAACGTGATGTTGAG
AACAAGAGCCAAGGTAATGTTCTAGAGCGCCGCCAACGTGATGCGGATAACAAGAGCCAGGGTAACGTTCTA
GAGTGTCGCCAACGTGATGTTGAGAACAAGAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCGGAA
AACAAGAGCCAAGGCAATGTTCTAGAGCGTCGTCAACGCGATGCAGAAAACAGAAGCCAAGGTAATGTTCTA
GAGCGTCGCCAACGTGACGTTGAGAACAAGAGCCAAGGTAACGTTCTAGAGCGTCGTCAACGTGATGCAGAT
AACAAGAGCCAGGGCAATGTTTTAGAGCGTCGCCAACGTGATGTTGAGAACAAGAGCCAAGGTAATGTTCTA
GAGCGTCGCCAAAATAATGTCCTTATTAAGAGTCAAGATAATGTTCTAGAGCGCCGCCAACGTGATGCGGAT
AACAAGAGCCAGGGTAACGTTCTAGAGCGTCGCCAACGTGATGTTGAGAACAAGAGCCAAGGCAATGTTTTA
GAGCGTCGTCAACGCGATGTTGAGAATAAGAGTCAAGTAGGTCAACTTATAGGGAAAAATCCACTTTTTTCA
AAGTCAACTGTATCTAGAGAAAATAATCACTCTAGTCAAGGTGACTCTAACAAACAGTCATTCTCTAAAAAA
GTATCTCAGGTTACTAATGTAGCTAATAGACCGATGTTAACTAATAATTCTAGAACAATTTCAGTGATAAAT

AAATTACCTAAAACAGGTGATGATCAAAATGTCATTTTTAAACTTGTAGGTTTTGGTTTAATTTTATTAACA
AGTCTCTGCGGTTTGAGACGCAATGAAAATTAA
ORF amino acid sequence (SEQ ID NO: 71):
LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSDGNQSQGNVLERRQRDAENKSQGNVLERRQRDAE
NRSQGNDLERRQRDVENKSQGNVLERRQRDADNKSQGNVLERRQRDVENKSQGNVLERRQNNVLIKSQDNDL
ERRQRDADNKSQGNVLERRQRDVENKSQGNVLERRQRDADNKSQGNVLECRQRDVENKSQGNVLERRQRDAE
NKSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDADNKSQGNVLERRQRDVENKSQGNVL
ERRQNNVLIKSQDNVLERRQRDADNKSQGNVLERRQRDVENKSQGNVLERRQRDVENKSQVGQLIGKNPLFS
KSTVSRENNHSSQGDSNKQSFSKKVSQVTNVANRPMLTNNSRTISVINKLPKTGDDQNVIFKLVGFGLILLT
SLCGLRRNEN

Strain IC458
ORF DNA sequence (SEQ ID NO: 78):
TTGTTCAATAAAATAGGTTTTAGAACTTGGAAATCAGGAAAGCTTTGGCTTTATATGGGAGTGCTAGGATCA
ACTATTATTTTAGGATCAAGTCCTGTATCTGCTATGGATAGTGTTGGAAATCAAAGTCAGGGCAATGTTTTA
GAGCGTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGTGATGCGGAA
AACAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTTTA
GAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGCGATGTTGAG
AATAAGAGCCAAGGTAATGTTCTAGAGCGTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGTAATGTTCTA
GAGCGTCGTCAACGTGATGCGGAAAACAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAA
AACAGAAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGGCAATGTTTTA
GAGCGTCGTCAACGCGATGTTGAGAATAAGAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAA
AACAGAAGCCAAGGCAATGTTTTAGAGCGTCGTCAACGTGATGCAGAAAACAGAAGCCAAGTAGGTCAACTT
ATAGGGAAAAATCCACTTCTTTCAAAGTCAATTATATCTAGAGAAAATAATCACTCTAGTCAAGGTGACTCT
AACAAACAGTCATTCTCTAAAAAAGTATCTCAGGTTACTAATGTAGCTAATAGACCGATGTTAACTAATAAT
TCTAGAACAATTTCAGTGATAAATAAATTACCTAAAACAGGTGATGATCAAAATGTCATTTTTAAACTTGTA
GGTTTTGGTTTAATTTTGTTAACAAGTCGCTGCGGTTTGAGACGCAATGAAAATTAA
ORF amino acid sequence (SEQ ID NO: 72):
LFNKIGFRTWKSGKLWLYMGVLGSTIILGSSPVSAMDSVGNQSQGNVLERRQRDVENKSQGNVLERRQRDAE
NKSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDVENKSQGNVL
ERRQRDAENKSQGNVLERRQRDAENRSQGNVLERRQRDAENRSQGNVLERRQRDVENKSQGNVLERRQRDAE
NRSQGNVLERRQRDAENRSQVGQLIGKNPLLSKSIISRENNHSSQGDSNKQSFSKKVSQVTNVANRPMLTNN
SRTISVINKLPKTGDDQNVIFKLVGFGLILLTSRCGLRRNEN

Table 9: Amino acid and encoding DNA sequences of gbs1309 proteins derived from different strains of *S. agalactiae*

Strain 0176H4A
ORF DNA sequence (SEQ ID NO: 85):
TTTAGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGT
CGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATAT
TCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATGATGCCTTATCGTCAAGTTTGCAAAGTAATA
GATAGCACTTTGCAAACAATCATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTA
AAAGAAAAAGAACGCTATCGTTTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTT
GAGGGTGATGGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTT
GTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCACGAAATATTACAG
CTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACT
ATTTTAATCACTAACTCTGATATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTT
AAGGTAAAGAAACATGAGCATTTTTGGGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAA
TATCCAATTGAATTAACCGATTTTACTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTT
TTTGATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTA
TTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAA
TCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACA
ATGGCAAATATGATTATATTTGAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTA
TACAGTGAGTATAAAGAAGGTTCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTT
TCTAAGCCCCTTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG
ORF amino acid sequence (SEQ ID NO: 79):

FSVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYRQVCKVI
DSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHF
VIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKAL
KVKKHEHFWDIYHVKEKLSSYLRKYPIELTDFTLDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKV
LNNFKYIKPAHLRNLSNRGIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIIFERANGLRELFFGSWRKV
YSEYKEGSFSAGRLFKKTDELDKFSKPLLKNGRKWSITGIKTK

Strain 12401

ORF DNA sequence (SEQ ID NO: 86):

TTTAGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGT
CGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATAT
TCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATGATGCCTTATtGTCAAGTTTGCAAAGTAATA
GATAGCACTTTGCAAACAATCATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTA
AAAGAAAAAGAACGCTATCGTTTTTATTTGGAAGAGCCACCCGAACgTAAAAAAGtGAAAAAACTGTATGTT
GaGGGTGATGGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTT
GTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCACGAAATATTACAG
CTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACT
ATTTTAATCACTAACTCTGATATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTT
AAGGTAAAGAAACATGAGCATTTTTGGGATATCTATCATGTtAAAGAAAAGTTAAGTTCATACCTTAGAAAA
TATCCAATTGAATTAACCGATTTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTT
TTTGATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTA
TTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAA
TCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACA
ATGGCAAATATGATTATATTTGAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTA
TACAGTGAGTATAAAGAAGGTTCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTATATAAATTT
TCTAAGCCCCTTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG

ORF amino acid sequence (SEQ ID NO: 80):

FSVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYCQVCKVI
DSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHF
VIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKAL
KVKKHEHFWDIYHVKEKLSSYLRKYPIELTDFALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKV
LNNFKYIKPAHLRNLSNRGIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIIFERANGLRELFFGSWRKV
YSEYKEGSFSAGRLFKKTDELYKFSKPLLKNGRKWSITGIKTK

Strain BAA23

ORF DNA sequence (SEQ ID NO: 87):

TTTAGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGT
CGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATAT
TCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATGATGCCTTATCGTCAAGTTTGCAAAGTAATA
GATAGCACTTTGCAAACAATCATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTA
AAAGAAAAAGAACGCTATCGTTTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTT
GAGGGTGATGGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTT
GTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCACGAAATATTACAG
CTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACT
ATTTTAATCACTAACTCTGATATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTT
AAGGTAAAGAAACATGAGCATTTTTGGGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAA
TATCCAATTGAATTAACCGATTTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTT
TTTGATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTA
TTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAA
TCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACA
ATGGCAAATATGATTATACTTGAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTA
TACAGTGAGTATAAAGAAGGTTCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTT
TCTAAGCCCCTTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG

ORF amino acid sequence (SEQ ID NO: 81):

FSVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYRQVCKVI
DSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHF
VIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKAL
KVKKHEHFWDIYHVKEKLSSYLRKYPIELTDFALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKV
LNNFKYIKPAHLRNLSNRGIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIILERANGLRELFFGSWRKV
YSEYKEGSFSAGRLFKKTDELDKFSKPLLKNGRKWSITGIKTK

Strain COH1

ORF DNA sequence (SEQ ID NO: 88):

ATGGAAGTTAAAAAATTCTCGGAAAAAGATTTTGTAAATGAAATAAATAAAATAAAACAGAAACAATTTTTA
AGTCAAATTGAACAGTATGAAAGCTATATCGCTCCTCAAATGAGAACGAAAGGCTATAAGAGGATCAATCAG
TCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGTCGCTGGACAAATGGCTTTGAA
ACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATATTCAATAGAATTCTTATATCAT
GTTGCAAAATTGGCTACAATGATGCCTTATCGTCAAGTTTGCAAAGTAATAGATAGCACTTTGCAAACAATC
ATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTAAAAGAAAAAGAACGCTATCGT
TTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTTGAGGGTGATGGAGTCATGATT
AAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTTGTTATTCATACAGGCTCAAAA
AAAGTTTCTACTAAAAGATATGAATTGCGGGACAAGCACGAAATATTACAGCTTAATTATGATAAAGCTAAA
TATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACTATTTTAATCACTAACTCTGAT
ATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTTAAGGTAAAGAAACATGAGCAT
TTTTGGGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAATATCCAATTGAATTAACCGAT
TTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTTTTTGATACTGTTGAATCACTG
ATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTATTAAATAATTTCAAATATATA
AAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAATCACAACACAGAAAGATAACG
TATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACAATGGCAAATATGATTATACTT
GAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTATACAGTGAGTATAAAGAAGGT
TCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTTTCTAAGCCCCTTCTAAAAAAT
GGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG

ORF amino acid sequence (SEQ ID NO: 82):

MEVKKFSEKDFVNEINKIKQKQFLSQIEQYESYIAPQMRTKGYKRINQSERTVVFSFGEITFSRSRWTNGFE
TRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYRQVCKVIDSTLQTIITKDCVLKAVKFVEKLLKEKERYR
FYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHFVIHTGSKKVSTKRYELRDKHEILQLNYDKAK
YNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKALKVKKHEHFWDIYHVKEKLSSYLRKYPIELTD
FALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKVLNNFKYIKPAHLRNLSNRGIGIMESQHRKIT
YRMKRRGMYWSKWGISTMANMIILERANGLRELFFGSWRKVYSEYKEGSFSAGRLFKKTDELDKFSKPLLKN
GRKWSITGIKTK

Strain IC105

ORF DNA sequence (SEQ ID NO: 89):

TTTAGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGT
CGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATAT
TCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATGATGCCTTATCGTCAAGTTTGCAAAGTAATA
GATAGCACTTTGCAAACAATCATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTA
AAAGAAAAAGAACGCTATCGTTTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTT
GAGGGTGATGGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTT
GTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCACGAAATATTACAG
CTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACT
ATTTTAATCACTAACTCTGATATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTT
AAGGTAAAGAAACATGAGCATTTTTGGGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAA
TATCCAATTGAATTAACCGATTTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTT
TTTGATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTA
TTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAA
TCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACA
ATGGCAAATATGATTATACTTGAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTA
TACAGTGAGTATAAAGAAGGTTCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTT
TCTAAGCCCCTTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG

ORF amino acid sequence (SEQ ID NO: 83):

FSVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYRQVCKVI
DSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHF
VIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKAL
KVKKHEHFWDIYHVKEKLSSYLRKYPIELTDFALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKV
LNNFKYIKPAHLRNLSNRGIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIILERANGLRELFFGSWRKV
YSEYKEGSFSAGRLFKKTDELDKFSKPLLKNGRKWSITGIKTK

Strain IC458

ORF DNA sequence (SEQ ID NO: 90):

TTTAGTGTAACCTATTCACAGTCTGAACGTACGGTTGTTTTCTCTTTTGGAGAAATAACATTTAGTAGGAGT
CGCTGGACAAATGGCTTTGAAACTAGAATACCAGTAGATGAGTGGTTAGGTCTTGAAAAATATAAGAGATAT
TCAATAGAATTCTTATATCATGTTGCAAAATTGGCTACAATGATGCCTTATCGTCAAGTTTGCAAAGTAATA
GATAGCACTTTGCAAACAATCATAACAAAAGACTGTGTTTTAAAAGCAGTAAAATTTGTAGAAAAATTGTTA
AAAGAAAAAGAACGCTATCGTTTTTATTTGGAAGAGCCACCCGAACGTAAAAAAGTGAAAAAACTGTATGTT
GAGGGTGATGGAGTCATGATTAAAAGCACAGATTCTAGAGAGGAAAGAAGGTATTTAGATTTAACACATTTT
GTTATTCATACAGGCTCAAAAAAAGTTTCTACTAAAAGATATGAATTGCAGGACAAGCACGAAATATTACAG
CTTAATTATGATAAAGCTAAATATAATCTTTTAGATTATATTTATAATAACTATGAAGTAGATGACGATACT
ATTTTAATCACTAACTCTGATATGGGTAAAGGCTATACTAGTAGAGTTTTTAAGGAATTAGGAAAAGCACTT
AAGGTAAAGAAACATGAGCATTTTTGGGATATCTATCATGTTAAAGAAAAGTTAAGTTCATACCTTAGAAAA
TATCCAATTGAATTAACCGATTTTGCTTTAGATGCGGTAAAAAAATATAATTCTGATAAGCTTGAATTAGTT
TTTGATACTGTTGAATCACTGATTTGTGATGAACTTGAAGATCAAGAATTTCAGAAGTTTAAGAAAAAAGTA
TTAAATAATTTCAAATATATAAAACCAGCTCATCTTAGAAATCTTTCAAATCGTGGTATTGGTATCATGGAA
TCACAACACAGAAAGATAACGTATAGAATGAAGCGACGTGGCATGTATTGGTCAAAGTGGGGAATCTCCACA
ATGGCAAATATGATTATACTTGAAAGAGCTAACGGTTTACGAGAATTATTTTTCGGTTCTTGGAGAAAGGTA
TACAGTGAGTATAAAGAAGGTTCATTTAGTGCAGGGCGACTTTTTAAAAAGACAGATGAATTAGATAAATTT
TCTAAGCCCCTTCTAAAAAATGGCAGAAAATGGAGTATAACAGGAATCAAAACAAAATAG

ORF amino acid sequence (SEQ ID NO: 84):

FSVTYSQSERTVVFSFGEITFSRSRWTNGFETRIPVDEWLGLEKYKRYSIEFLYHVAKLATMMPYRQVCKVI
DSTLQTIITKDCVLKAVKFVEKLLKEKERYRFYLEEPPERKKVKKLYVEGDGVMIKSTDSREERRYLDLTHF
VIHTGSKKVSTKRYELQDKHEILQLNYDKAKYNLLDYIYNNYEVDDDTILITNSDMGKGYTSRVFKELGKAL
KVKKHEHFWDIYHVKEKLSSYLRKYPIELTDFALDAVKKYNSDKLELVFDTVESLICDELEDQEFQKFKKKV
LNNFKYIKPAHLRNLSNRGIGIMESQHRKITYRMKRRGMYWSKWGISTMANMIILERANGLRELFFGSWRKV
YSEYKEGSFSAGRLFKKTDELDKFSKPLLKNGRKWSITGIKTK

Table 10: Amino acid and encoding DNA sequences of gbs1477 proteins derived from different strains of *S. agalactiae*

Strain 0176H4A

ORF DNA sequence (SEQ ID NO: 133):

ATGAAAAAAATCAACAAATTTTTTGTGGCGTTCTCAGCGTTGTTACTGATTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGAAAAAGAAAAAACAACTGAGACTGTTACTTTGCATAAAATTTTACAAACTGATACA
AACCTTAAGAATAGTGCTTTCCCTGGTACAAAAGGGCTAGATGGAACTGAATATGACGGGAAAGCTATTGAT
AAATTGGATAGCTACTTTGGCAATGACTCAAAAGATATTGGTGGGGCTTACTTTATATTGGCAAATAGCAAG
GGTGAATATATCAAAGCTAATGATAAAAATAAATTAAAGCCTGAGTTTAGTGGGAACACTCCGAAAACGACC
CTCAATATTAGTGAAGCTGTAGGTGGTTTGACAGAAGAAAACGCAGGTATTAAGTTTGAAACCACTGGTTTA
AGAGGGGATTTCCAGATTATTGAATTGAAAGACAAGTCAACTTACAATAATGGTGGGGCCATCTTGGCTGAT
TCAAAAGCGGTTCCAGTGAAAATCACTCTTCCATTGATAAACAAGGATGGTGTTGTTAAAGATGCACACGTC
TATCCAAAGAACACTGAAACAAAACCGCAAATTGACAAGAACTTTGCTGATAAAAATCTTGATTATATTAAC
AACCAAAAAGACAAAGGTACTATATCAGCAACTGTTGGTGATGTTAAAAAATATACTGTTGGGACAAAAATC
CTTAAAGGATCTGACTATAAAAAATTAGTTTGGACCGATAGCATGACGAAAGGATTGACGTTTAACAACGAT
GTTACTGTAACATTGGATGGTGCAAATTTTGAACAATCAAATTACACCTTAGTAGCTGATGACCAAGGTTTC
CGTCTTGTCTTGAATGCAACAGGTCTTTCTAAAGTAGCAGAAGCTGCAAAAACAAAAGATGTTGAAATCAAA
ATCAACTATTCAGCTACAGTAAACGGTTCTACTGTCGTTGAAAAGTCAGAAAATAATGATGTCAAACTAGAT
TATGGTAACAACCCAACAACTGAAAACGAACCACAAACTGGTAATCCAGTTAACAAAGAAATCACAGTTCGA
AAGACTTGGGCAGTGGATGGTAATGAAGTGAATAAGGGAGATGAAAAAGTTGACGCTGTCTTCACGTTGCAA
GTTAAAGATAGTGACAAATGGGTGAATGTCGATTCAGCAACAGCAACAGCAGCAACTGACTTCAAATACACT
TTCAAAAACTTGGATAATGCCAAAACTTACCGTGTTGTAGAACGTGTTAGCGGCTACGCTCCAGCCTACGTT
TCATTTGTGGGTGGAGTTGTGACTATTAAGAATAACAAAAACTCAAATGACCCAACTCCAATCAATCCATCA
GAACCAAAAGTTGTGACTTATGGACGTAAATTTGTGAAAACAAATCAAGATGGCTCTGAACGTCTAGCAGGA
GCTACTTTCCTTGTTAAGAACTCACAAAGTCAATACTTGGCACGTAAATCAGGTGTTGCAACTAATGAAGCT
CACAAAGCAGTAACAGATGCTAAAGTACAACTGGATGAAGCTGTTAAAGCTTATAACAAATTGACTAAAGAA
CAACAAGAAAGTCAAGATGGTAAAGCAGCATTGAATCTTATTGATGAAAAACAAACAGCTTACAATGAAGCT
TTTGCTAAAGCAAACTACTCATATGAATGGGTTGTAGATAAAAACGCTGCAAACGTTGTTAAATTGATTTCT
AATACAGCTGGTAAATTTGAAATTACAGGTTTGAATGCAGGCGAGTATAGTTTGGAAGAGACTCAAGCACCA
ACAGGTTATGCTAAATTGTCAAGTGATGTATCATTTAAAGTAAATGATACATCGTATAGCGAAGGGGCTTCA
AATGATATTGCATACGATAAAGACTCCGGTAAAACAGATGCACAAAAAGTTGTCAACAAAAAAGTAACAATC

CCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCGGTAGTT
ATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 91):

MKKINKFFVAFSALLLILTSLLSVAPAFAEKEKTTETVTLHKILQTDTNLKNSAFPGTKGLDGTEYDGKAID
KLDSYFGNDSKDIGGAYFILANSKGEYIKANDKNKLKPEFSGNTPKTTLNISEAVGGLTEENAGIKFETTGL
RGDFQIIELKDKSTYNNGGAILADSKAVPVKITLPLINKDGVVKDAHVYPKNTETKPQIDKNFADKNLDYIN
NQKDKGTISATVGDVKKYTVGTKILKGSDYKKLVWTDSMTKGLTFNNDVTVTLDGANFEQSNYTLVADDQGF
RLVLNATGLSKVAEAAKTKDVEIKINYSATVNGSTVVEKSENNDVKLDYGNNPTTENEPQTGNPVNKEITVR
KTWAVDGNEVNKGDEKVDAVFTLQVKDSDKWVNVDSATATAATDFKYTFKNLDNAKTYRVVERVSGYAPAYV
SFVGGVVTIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQDGSERLAGATFLVKNSQSQYLARKSGVATNEA
HKAVTDAKVQLDEAVKAYNKLTKEQQESQDGKAALNLIDEKQTAYNEAFAKANYSYEWVVDKNAANVVKLIS
NTAGKFEITGLNAGEYSLEETQAPTGYAKLSSDVSFKVNDTSYSEGASNDIAYDKDSGKTDAQKVVNKKVTI
PQTGGIGTILFTIIGLSIMLGAVVIMKRRQSEEA

Strain 12351

ORF DNA sequence (SEQ ID NO: 134):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCATTGCTACTGACCGTAACATCATTGTTCTCAGTT
GCACCAGTGTTTGCGGAAGAAGCAAAAACTACTGACACAGTGACCTTGCACAAGATTGTCATGCCTCGAACT
GCATTTGACGGTTTTACTGCTGGTACAAAGGGTAAGGATAATACTGACTACGTTGGTAAACAAATCGAAGAC
CTTAAAACTTACTTTGGCTCAGGCGAAGCGAAAGAAATCGCAGGTGCTTACTTTGCTTTCAAAAATGAAGCT
GGTACTAAATACATCACTGAAAATGGTGAAGAAGTTGATACTTTGGATACAACAGATGCCAAAGGTGGTGCT
GTTCTTAAAGGTTTAACAACAGACAATGGTTTCAAATTTAACACTTCTAAATTAACAGGAACTTACCAAATC
GTTGAATTGAAAGAAAAATCTACATACAACAACGATGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTT
AAAATCACTCTTCCATTGGTAAACGACAATGGTGTTGTTAAAGACGCTCACGTTTATCCAAAGAACACTGAA
ACAAAACCACAAGTAGATAAGAACTTCGCAGATAAAGAACTTGATTATGCGAACAACAAAAAAGACAAAGGG
ACTGTCTCAGCATCTGTTGGTGATGTTAAAAAATATCATGTTGGAACAAAAATCCTTAAAGGTTCAGACTAT
AAGAAATTAATCTGGACCGATAGCATGACCAAAGGTTTGACTTTCAACAACGATATTGCTGTAACATTGGAT
GGTGCAACTCTTGATGCTACAAATTACAAACTTGTAGCAGATGACCAAGGTTTCCGCCTTGTCTTGACTGAC
AAAGGTCTTGAAGCAGTGGCAAAAGCCGCAAAAACAAAAGATGTTGAAATCAAGATCACTTACTCAGCTACT
TTGAACGGTTCTGCTGTCGTTGAAGTTCTAGAAACCAATGATGTTAAATTGGACTACGGCAACAACCCAACA
ATTGAAAATGAACCAAAAGAAGGTATTCCAGTTGATAAGAAAATCACTGTTAACAAAACATGGGCAGTAGAT
GGCAATGAAGTGAATAAAGCAGATGAAACAGTTGATGCTGTCTTCACCTTGCAAGTTAAAGATGGTGACAAA
TGGGTGAATGTTGATTCAGCTAAAGCAACAGCTGCAACTAGCTTCAAACACACTTTTGAAAACTTGGATAAT
GCTAAAACTTACCGCGTTATCGAACGTGTTAGCGGCTACGCTCCAGAATACGTCTCATTTGTAAATGGCGTT
GTAACCATCAAGAACAACAAAGACTCAAATGAGCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACT
TATGGACGTAAATTTGTGAAAACAAATAAAGATGGAAAAGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAG
AAAGATGGCAAGTACTTGGCACGTAAATCAGGTGTTGCAACAGATGCAGAAAAAGCTGCTGTAGATTCAACT
AAATCAGCATTGGATGCTGCTGTTAAAGCTTACAATGATTTGACTAAAGAAAAACAAGAAGGTCAAGATGGT
AAATCAGCATTGGCTACCGTTAGTGAAAAACAAAAAGCTTACATTGATGCCTTTGTTAAAGCTAACTACTCA
TACGAATGGGTTGAAGATAAAAATGCTAAGAATGTTGTTAAATTGATTTCTAACGATAAAGGTCAATTTGAA
ATTACTGGCTTGACTGAAGGTCAATACTCATTGGAAGAAACACAAGCACCAACTGGTTATGCTAAATTATCA
GGTGATGTTTCGTTTAATGTTAATGCTACTTCATACAGTAAAGGTTCTGCTCAAGATATTGAGTATACCCAA
GGTTCTAAAACTAAAGATGCACAACAAGTTATCAATAAGAAGGTTACTATTCCACAAACAGGTGGTATTGGT
ACAATTTTTTTCACAATTATTGGATTAAGTATTATGCTTGGAGCGGTAGTTATCATGAAAAGACGTCAATCA
GAGGAAGTTTAA

ORF amino acid sequence (SEQ ID NO: 92):

MKKINKYFAVFSALLLTVTSLFSVAPVFAEEAKTTDTVTLHKIVMPRTAFDGFTAGTKGKDNTDYVGKQIED
LKTYFGSGEAKEIAGAYFAFKNEAGTKYITENGEEVDTLDTTDAKGGAVLKGLTTDNGFKFNTSKLTGTYQI
VELKEKSTYNNDGSILADSKAVPVKITLPLVNDNGVVKDAHVYPKNTETKPQVDKNFADKELDYANNKKDKG
TVSASVGDVKKYHVGTKILKGSDYKKLIWTDSMTKGLTFNNDIAVTLDGATLDATNYKLVADDQGFRLVLTD
KGLEAVAKAAKTKDVEIKITYSATLNGSAVVEVLETNDVKLDYGNNPTIENEPKEGIPVDKKITVNKTWAVD
GNEVNKADETVDAVFTLQVKDGDKWVNVDSAKATAATSFKHTFENLDNAKTYRVIERVSGYAPEYVSFVNGV
VTIKNNKDSNEPTPINPSEPKVVTYGRKFVKTNKDGKERLAGATFLVKKDGKYLARKSGVATDAEKAAVDST
KSALDAAVKAYNDLTKEKQEGQDGKSALATVSEKQKAYIDAFVKANYSYEWVEDKNAKNVVKLISNDKGQFE
ITGLTEGQYSLEETQAPTGYAKLSGDVSFNVNATSYSKGSAQDIEYTQGSKTKDAQQVINKKVTIPQTGGIG
TIFFTIIGLSIMLGAVVIMKRRQSEEV

Strain 12401

ORF DNA sequence (SEQ ID NO: 135):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTATTAATTTTAACATCGTTGTTATCGGTA
GCTCCGGTATTTGCTGCTGAGATGGGAAATATCACTAAAACAGTAACCTTACACAAAATTGTTCAAACATCC
GATAATTTGGCTAAGCCAAATTTCCCAGGAATAAATGGATTGAATGGAACGAAGTATATGGGTCAAAAACTT
ACTGACATTTCAGGATATTTTGGGCAAGGTTCTAAAGAAATCGCCGGTGCTTTCTTTGCGGTTATGAATGAA
AGTCAGACAAAATATATCACAGAAAGTGGTACTGAAGTAGAAAGTATCGATGCAGCAGGTGTCCTTAAAGGT
TTGACAACTGAAAACGGCATTACATTTAATACTGCAAACTTAAAAGGAACATACCAAATCGTTGAGTTGCTT
GACAAATCTAATTATAAAAATGGTGACAAAGTTCTTGCTGACTCAAAAGCTGTCCCAGTGAAAATCACTCTT
CCTTTGTATAACGAAGAAGGAATTGTCGTGGACGCTGAAGTGTATCCAAAGAATACAGAAGAAGCACCACAA
ATCGACAAAAACTTTGCTAAAGCAAATAAATTGTTGAATGACAGTGATAATTCAGCTATTGCAGGTGGGGCA
GACTACGACAAATATCAGGCAGAAAAAGCAAAAGCTACTGCTGAAATCGGTCAAGAAATCCCTTACGAAGTT
AAAACAAAAATCCAAAAAGGGTCTAAATACAAAAACCTTGCTTGGGTCGATACCATGTCAAATGGTTTGACA
ATGGGTAACACTGTTAACTTAGAAGCATCGTCAGGCTCTTTTGTAGAAGGTACAGATTACAATGTTGAACGT
GATGACCGTGGTTTCACTTTGAAATTCACAGATACAGGTTTGACTAAGCTACAAAAAGAAGCGGAAACACAA
GCTGTTGAATTCACATTGACATATAGCGCAACAGTTAACGGTGCGGCTATTGATGACAAGCCAGAAAGCAAT
GATATCAAACTTCAATACGGTAACAAACCAGGTAAAAAAGTAAAAGAAATCCCAGTAACACCGTCAAATGGC
GAAATCACTGTTAGCAAAACTTGGGACAAAGGTTCAGATTTAGAGAATGCGAATGTTGTTTATACCCTTAAA
GATGGTGGAACAGCTGTTGCCTCAGTTTCATTGACAAAAACAACACCAAATGGCGAAATCAACTTAGGTAAT
GGTATTAAATTTACAGTTACTGGAGCGTTTGCTGGTAAATTCAGTGGTCTGACTGATAGTAAAACATACATG
ATCTCAGAACGTATCGCTGGTTATGGTAATACAATCACTACTGGTGCTGGTAGTGCAGCTATCACCAATACT
CCAGATTCAGACAACCCAACACCACTTAATCCAACTGAACCAAAAGTTGTGACACACGGTAAAAAATTCGTC
AAAACAAGTTCGACTGAAACAGAACGCTTGCAAGGTGCACAGTTCGTTGTTAAAGATTCAGCTGGTAAATAC
CTTGCATTGAAATCATCTGCGACAATATCAGCTCAAACAACAGCTTACACAAATGCTAAAACTGCTCTTGAC
GCTAAAATCGCAGCTTACAACAAACTTTCAGCAGACGATCAAAAAGGTACTAAAGGTGAAACAGCTAAAGCA
GAAATCAAAACTGCTCAAGACGCTTACAATGCAGCCTTCATCGTAGCTCGTACAGCTTACGAGTGGGTAACT
AATAAAGAAGATGCTAACGTTGTTAAAGTGACTTCAAACGCTGACGGTCAATTTGAAGTTAGCGGTCTTGCA
ACTGGTGATTATAAACTTGAAGAAACACAAGCTCCAGCTGGTTACGCTAAATTAGCAGGTGATGTTGATTTC
AAAGTTGGAAACAGCTCAAAAGCAGACGACTCAGGTAACATTGATTACACTGCTAGCAGCAATAAAAAAGAC
GCTCAACGCATAGAAAACAAAAAAGTGACTATTCCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATT
ATTGGTTTAAGCATTATGCTTGGAGCGGTAATTATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 93):

MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDNLAKPNFPGINGLNGTKYMGQKL
TDISGYFGQGSKEIAGAFFAVMNESQTKYITESGTEVESIDAAGVLKGLTTENGITFNTANLKGTYQIVELL
DKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDAEVYPKNTEEAPQIDKNFAKANKLLNDSDNSAIAGGA
DYDKYQAEKAKATAEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASSGSFVEGTDYNVER
DDRGFTLKFTDTGLTKLQKEAETQAVEFTLTYSATVNGAAIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNG
EITVSKTWDKGSDLENANVVYTLKDGGTAVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLTDSKTYM
ISERIAGYGNTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTHGKKFVKTSSTETERLQGAQFVVKDSAGKY
LALKSSATISAQTTAYTNAKTALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWVT
NKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFKVGNSSKADDSGNIDYTASSNKKD
AQRIENKKVTIPQTGGIGTILFTIIGLSIMLGAVIIMKRRQSEEA

Strain 126H4A

ORF DNA sequence (SEQ ID NO: 136):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCCTTGCTACTGACCGTAACATCATTGCTCTCAGTT
GCACCAGCGTTTGCGGACGAAGCAACAACTAATACAGTGACTTTGCACAAGATCTTGCAAACTGAATCAAAT
CTTAATAAAAGTAACTTCCCAGGAACTACAGGCCTTAACGGAGATGACTATAAAGGTGAATCTATTTCTGAC
CTTGCTGAATACTTTGGATCAGGTTCTAAAGAAATTGACGGTGCTTTCTTTGCTTTGGCTTTAGAAGAGGAA
AAAGATGGTGTCGTACAATATGTTAAGGCAAAAGCAAATGACAAATTAACACCAGACTTAATTACTAAAGGT
ACACCTGCAACAACAACAAAAGTTGAAGAAGCTGTAGGTGGTTTGACAACTGGTACGGGTATTGTTTTCAAT
ACAGCTGGTTTGAAAGGTAATTTCAAAATTATTGAATTGAAAGACAAATCAACTTACAACAATAATGGTTCC
CTCTTAGCAGCTTCAAAAGCAGTTCCGGTGAAAATCACTCTTCCATTGGTAAGCAAAGATGGTGTTGTTAAA
GATGCACACGTTTATCCAAAGAACACTGAAACAAAACCAGAAGTAGACAAGAACTTCGCTAAAACAAACGAT
TTGACAGCTCTCAAAGACGCTACTCTTCTTAAGGCTGGTGCAGACTACAAAAACTATTCAGCGACTAAAGCT
ACTGTAACAGCTGAAATCGGTAAAGTTATCCCTTACGAAGTTAAAACAAAAGTTCTTAAAGGTTCTAAATAC
GAAAAACTGGTTTGGACCGATACCATGTCAAATGGTTTGACAATGGGTGATGATGTTAACCTTGCAGTTTCA
GGGACTACAACAACTTTCATTAAAGATATAGATTACACTCTTAGCATTGATGACCGTGGTTTCACATTGAAA
TTCAAAGCTACTGGATTGGACAAATTGGAAGAAGCAGCTAAAGCATCTGATGTTGAATTTACATTGACTTAT
AAAGCTACTGTTAATGGCCAAGCAATTATTGACAACCCAGAAGTCAATGACATCAAATTGGACTATGGTAAT
AAACCTGGTACAGATTTATCAGAACAACCTGTGACACCTGAAGATGGTGAAGTTAAAGTCACTAAAACATGG
GCAGCAGGTGCTAATAAAGCAGACGCTAAAGTTGTCTACACACTTAAAAATGCTACTAAACAAGTCGTAGCT

TCTGTCGCATTGACCGCAGCTGATACAAAAGGTACGATTAATCTTGGTAAAGGCATGACCTTTGAAATCACA
GGAGCTTTCTCAGGTACATTCAAAGGCCTTCAAAATAAAGCTTACACTGTTTCTGAACGTGTTGCAGGTTAT
ACTAATGCTATTAATGTTACTGGTAATGCTGTTGCTATCACCAATACACCAGACAGTGACAATCCAACGCCA
CTTAACCCAACTCAACCAAAAGTTGAAACACATGGTAAGAAATTTGTCAAAGTTGGCGATGCAGATGCCCGC
TTAGCTGGTGCACAATTCGTTGTGAAAAATTCAGCTGGTAAATTCCTTGCTCTTAAAGAAGATGCAGCTGTA
TCAGGAGCTCAAACTGAATTGGCAACTGCTAAAACAGACTTGGATAATGCCATCAAAGCTTACAACGGTTTG
ACAAAAGCGCAGCAAGAAGGTGCTGATGGTACATCAGCAAAAGAACTTATCAACACTAAACAGTCAGCTTAC
GACGCAGCCTTCATCAAAGCACGTACAGCTTATATATGGGTAGATGAAAAAACTAAAGCTATTACCTTCACT
TCAAATAATCAAGGTCAATTTGAAGTTACTGGTCTTGAAGTAGGTTCTTACAAACTTGAAGAAACTCTTGCA
CCAGCAGGTTATGCTAAATTGTCAGGCGACATTGAGTTTACAGTTGGACACGATTCTTACACAAGTGGTGAC
ATCAAGTACAAGACAGATGATGCTAGCAACAATGCACAAAAAGTTTTCAATAAAAAAGTAACCATCCCACAA
ACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCGGTAGTTATCATG
AAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 94):

MKKINKYFAVFSALLLTVTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGDDYKGESISD
LAEYFGSGSKEIDGAFFALALEEEKDGVVQYVKAKANDKLTPDLITKGTPATTTKVEEAVGGLTTGTGIVFN
TAGLKGNFKIIELKDKSTYNNNGSLLAASKAVPVKITLPLVSKDGVVKDAHVYPKNTETKPEVDKNFAKTND
LTALKDATLLKAGADYKNYSATKATVTAEIGKVIPYEVKTKVLKGSKYEKLVWTDTMSNGLTMGDDVNLAVS
GTTTTFIKDIDYTLSIDDRGFTLKFKATGLDKLEEAAKASDVEFTLTYKATVNGQAIIDNPEVNDIKLDYGN
KPGTDLSEQPVTPEDGEVKVTKTWAAGANKADAKVVYTLKNATKQVVASVALTAADTKGTINLGKGMTFEIT
GAFSGTFKGLQNKAYTVSERVAGYTNAINVTGNAVAITNTPDSDNPTPLNPTQPKVETHGKKFVKVGDADAR
LAGAQFVVKNSAGKFLALKEDAAVSGAQTELATAKTDLDNAIKAYNGLTKAQQEGADGTSAKELINTKQSAY
DAAFIKARTAYIWVDEKTKAITFTSNNQGQFEVTGLEVGSYKLEETLAPAGYAKLSGDIEFTVGHDSYTSGD
IKYKTDDASNNAQKVFNKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSEEA

Strain 49447

ORF DNA sequence (SEQ ID NO: 137):

ATGAAAAAAATCAACAAATTTTTTGTGGCGTTCTCAGCGTTGTTACTGATTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGAAAAAGAAAAAACAACTGAGACTGTTACTTTGCATAAAATTTTACAAACTGATACA
AACCTTAAGAATAGTGCTTTCCCTGGTACAAAAGGGCTAGATGGAACTGAATATGACGGGAAAGCTATTGAT
AAATTGGATAGCTACTTTGGCAATGACTCAAAAGATATTGGTGGGGCTTACTTTATATTGGCAAATAGCAAG
GGTGAATATATCAAAGCTAATGATAAAAATAAATTAAAGCCTGAGTTTAGTGGGAACACTCCGAAAACGACC
CTCAATATTAGTGAAGCTGTAGGTGGTTTGACAGAAGAAAACGCAGGTATTAAGTTTGAAACCACTGGTTTA
AGAGGGGATTTCCAGATTATTGAATTGAAAGACAAGTCAACTTACAATAATGGTGGGGCCATCTTGGCTGAT
TCAAAAGCGGTTCCAGTGAAAATCACTCTTCCATTGATAAACAAGGATGGTGTTGTTAAAGATGCACACGTC
TATCCAAAGAACACTGAAACAAAACCGCAAATTGACAAGAACTTTGCTGATAAAAATCTTGATTATATTAAC
AACCAAAAAGACAAAGGTACTATATCAGCAACTGTTGGTGATGTTAAAAAATATACTGTTGGGACAAAAATC
CTTAAAGGATCTGACTATAAAAAATTAGTTTGGACCGATAGCATGACGAAAGGATTGACGTTTAACAACGAT
GTTACTGTAACATTGGATGGTGCAAATTTTGAACAATCAAATTACACCTTAGTAGCTGATGACCAAGGTTTC
CGTCTTGTCTTGAATGCAACAGGTCTTTCTAAAGTAGCAGAAGCTGCAAAAACAAAAGATGTTGAAATCAAA
ATCAACTATTCAGCTACAGTAAACGGTTCTACTGTCGTTGAAAAGTCAGAAAATAATGATGTCAAACTAGAT
TATGGTAACAACCCAACAACTGAAAACGAACCACAAACTGGTAATCCAGTTAACAAAGAAATCACAGTTCGA
AAGACTTGGGCAGTGGATGGTAATGAAGTGAATAAGGGAGATGAAAAAGTTGACGCTGTCTTCACGTTGCAA
GTTAAAGATAGTGACAAATGGGTGAATGTCGATTCAGCAACAGCAACAGCAGCAACTGACTTCAAATACACT
TTCAAAAACTTGGATAATGCCAAAACTTACCGTGTTGTAGAACGTGTTAGCGGCTACGCTCCAGCCTACGTT
TCATTTGTGGGTGGAGTTGTGACTATTAAGAATAACAAAAACTCAAATGACCCAACTCCAATCAATCCATCA
GAACCAAAAGTTGTGACTTATGGACGTAAATTTGTGAAAACAAATCAAGATGGCTCTGAACGTCTAGCAGGA
GCTACTTTCCTTGTTAAGAACTCACAAAGTCAATACTTGGCACGTAAATCAGGTGTTGCAACTAATGAAGCT
CACAAAGCAGTAACAGATGCTAAAGTACAACTGGATGAAGCTGTTAAAGCTTATAACAAATTGACTAAAGAA
CAACAAGAAAGTCAAGATGGTAAAGCAGCATTGAATCTTATTGATGAAAAACAAACAGCTTACAATGAAGCT
TTTGCTAAAGCAAACTACTCATATGAATGGGTTGTAGATAAAAACGCTGCAAACGTTGTTAAATTGATTTCT
AATACAGCTGGTAAATTTGAAATTACAGGTTTGAATGCAGGCGAGTATAGTTTGGAAGAGACTCAAGCACCA
ACAGGTTATGCTAAATTGTCAAGTGATGTATCATTTAAAGTAAATGATACATCGTATAGCGAAGGGGCTTCA
AATGATATTGCATACGATAAAGACTCCGGTAAAACAGATGCACAAAAAGTTGTCAACAAAAAAGTAACAATC
CCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCGGTAGTT
ATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 95):

MKKINKFFVAFSALLLILTSLLSVAPAFAEKEKTTETVTLHKILQTDTNLKNSAFPGTKGLDGTEYDGKAID
KLDSYFGNDSKDIGGAYFILANSKGEYIKANDKNKLKPEFSGNTPKTTLNISEAVGGLTEENAGIKFETTGL
RGDFQIIELKDKSTYNNGGAILADSKAVPVKITLPLINKDGVVKDAHVYPKNTETKPQIDKNFADKNLDYIN

NQKDKGTISATVGDVKKYTVGTKILKGSDYKKLVWTDSMTKGLTFNNDVTVTLDGANFEQSNYTLVADDQGF
RLVLNATGLSKVAEAAKTKDVEIKINYSATVNGSTVVEKSENNDVKLDYGNNPTTENEPQTGNPVNKEITVR
KTWAVDGNEVNKGDEKVDAVFTLQVKDSDKWVNVDSATATAATDFKYTFKNLDNAKTYRVVERVSGYAPAYV
SFVGGVVTIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQDGSERLAGATFLVKNSQSQYLARKSGVATNEA
HKAVTDAKVQLDEAVKAYNKLTKEQQESQDGKAALNLIDEKQTAYNEAFAKANYSYEWVVDKNAANVVKLIS
NTAGKFEITGLNAGEYSLEETQAPTGYAKLSSDVSFKVNDTSYSEGASNDIAYDKDSGKTDAQKVVNKKVTI
PQTGGIGTILFTIIGLSIMLGAVVIMKRRQSEEA

Strain 5095S2

ORF DNA sequence (SEQ ID NO: 138):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTATTAATTTTAACATCGTTGTTATCGGTA
GCTCCGGTATTTGCTGCTGAGATGGGAAATATCACTAAAACAGTAACCTTACACAAAATTGTTCAAACATCC
GATAATTTGGCTAAGCCAAATTTCCCAGGAATAAATGGATTGAATGGAACGAAGTATATGGGTCAAAAACTT
ACTGACATTTCAGGATATTTTGGGCAAGGTTCTAAAGAAATCGCCGGTGCTTTCTTTGCGGTTATGAATGAA
AGTCAGACAAAATATATCACAGAAAGTGGTACTGAAGTAGAAAGTATCGATGCAGCAGGTGTCCTTAAAGGT
TTGACAACTGAAAACGGCATTACATTTAATACTGCAAACTTAAAAGGAACATACCAAATCGTTGAGTTGCTT
GACAAATCTAATTATAAAAATGGTGACAAAGTTCTTGCTGACTCAAAAGCTGTCCCAGTGAAAATCACTCTT
CCTTTGTATAACGAAGAAGGAATTATCGTGGACGCTGAAGTGTATCCAAAGAATACAGAAGAAGCACCACAA
ATCGACAAAAACTTTGCTAAAGCAAATAAATTGTTGAATGACAGTGATAATTCAGCTATTGCAGGTGGGGCA
GACTACGACAAATATCAGGCAGAAAAAGCAAAAGCTACTGCTGAAATCGGTCAAGAAATCCCTTACGAAGTT
AAAACAAAAATCCAAAAAGGGTCTAAATACAAAAACCTTGCTTGGGTCGATACCATGTCAAATGGTTTGACA
ATGGGTAACACTGTTAACTTAGAAGCATCGTCAGGCTCTTTTGTAGAAGGTACAGATTACAATGTTGAACGT
GATGACCGTGGTTTCACTTTGAAATTCACAGATACAGGTTTGACTAAGCTACAAAAAGAAGCGGAAACACAC
GCTGTTGAATTCACATTGACATATAGCGCAACAGTTAACGGTGCGGCTATTGATGACAAGCCAGAAAGCAAT
GATATCAAACTTCAATACGGTAACAAACCAGGTAAAAAAGTAAAAGAAATCCCAGTAACACCGTCAAATGGC
GAAATCACTGTTAGCAAAACTTGGGACAAAGGTTCAGATTTAGAGAATGCGAATGTTGTTTATACCCTTAAA
GATGGTGGAACAGCTGTTGCCTCAGTTTCATTGACAAAAACAACACCAAATGGCGAAATCAACTTAGGTAAT
GGTATTAAATTTACAGTTACTGGAGCGTTTGCTGGTAAATTCAGTGGTCTGACTGATAGTAAAACATACATG
ATCTCAGAACGTATCGCTGGTTATGGTAATACAATCACTACTGGTGCTGGTAGTGCAGCTATCACCAATACT
CCAGATTCAGACAACCCAACACCACTTAATCCAACTGAACCAAAAGTTGTGACACACGGTAAAAAATTCGTC
AAAACAAGTTCGACTGAAACAGAACGCTTGCAAGGTGCACAGTTCGTTGTTAAAGATTCAGCTGGTAAATAC
CTTGCATTGAAATCATCTGCGACAATATCAGCTCAAACAACAGCTTACACAAATGCTAAAACTGCTCTTGAC
GCTAAAATCGCAGCTTACAACAAACTTTCAGCAGACGATCAAAAAGGTACTAAAGGTGAAACAGCTAAAGCA
GAAATCAAAACTGCTCAAGACGCTTACAATGCAGCCTTCATCGTAGCTCGTACAGCTTACGAGTGGGTAACT
AATAAAGAAGATGCTAACGTTGTTAAAGTGACTTCAAACGCTGACGGTCAATTTGAAGTTAGCGGTCTTGCA
ACTGGTGATTATAAACTTGAAGAAACACAAGCTCCAGCTGGTTACGCTAAATTAGCAGGTGATGTTGATTTC
AAAGTTGGAAACAGCTCAAAAGCAGACGACTCAGGTAACATTGATTACACTGCTAGCAGCAATAAAAAAGAC
GCTCAACGCATAGAAAACAAAAAAGTGACTATTCCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATT
ATTGGTTTAAGCATTATGCTTGGAGCGGTAATTATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 96):

MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDNLAKPNFPGINGLNGTKYMGQKL
TDISGYFGQGSKEIAGAFFAVMNESQTKYITESGTEVESIDAAGVLKGLTTENGITFNTANLKGTYQIVELL
DKSNYKNGDKVLADSKAVPVKITLPLYNEEGIIVDAEVYPKNTEEAPQIDKNFAKANKLLNDSDNSAIAGGA
DYDKYQAEKAKATAEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASSGSFVEGTDYNVER
DDRGFTLKFTDTGLTKLQKEAETHAVEFTLTYSATVNGAAIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNG
EITVSKTWDKGSDLENANVVYTLKDGGTAVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLTDSKTYM
ISERIAGYGNTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTHGKKFVKTSSTETERLQGAQFVVKDSAGKY
LALKSSATISAQTTAYTNAKTALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWVT
NKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFKVGNSSKADDSGNIDYTASSNKKD
AQRIENKKVTIPQTGGIGTILFTIIGLSIMLGAVIIMKRRQSEEA

Strain 6313

ORF DNA sequence (SEQ ID NO: 139):

ATGAAAAAAAATCAACAAATGTCTTACAGTGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGTAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATTAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACACTGGTTTTGCTTTTAACACTGCTAAGTTAAAAGGAACTTACCAAATCGTT
GAATTGAAAGAAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA

ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
AAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCTGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAGTTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGTTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATACT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATATGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAGAAA
GAAGGAAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATAGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGA
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTGTCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 97):

MKKINKCLTVFSTLLLILTSLFSVAPAFADDVTTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDTGFAFNTAKLKGTYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGKDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEVPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDVNVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNTKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYSLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVVMKKRQSEEA

Strain BAA23

ORF DNA sequence (SEQ ID NO: 140):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT

ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 98):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain BAA611

ORF DNA sequence (SEQ ID NO: 141):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 99):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain C388/90

ORF DNA sequence (SEQ ID NO: 142):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCATTGCTACTGACCGTAACATCATTGTTCTCAGTT
GCACCAGTGTTTGCGGAAGAAGCAAAAACTACTGACACAGTGACCTTGCACAAGATTGTCATGCCTCGAACT
GCATTTGACGGTTTTACTGCTGGTACAAAGGGTAAGGATAATACTGACTACGTTGGTAAACAAATCGAAGAC
CTTAAAACTTACTTTGGCTCAGGCGAAGCGAAAGAAATCGCAGGTGCTTACTTTGCTTTCAAAAATGAAGCT
GGTACTAAATACATCACTGAAAATGGTGAAGAAGTTGATACTTTGGATACAACAGATGCCAAAGGTGGTGCT
GTTCTTAAAGGTTTAACAACAGACAATGGTTTCAAATTTAACACTTCTAAATTAACAGGAACTTACCAAATC
GTTGAATTGAAAGAAAAATCTACATACAACAACGATGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTT
AAAATCACTCTTCCATTGGTAAACGACAATGGTGTTGTTAAAGACGCTCACGTTTATCCAAAGAACACTGAA
ACAAAACCACAAGTAGATAAGAACTTCGCAGATAAAGAACTTGATTATGCGAACAACAAAAAAGACAAAGGG
ACTGTCTCAGCATCTGTTGGTGATGTTAAAAAATATCATGTTGGAACAAAAATCCTTAAAGGTTCAGACTAT
AAGAAATTAATCTGGACCGATAGCATGACCAAAGGTTTGACTTTCAACAACGATATTGCTGTAACATTGGAT
GGTGCAACTCTTGATGCTACAAATTACAAACTTGTAGCAGATGACCAAGGTTTCCGCCTTGTCTTGACTGAC
AAAGGTCTTGAAGCAGTGGCAAAAGCCGCAAAAACAAAAGATGTTGAAATCAAGATCACTTACTCAGCTACT
TTGAACGGTTCTGCTGTCGTTGAAGTTCTAGAAACCAATGATGTTAAATTGGACTACGGCAACAACCCAACA
ATTGAAAATGAACCAAAAGAAGGTATTCCAGTTGATAAGAAAATCACTGTTAACAAAACATGGGCAGTAGAT
GGCAATGAAGTGAATAAAGCAGATGAAACAGTTGATGCTGTCTTCACCTTGCAAGTTAAAGATGGTGACAAA
TGGGTGAATGTTGATTCAGCTAAAGCAACAGCTGCAACTAGCTTCAAACACACTTTTGAAAACTTGGATAAT
GCTAAAACTTACCGCGTTATCGAACGTGTTAGCGGCTACGCTCCAGAATACGTCTCATTTGTAAATGGCGTT
GTAACCATCAAGAACAACAAAGACTCAAATGAGCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACT
TATGGACGTAAATTTGTGAAAACAAATAAAGATGGAAAAGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAG
AAAGATGGCAAGTACTTGGCACGTAAATCAGGTGTTGCAACAGATGCAGAAAAAGCTGCTGTAGATTCAACT
AAATCAGCATTGGATGCTGCTGTTAAAGCTTACAATGATTTGACTAAAGAAAAACAAGAAGGTCAAGATGGT
AAATCAGCATTGGCTACCGTTAGTGAAAAACAAAAAGCTTACAATGATGCCTTTGTTAAAGCTAACTACTCA
TACGAATGGGTTGAAGATAAAAATGCTAAGAATGTTGTTAAATTGATTTCTAACGATAAAGGTCAATTTGAA
ATTACTGGCTTGACTGAAGGTCAATACTCATTGGAAGAAACACAAGCACCAACTGGTTATGCTAAATTATCA
GGTGATGTTTCGTTTAATGTTAATGCTACTTCATACAGTAAAGGTTCTGCTCAAGATATTGAGTATACCCAA
GGTTCTAAAACTAAAGATGCACAACAAGTTATCAATAAGAAGGTTACTATTCCACAAACAGGTGGTATTGGT
ACAATTTTTTTCACAATTATTGGATTAAGTATTATGCTTGGAGCGGTAGTTATCATGAAAAGACGTCAATCA
GAGGAAGTTTAA

ORF amino acid sequence (SEQ ID NO: 100):

MKKINKYFAVFSALLLTVTSLFSVAPVFAEEAKTTDTVTLHKIVMPRTAFDGFTAGTKGKDNTDYVGKQIED
LKTYFGSGEAKEIAGAYFAFKNEAGTKYITENGEEVDTLDTTDAKGGAVLKGLTTDNGFKFNTSKLTGTYQI
VELKEKSTYNNDGSILADSKAVPVKITLPLVNDNGVVKDAHVYPKNTETKPQVDKNFADKELDYANNKKDKG
TVSASVGDVKKYHVGTKILKGSDYKKLIWTDSMTKGLTFNNDIAVTLDGATLDATNYKLVADDQGFRLVLTD
KGLEAVAKAAKTKDVEIKITYSATLNGSAVVEVLETNDVKLDYGNNPTIENEPKEGIPVDKKITVNKTWAVD
GNEVNKADETVDAVFTLQVKDGDKWVNVDSAKATAATSFKHTFENLDNAKTYRVIERVSGYAPEYVSFVNGV
VTIKNNKDSNEPTPINPSEPKVVTYGRKFVKTNKDGKERLAGATFLVKKDGKYLARKSGVATDAEKAAVDST
KSALDAAVKAYNDLTKEKQEGQDGKSALATVSEKQKAYNDAFVKANYSYEWVEDKNAKNVVKLISNDKGQFE
ITGLTEGQYSLEETQAPTGYAKLSGDVSFNVNATSYSKGSAQDIEYTQGSKTKDAQQVINKKVTIPQTGGIG
TIFFTIIGLSIMLGAVVIMKRRQSEEV

Strain IC97

ORF DNA sequence (SEQ ID NO: 143):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTATTAATTTTAACATCGTTGTTATCGGTA
GCTCCGGTATTTGCTGCTGAGATGGGAAATATCACTAAAACAGTAACCTTACACAAAATTGTTCAAACATCC
GATAATTTGGCTAAGCCAAATTTCCCAGGAATAAATGGATTGAATGGAACGAAGTATATGGGTCAAAAACTT
ACTGACATTTCAGGATATTTTGGGCAAGGTTCTAAAGAAATCGCCGGTGCTTTCTTTGCGGTTATGAATGAA
AGTCAGACAAAATATATCACAGAAAGTGGTACTGAAGTAGAAAGTATCGATGCAGCAGGTGTCCTTAAAGGT
TTGACAACTGAAAACGGCATTACATTTAATACTGCAAACTTAAAAGGAACATACCAAATCGTTGAGTTGCTT
GACAAATCTAATTATAAAAATGGTGACAAAGTTCTTGCTGACTCAAAAGCTGTCCCAGTGAAAATCACTCTT
CCTTTGTATAACGAAGAAGGAATTGTCGTGGACGCTGAAGTGTATCCAAAGAATACAGAAGAAGCACCACAA
ATCGACAAAAACTTTGCTAAAGCAAATAAATTGTTGAATGACAGTGATAATTCAGCTATTGCAGGTGGGGCA
GACTACGACAAATATCAGGCAGAAAAAGCAAAAGCTACTGCTGAAATCGGTCAAGAAATCCCTTACGAAGTT
AAAACAAAAATCCAAAAAGGGTCTAAATACAAAAACCTTGCTTGGGTCGATACCATGTCAAATGGTTTGACA
ATGGGTAACACTGTTAACTTAGAAGCATCGTCAGGCTCTTTTGTAGAAGGTACAGATTACAATGTTGAACGT
GATGACCGTGGTTTCACTTTGAAATTCACAGATACAGGTTTGACTAAGCTACAAAAAGAAGCGGAAACACAA
GCTGTTGAATTCACATTGACATATAGCGCAACAGTTAACGGTGCGGCTATTGATGACAAGCCAGAAAGCAAT
GATATCAAACTTCAATACGGTAACAAACCAGGTAAAAAAGTAAAAGAAATCCCAGTAACACCGTCAAATGGC

GAAATCACTGTTAGCAAAACTTGGGACAAAGGTTCAGATTTAGAGAATGCGAATGTTGTTTATACCCTTAAA
GATGGTGGAACAGCTGTTGCCTCAGTTTCATTGACAAAAACAACACCAAATGGCGAAATCAACTTAGGTAAT
GGTATTAAATTTACAGTTACTGGAGCGTTTGCTGGTAAATTCAGTGGTCTGACTGATAGTAAAACATACATG
ATCTCAGAACGTATCGCTGGTTATGGTAATACAATCACTACTGGTGCTGGTAGTGCAGCTATCACCAATACT
CCAGATTCAGACAACCCAACACCACTTAATCCAACTGAACCAAAAGTTGTGACACACGGTAAAAAATTCGTC
AAAACAAGTTCGACTGAAACAGAACGCTTGCAAGGTGCACAGTTCGTTGTTAAAGATTCAGCTGGTAAATAC
CTTGCATTGAAATCATCTGCGACAATATCAGCTCAAACAACAGCTTACACAAATGCTAAAACTGCTCTTGAC
GCTAAAATCGCAGCTTACAACAAACTTTCAGCAGACGATCAAAAAGGTACTAAAGGTGAAACAGCTAAAGCA
GAAATCAAAACTGCTCAAGACGCTTACAATGCAGCCTTCATCGTAGCTCGTACAGCTTACGAGTGGGTAACT
AATAAAGAAGATGCTAACGTTGTTAAAGTGACTTCAAACGCTGACGGTCAATTTGAAGTTAGCGGTCTTGCA
ACTGGTGATTATAAACTTGAAGAAACACAAGCTCCAGCTGGTTACGCTAAATTAGCAGGTGATGTTGATTTC
AAAGTTGGAAACAGCTCAAAAGCAGACGACTCAGGTAACATTGATTACACTGCTAGCAGCAATAAAAAAGAC
GCTCAACGCATAGAAAACAAAAAAGTGACTATTCCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATT
ATTGGTTTAAGCATTATGCTTGGAGCGGTAATTATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 101):

MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDNLAKPNFPGINGLNGTKYMGQKL
TDISGYFGQGSKEIAGAFFAVMNESQTKYITESGTEVESIDAAGVLKGLTTENGITFNTANLKGTYQIVELL
DKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDAEVYPKNTEEAPQIDKNFAKANKLLNDSDNSAIAGGA
DYDKYQAEKAKATAEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASSGSFVEGTDYNVER
DDRGFTLKFTDTGLTKLQKEAETQAVEFTLTYSATVNGAAIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNG
EITVSKTWDKGSDLENANVVYTLKDGGTAVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLTDSKTYM
ISERIAGYGNTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTHGKKFVKTSSTETERLQGAQFVVKDSAGKY
LALKSSATISAQTTAYTNAKTALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWVT
NKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFKVGNSSKADDSGNIDYTASSNKKD
AQRIENKKVTIPQTGGIGTILFTIIGLSIMLGAVIIMKRRQSEEA

Strain IC98

ORF DNA sequence (SEQ ID NO: 144):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 102):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV

ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC105

ORF DNA sequence (SEQ ID NO: 145):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTATTAATTTTAACATCGTTGTTATCGGTA
GCTCCGGTATTTGCTGCTGAGATGGGAAATATCACTAAAACAGTAACCTTACACAAAATTGTTCAAACATCC
GATAATTTGGCTAAGCCAAATTTCCCAGGAATAAATGGATTGAATGGAACGAAGTATATGGGTCAAAAACTT
ACTGACATTTCAGGATATTTTGGGCAAGGTTCTAAAGAAATCGCCGGTGCTTTCTTTGCGGTTATGAATGAA
AGTCAGACAAAATATATCACAGAAAGTGGTACTGAAGTAGAAAGTATCGATGCAGCAGGTGTCCTTAAAGGT
TTGACAACTGAAAACGGCATTACATTTAATACTGCAAACTTAAAAGGAACATACCAAATCGTTGAGTTGCTT
GACAAATCTAATTATAAAAATGGTGACAAAGTTCTTGCTGACTCAAAAGCTGTCCCAGTGAAAATCACTCTT
CCTTTGTATAACGAAGAAGGAATTGTCGTGGACGCTGAAGTGTATCCAAAGAATACAGAAGAAGCACCACAA
ATCGACAAAAACTTTGCTAAAGCAAATAAATTGTTGAATGACAGTGATAATTCAGCTATTGCAGGTGGGGCA
GACTACGACAAATATCAGGCAGAAAAAGCAAAAGCTACTGCTGAAATCGGTCAAGAAATCCCTTACGAAGTT
AAAACAAAAATCCAAAAAGGGTCTAAATACAAAAACCTTGCTTGGGTCGATACCATGTCAAATGGTTTGACA
ATGGGTAACACTGTTAACTTAGAAGCATCGTCAGGCTCTTTTGTAGAAGGTACAGATTACAATGTTGAACGT
GATGACCGTGGTTTCACTTTGAAATTCACAGATACAGGTTTGACTAAGCTACAAAAAGAAGCGGAAACACAC
GCTGTTGAATTCACATTGACATATAGCGCAACAGTTAACGGTGCGGCTATTGATGACAAGCCAGAAAGCAAT
GATATCAAACTTCAATACGGTAACAAACCAGGTAAAAAAGTAAAAGAAATCCCAGTAACACCGTCAAATGGC
GAAATCACTGTTAGCAAAACTTGGGACAAAGGTTCAGATTTAGAGAATGCGAATGTTGTTTATACCCTTAAA
GATGGTGGAACAGCTGTTGCCTCAGTTTCATTGACAAAAACAACACCAAATGGCGAAATCAACTTAGGTAAT
GGTATTAAATTTACAGTTACTGGAGCGTTTGCTGGTAAATTCAGTGGTCTGACTGATAGTAAAACATACATG
ATCTCAGAACGTATCGCTGGTTATGGTAATACAATCACTACTGGTGCTGGTAGTGCAGCTATCACCAATACT
CCAGATTCAGACAACCCAACACCACTTAATCCAACTGAACCAAAAGTTGTGACACACGGTAAAAAATTCGTC
AAAACAAGTTCGACTGAAACAGAACGCTTGCAAGGTGCACAGTTCGTTGTTAAAGATTCAGCTGGTAAATAC
CTTGCATTGAAATCATCTGCGACAATATCAGCTCAAACAACAGCTTACACAAATGCTAAAACTGCTCTTGAC
GCTAAAATCGCAGCTTACAACAAACTTTCAGCAGACGATCAAAAAGGTACTAAAGGTGAAACAGCTAAAGCA
GAAATCAAAACTGCTCAAGACGCTTACAATGCAGCCTTCATCGTAGCTCGTACAGCTTACGAGTGGGTAACT
AATAAAGAAGATGCTAACGTTGTTAAAGTGACTTCAAACGCTGACGGTCAATTTGAAGTTAGCGGTCTTGCA
ACTGGTGATTATAAACTTGAAGAAACACAAGCTCCAGCTGGTTACGCTAAATTAGCAGGTGATGTTGATTTC
AAAGTTGGAAACAGCTCAAAAGCAGACGACTCAGGTAACATTGATTACACTGCTAGCAGCAATAAAAAAGAC
GCTCAACGCATAGAAAACAAAAAAGTGACTATTCCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATT
ATTGGTTTAAGCATTATGCTTGGAGCGGTAATTATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 103):

MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDNLAKPNFPGINGLNGTKYMGQKL
TDISGYFGQGSKEIAGAFFAVMNESQTKYITESGTEVESIDAAGVLKGLTTENGITFNTANLKGTYQIVELL
DKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDAEVYPKNTEEAPQIDKNFAKANKLLNDSDNSAIAGGA
DYDKYQAEKAKATAEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASSGSFVEGTDYNVER
DDRGFTLKFTDTGLTKLQKEAETHAVEFTLTYSATVNGAAIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNG
EITVSKTWDKGSDLENANVVYTLKDGGTAVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLTDSKTYM
ISERIAGYGNTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTHGKKFVKTSSTETERLQGAQFVVKDSAGKY
LALKSSATISAQTTAYTNAKTALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWVT
NKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFKVGNSSKADDSGNIDYTASSNKKD
AQRIENKKVTIPQTGGIGTILFTIIGLSIMLGAVIIMKRRQSEEA

Strain IC216

ORF DNA sequence (SEQ ID NO: 146):

ATGAAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT

GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGTAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 104):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVVTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC245

ORF DNA sequence (SEQ ID NO: 147):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT

GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 105):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC250

ORF DNA sequence (SEQ ID NO: 148):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 106):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC251

ORF DNA sequence (SEQ ID NO: 149):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 107):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC252

ORF DNA sequence (SEQ ID NO: 150):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCATTGCTACTGACCGTAACATCATTGTTCTCAGTT
GCACCAGTGTTTGCGGAAGAAGCAAAAACTACTGACACAGTGACCTTGCACAAGATTGTCATGCCTCGAACT
GCATTTGACGGTTTTACTGCTGGTACAAAGGGTAAGGATAATACTGACTACGTTGGTAAACAAATCGAAGAC
CTTAAAACTTACTTTGGCTCAGGCGAAGCGAAAGAAATCGCAGGTGCTTACTTTGCTTTCAAAAATGAAGCT
GGTACTAAATACATCACTGAAAATGGTGAAGAAGTTGATACTTTGGATACAACAGATGCCAAAGGTGGTGCT
GTTCTTAAAGGTTTAACAACAGACAATGGTTTCAAATTTAACACTTCTAAATTAACAGGAACTTACCAAATC
GTTGAATTGAAAGAAAAATCTACATACAACAACGATGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTT
AAAATCACTCTTCCATTGGTAAACGACAATGGTGTTGTTAAAGACGCTCACGTTTATCCAAAGAACACTGAA
ACAAAACCACAAGTAGATAAGAACTTCGCAGATAAAGAACTTGATTATGCGAACAACAAAAAAGACAAAGGG
ACTGTCTCAGCATCTGTTGGTGATGTTAAAAAATATCATGTTGGAACAAAAATCCTTAAAGGTTCAGACTAT
AAGAAATTAATCTGGACCGATAGCATGACCAAAGGTTTGACTTTCAACAACGATATTGCTGTAACATTGGAT
GGTGCAACTCTTGATGCTACAAATTACAAACTTGTAGCAGATGACCAAGGTTTCCGCCTTGTCTTGACTGAC
AAAGGTCTTGAAGCAGTGGCAAAAGCCGCAAAAACAAAAGATGTTGAAATCAAGATCACTTACTCAGCTACT
TTGAACGGTTCTGCTGTCGTTGAAGTTCTAGAAACCAATGATGTTAAATTGGACTACGGCAACAACCCAACA

ATTGAAAATGAACCAAAAGAAGGTATTCCAGTTGATAAGAAAATCACTGTTAACAAAACATGGGCAGTAGAT
GGCAATGAAGTGAATAAAGCAGATGAAACAGTTGATGCTGTCTTCACCTTGCAAGTTAAAGATGGTGACAAA
TGGGTGAATGTTGATTCAGCTAAAGCAACAGCTGCAACTAGCTTCAAACACACTTTTGAAAACTTGGATAAT
GCTAAAACTTACCGCGTTATCGAACGTGTTAGCGGCTACGCTCCAGAATACGTCTCATTTGTAAATGGCGTT
GTAACCATCAAGAACAACAAAGACTCAAATGAGCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACT
TATGGACGTAAATTTGTGAAAACAAATAAAGATGGAAAAGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAG
AAAGATGGCAAGTACTTGGCACGTAAATCAGGTGTTGCAACAGATGCAGAAAAAGCTGCTGTAGATTCAACT
AAATCAGCATTGGATGCTGCTGTTAAAGCTTACAATGATTTGACTAAAGAAAAACAAGAAGGTCAAGATGGT
AAATCAGCATTGGCTACCGTTAGTGAAAAACAAAAAGCTTACAATGATGCCTTTGTTAAAGCTAACTACTCA
TACGAATGGGTTGAAGATAAAAATGCTAAGAATGTTGTTAAATTGATTTCTAACGATAAAGGTCAATTTGAA
ATTACTGGCTTGACTGAAGGTCAATACTCATTGGAAGAAACACAAGCACCAACTGGTTATGCTAAATTATCA
GGTGATGTTTCGTTTAATGTTAATGCTACTTCATACAGTAAAGGTTCTGCTCAAGATATTGAGTATACCCAA
GGTTCTAAAACTAAAGATGCACAACAAGTTATCAATAAGAAGGTTACTATTCCACAAACAGGTGGTATTGGT
ACAATTTTTTTCACAATTATTGGATTAAGTATTATGCTTGGAGCGGTAGTTATCATGAAAAGACGTCAATCA
GAGGAAGTTTAA

ORF amino acid sequence (SEQ ID NO: 108):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC253

ORF DNA sequence (SEQ ID NO: 151):

ATGAAAAAAATCAACAAATGTCTTACAGTGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGTAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATTAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACACTGGTTTTGCTTTTAACACTGCTAAGTTAAAAGGAACTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
AAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCTGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAGTTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGTTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATACT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATATGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAGAAA
GAAGGAAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATAGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGA
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTGTCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 109):

MKKINKCLTVFSTLLLILTSLFSVAPAFADDVTTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDTGFAFNTAKLKGTYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGKDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEVPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDVNVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNTKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYSLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVVMKKRQSEEA

Strain IC254

ORF DNA sequence (SEQ ID NO: 152):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTACTGACTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGATGAAGCAACAACTAATACAGTGACTTTGCACAAGATTTTGCAAACCGAATCAAAT
CTTAACAAAAGTAACTTCCCAGGAACTACAGGTCTTAACGGAAAAGACTACAAAGGTGGAGCTATTTCTGAC
CTTGCTGGTTACTTTGGCGAGGGATCTAAAGAAATCGAAGGTGCGTTCTTTGCTTTAGCTTTGAAAGAAGAT
AAAAGTGGTAAAGTGCAATATGTTAAGGCAAAAGAAGGTAACAAATTAACACCAGCCTTAATTAATAAAGAT
GGTACTCCTGAAATAACAGTAAATATTGATGAGGCCGTGTCTGGATTGACACCAGAGGGAGATACTGGACTT
GTTTTCAACACCAAAGGATTGAAAGGCGAGTTTAAAATTGTTGAAGTTAAATCAAAATCTACTTACAACAAT
AATGGTTCCCTCCTGGCTGCTTCAAAAGCGGTTCCAGTTAACATCACTCTTCCATTGGTAAATGAAGATGGT
GTTGTTGCTGATGCCCATGTTTATCCAAAGAACACTGAAGAAAAACCAGAAATTGATAAAAACTTTGCTAAA
ACAAACGATTTGACAGCATTGACAGATGTTAATAGACTTTTGACAGCTGGCGCAAATTATGGTAATTATGCA
CGTGACAAAGCAACTGCTACTGCTGAAATCGGTAAAGTTGTTCCTTATGAAGTTAAAACAAAAATTCACAAA
GGTTCTAAATACGAAAACTTGGTTTGGACAGATATAATGTCAAATGGTTTGACAATGGGTTCAACTGTTAGC
CTTAAAGCTTCAGGAACTACAGAAACTTTTGCTAAGGATACAGACTATGAACTTAGCATTGATGCCCGTGGT
TTCACATTAAAATTCACAGCTGATGGATTGGGCAAATTGGAAAAAGCAGCTAAAACAGCTGATATTGAATTT
ACATTGACTTATAGTGCTACTGTTAATGGTCAAGCAATTATTGATAATCCAGAATCCAATGATATCAAATTG
TCGTATGGTAACAAACCAGGTAAAGACTTGACTGAACTTCCTGTTACACCTTCAAAGGGTGAAGTAACAGTT
GCTAAAACTTGGTCTGACGGAATTGCACCTGATGGTGTAAACGTTGTTTACACATTGAAAGATAAAGATAAA
ACTGTTGCTTCAGTATCATTGACAAAAACATCTAAAGGTACAATCGACCTTGGAAATGGTATCAAATTTGAA
GTATCTGGTAACTTCTCGGGTAAATTCACTGGTCTAGAAAACAAATCATACATGATCTCAGAACGTGTTTCT
GGTTACGGAAGTGCAATAAATCTAGAAAATGGTAAAGTAACCATTACCAATACCAAAGATTCTGATAACCCA
ACACCATTGAACCCAACTGAACCAAAAGTTGAAACTCATGGTAAGAAATTTGTCAAAACTAATGAACAAGGT
GACCGTTTGGCTGGTGCACAATTCGTTGTGAAAAACTCAGCAGGTAAATACCTTGCTCTTAAAGCAGATCAA
TCAGAAGGTCAAAAAACTTTAGCTGCTAAGAAAATAGCTTTAGATGAAGCTATCGCTGCTTATAACAAGTTG
TCTGCAACAGACCAAAAAGGTGAAAAAGGAATTACTGCAAAAGAACTTATCAAAACTAAACAAGCAGATTAC
GATGCAGCCTTCATTGAGGCTCGTACAGCTTATGAGTGGATAACAGATAAGGCTAGAGCCATTACCTACACT
TCAAACGATCAAGGTCAATTTGAAGTTACAGGTCTTGCAGACGGTACTTACAACCTTGAAGAAACACTTGCT
CCAGCAGGATTTGCTAAGTTGGCAGGTAATATTAAGTTTGTAGTTAATCAAGGGTCATACATAACAGGTGGT
AACATTGACTACGTTGCTAACAGCAACCAAAAAGATGCGACACGTGTAGAAAATAAAAAGGTAACAATCCCA
CAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATC
ATGAAAAGACGCCAATCAAAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 110):

MKRINKYFAMFSALLLTLTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGKDYKGGAISD
LAGYFGEGSKEIEGAFFALALKEDKSGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGL
VFNTKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADAHVYPKNTEEKPEIDKNFAK
TNDLTALTDVNRLLTAGANYGNYARDKATATAEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVS
LKASGTTETFAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQAIIDNPESNDIKL
SYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGVNVVYTLKDKDKTVASVSLTKTSKGTIDLGNGIKFE
VSGNFSGKFTGLENKSYMISERVSGYGSAINLENGKVTITNTKDSDNPTPLNPTEPKVETHGKKFVKTNEQG
DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAKKIALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADY
DAAFIEARTAYEWITDKARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFVVNQGSYITGG
NIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSKEA

Strain IC255

ORF DNA sequence (SEQ ID NO: 153):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT

AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 111):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC287

ORF DNA sequence (SEQ ID NO: 154):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA

GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 112):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC289

ORF DNA sequence (SEQ ID NO: 155):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTATTAATTTTAACATCGTTGTTATCGGTA
GCTCCGGTATTTGCTGCTGAGATGGGAAATATCACTAAAACAGTAACCTTACACAAAATTGTTCAAACATCC
GATAATTTGGCTAAGCCAAATTTCCCAGGAATAAATGGATTGAATGGAACGAAGTATATGGGTCAAAAACTT
ACTGACATTTCAGGATATTTTGGGCAAGGTTCTAAAGAAATCGCCGGTGCTTTCTTTGCGGTTATGAATGAA
AGTCAGACAAAATATATCACAGAAAGTGGTACTGAAGTAGAAAGTATCGATGCAGCAGGTGTCCTTAAAGGT
TTGACAACTGAAAACGGCATTACATTTAATACTGCAAACTTAAAAGGAACATACCAAATCGTTGAGTTGCTT
GACAAATCTAATTATAAAAATGGTGACAAAGTTCTTGCTGACTCAAAAGCTGTCCCAGTGAAAATCACTCTT
CCTTTGTATAACGAAGAAGGAATTGTCGTGGACGCTGAAGTGTATCCAAAGAATACAGAAGAAGCACCACAA
ATCGACAAAAACTTTGCTAAAGCAAATAAATTGTTGAATGACAGTGATAATTCAGCTATTGCAGGTGGGGCA
GACTACGACAAATATCAGGCAGAAAAAGCAAAAGCTACTGCTGAAATCGGTCAAGAAATCCCTTACGAAGTT
AAAACAAAAATCCAAAAAGGGTCTAAATACAAAAACCTTGCTTGGGTCGATACCATGTCAAATGGTTTGACA
ATGGGTAACACTGTTAACTTAGAAGCATCGTCAGGCTCTTTTGTAGAAGGTACAGATTACAATGTTGAACGT
GATGACCGTGGTTTCACTTTGAAATTCACAGATACAGGTTTGACTAAGCTACAAAAAGAAGCGGAAACACAA
GCTGTTGAATTCACATTGACATATAGCGCAACAGTTAACGGTGCGGCTATTGATGACAAGCCAGAAAGCAAT
GATATCAAACTTCAATACGGTAACAAACCAGGTAAAAAAGTAAAAGAAATCCCAGTAACACCGTCAAATGGC
GAAATCACTGTTAGCAAAACTTGGGACAAAGGTTCAGATTTAGAGAATGCGAATGTTGTTTATACCCTTAAA
GATGGTGGAACAGCTGTTGCCTCAGTTTCATTGACAAAAACAACACCAAATGGCGAAATCAACTTAGGTAAT
GGTATTAAATTTACAGTTACTGGAGCGTTTGCTGGTAAATTCAGTGGTCTGACTGATAGTAAAACATACATG
ATCTCAGAACGTATCGCTGGTTATGGTAATACAATCACTACTGGTGCTGGTAGTGCAGCTATCACCAATACT
CCAGATTCAGACAACCCAACACCACTTAATCCAACTGAACCAAAAGTTGTGACACACGGTAAAAAATTCGTC
AAAACAAGTTCGACTGAAACAGAACGCTTGCAAGGTGCACAGTTCGTTGTTAAAGATTCAGCTGGTAAATAC
CTTGCATTGAAATCATCTGCGACAATATCAGCTCAAACAACAGCTTACACAAATGCTAAAACTGCTCTTGAC
GCTAAAATCGCAGCTTACAACAAACTTTCAGCAGACGATCAAAAAGGTACTAAAGGTGAAACAGCTAAAGCA
GAAATCAAAACTGCTCAAGACGCTTACAATGCAGCCTTCATCGTAGCTCGTACAGCTTACGAGTGGGTAACT
AATAAAGAAGATGCTAACGTTGTTAAAGTGACTTCAAACGCTGACGGTCAATTTGAAGTTAGCGGTCTTGCA
ACTGGTGATTATAAACTTGAAGAAACACAAGCTCCAGCTGGTTACGCTAAATTAGCAGGTGATGTTGATTTC
AAAGTTGGAAACAGCTCAAAAGCAGACGACTCAGGTAACATTGATTACACTGCTAGCAGCAATAAAAAAGAC
GCTCAACGCATAGAAAACAAAAAAGTGACTATTCCACAAACAGGTGGTATTGGTACAATTCTTTTCACAATT
ATTGGTTTAAGCATTATGCTTGGAGCGGTAATTATCATGAAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 113):

MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDNLAKPNFPGINGLNGTKYMGQKL
TDISGYFGQGSKEIAGAFFAVMNESQTKYITESGTEVESIDAAGVLKGLTTENGITFNTANLKGTYQIVELL
DKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDAEVYPKNTEEAPQIDKNFAKANKLLNDSDNSAIAGGA
DYDKYQAEKAKATAEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASSGSFVEGTDYNVER
DDRGFTLKFTDTGLTKLQKEAETQAVEFTLTYSATVNGAAIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNG
EITVSKTWDKGSDLENANVVYTLKDGGTAVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLTDSKTYM
ISERIAGYGNTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTHGKKFVKTSSTETERLQGAQFVVKDSAGKY

LALKSSATISAQTTAYTNAKTALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWVT
NKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFKVGNSSKADDSGNIDYTASSNKKD
AQRIENKKVTIPQTGGIGTILFTIIGLSIMLGAVIIMKRRQSEEA

Strain IC291

ORF DNA sequence (SEQ ID NO: 156):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 114):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC304

ORF DNA sequence (SEQ ID NO: 157):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT

GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 115):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC305

ORF DNA sequence (SEQ ID NO: 158):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA

ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 116):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC306

ORF DNA sequence (SEQ ID NO: 159):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 117):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC361

ORF DNA sequence (SEQ ID NO: 160):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 118):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC363

ORF DNA sequence (SEQ ID NO: 161):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTACTGACTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGATGAAGCAACAACTAATACAGTGACTTTGCACAAGATTTTGCAAACCGAATCAAAT
CTTAACAAAAGTAACTTCCCAGGAACTACAGGTCTTAACGGAAAAGACTACAAAGGTGGAGCTATTTCTGAC
CTTGCTGGTTACTTTGGCGAGGGATCTAAAGAAATCGAAGGTGCGTTCTTTGCTTTAGCTTTGAAAGAAGAT
AAAAGTGGTAAAGTGCAATATGTTAAGGCAAAAGAAGGTAACAAATTAACACCAGCCTTAATTAATAAAGAT
GGTACTCCTGAAATAACAGTAAATATTGATGAGGCCGTGTCTGGATTGACACCAGAGGGAGATACTGGACTT
GTTTTCAACACCAAAGGATTGAAAGGCGAGTTTAAAATTGTTGAAGTTAAATCAAAATCTACTTACAACAAT
AATGGTTCCCTCCTGGCTGCTTCAAAAGCGGTTCCAGTTAACATCACTCTTCCATTGGTAAATGAAGATGGT
GTTGTTGCTGATGCCCATGTTTATCCAAAGAACACTGAAGAAAAACCAGAAATTGATAAAAACTTTGCTAAA
ACAAACGATTTGACAGCATTGACAGATGTTAATAGACTTTTGACAGCTGGCGCAAATTATGGTAATTATGCA
CGTGACAAAGCAACTGCTACTGCTGAAATCGGTAAAGTTGTTCCTTATGAAGTTAAAACAAAAATTCACAAA
GGTTCTAAATACGAAAACTTGGTTTGGACAGATATAATGTCAAATGGTTTGACAATGGGTTCAACTGTTAGC
CTTAAAGCTTCAGGAACTACAGAAACTTTTGCTAAGGATACAGACTATGAACTTAGCATTGATGCCCGTGGT
TTCACATTAAAATTCACAGCTGATGGATTGGGCAAATTGGAAAAAGCAGCTAAAACAGCTGATATTGAATTT
ACATTGACTTATAGTGCTACTGTTAATGGTCAAGCAATTATTGATAATCCAGAATCCAATGATATCAAATTG
TCGTATGGTAACAAACCAGGTAAAGACTTGACTGAACTTCCTGTTACACCTTCAAAGGGTGAAGTAACAGTT
GCTAAAACTTGGTCTGACGGAATTGCACCTGATGGTGTAAACGTTGTTTACACATTGAAAGATAAAGATAAA

ACTGTTGCTTCAGTATCATTGACAAAAACATCTAAAGGTACAATCGACCTTGGAAATGGTATCAAATTTGAA
GTATCTGGTAACTTCTCGGGTAAATTCACTGGTCTAGAAAACAAATCATACATGATCTCAGAACGTGTTTCT
GGTTACGGAAGTGCAATAAATCTAGAAAATGGTAAAGTAACCATTACCAATACCAAAGATTCTGATAACCCA
ACACCATTGAACCCAACTGAACCAAAAGTTGAAACTCATGGTAAGAAATTTGTCAAAACTAATGAACAAGGT
GACCGTTTGGCTGGTGCACAATTCGTTGTGAAAAACTCAGCAGGTAAATACCTTGCTCTTAAAGCAGATCAA
TCAGAAGGTCAAAAAACTTTAGCTGCTAAGAAAATAGCTTTAGATGAAGCTATCGCTGCTTATAACAAGTTG
TCTGCAACAGACCAAAAAGGTGAAAAAGGAATTACTGCAAAAGAACTTATCAAAACTAAACAAGCAGATTAC
GATGCAGCCTTCATTGAGGCTCGTACAGCTTATGAGTGGATAACAGATAAGGCTAGAGCCATTACCTACACT
TCAAACGATCAAGGTCAATTTGAAGTTACAGGTCTTGCAGACGGTACTTACAACCTTGAAGAAACACTTGCT
CCAGCAGGATTTGCTAAGTTGGCAGGTAATATTAAGTTTGTAGTTAATCAAGGGTCATACATAACAGGTGGT
AACATTGACTACGTTGCTAACAGCAACCAAAAAGATGCGACACGTGTAGAAAATAAAAAGGTAACAATCCCA
CAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATC
ATGAAAAGACGCCAATCAAAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 119):

MKRINKYFAMFSALLLTLTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGKDYKGGAISD
LAGYFGEGSKEIEGAFFALALKEDKSGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGL
VFNTKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADAHVYPKNTEEKPEIDKNFAK
TNDLTALTDVNRLLTAGANYGNYARDKATATAEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVS
LKASGTTETFAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQAIIDNPESNDIKL
SYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGVNVVYTLKDKDKTVASVSLTKTSKGTIDLGNGIKFE
VSGNFSGKFTGLENKSYMISERVSGYGSAINLENGKVTITNTKDSDNPTPLNPTEPKVETHGKKFVKTNEQG
DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAKKIALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADY
DAAFIEARTAYEWITDKARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFVVNQGSYITGG
NIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSKEA

Strain IC365

ORF DNA sequence (SEQ ID NO: 162):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCATTGCTACTGACCGTAACATCATTGTTCTCAGTT
GCACCAGTGTTTGCGGAAGAAGCAAAAACTACTGACACAGTGACCTTGCACAAGATTGTCATGCCTCGAACT
GCATTTGACGGTTTTACTGCTGGTACAAAGGGTAAGGATAATACTGACTACGTTGGTAAACAAATCGAAGAC
CTTAAAACTTACTTTGGCTCAGGCGAAGCGAAAGAAATCGCAGGTGCTTACTTTGCTTTCAAAAATGAAGCT
GGTACTAAATACATCACTGAAAATGGTGAAGAAGTTGATACTTTGGATACAACAGATGCCAAAGGTTGTGCT
GTTCTTAAAGGTTTAACAACAGACAATGGTTTCAAATTTAACACTTCTAAATTAACAGGAACTTACCAAATC
GTTGAATTGAAAGAAAAATCTACATACAACAACGATGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTT
AAAATCACTCTTCCATTGGTAAACGACAATGGTGTTGTTAAAGACGCTCACGTTTATCCAAAGAACACTGAA
ACAAAACCACAAGTAGATAAGAACTTCGCAGATAAAGAACTTGATTATGCGAACAACAAAAAAGACAAAGGG
ACTGTCTCAGCATCTGTTGGTGATGTTAAAAAATACCATGTTGGAACAAAAATCCTTAAAGGTTCAGACTAT
AAGAAATTAATCTGGACCGATAGCATGACCAAAGGTTTGACTTTCAACAACGATATTGCTGTAACATTGGAT
GGTGCAACTCTTGATGCTACAAATTACAAACTTGTAGCAGATGACCAAGGTTTCCGCCTTGTCTTGACTGAC
AAAGGTCTTGAAGCAGTGGCAAAAGCCGCAAAAACAAAAGATGTTGAAATCAAGATCACTTACTCAGCTACT
TTGAACGGTTCTGCTGTCGTTGAAGTTCTAGAAACCAATGATGTTAAATTGGACTACGGCAACAACCCAACA
ATTGAAAATGAACCAAAAGAAGGTATTCCAGTTGATAAGAAAATCACTGTTAACAAAACATGGGCAGTAGAT
GGCAATGAAGTGAATAAAGCAGATGAAACAGTTGATGCTGTCTTCACCTTGCAAGTTAAAGATGGTGACAAA
TGGGTGAATGTTGATTCAGCTAAAGCAACAGCTGCAACTAGCTTCAAACACACTTTTGAAAACTTGGATAAT
GCTAAAACTTACCGCGTTATCGAACGTGTTAGCGGCTACGCTCCAGAATACGTCTCATTTGTAAATGGCGTT
GTAACCATCAAGAACAACAAAGACTCAAATGAGCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACT
TATGGACGTAAATTTGTGAAAACAAATAAAGATGGAAAAGAACGCTTGGCAGGAGCTACCTTCCTTGTTAAG
AAAGATGGCAAGTACTTGGCACGTAAATCAGGTGTTGCAACAGATGCAGAAAAAGCTGCTGTAGATTCAACT
AAATCAGCATTGGATGCTGCTGTTAAAGCTTACAATGATTTGACTAAAGAAAAACAAGAAGGTCAAGATGGT
AAATCAGCATTGGCTACCGTTAGTGAAAAACAAAAAGCTTACAATGATGCCTTTGTTAAAGCTAACTACTCA
TACGAATGGGTTGAAGATAAAAATGCTAAGAATGTTGTTAAATTGATTTCTAACGATAAAGGTCAATTTGAA
ATTACTGGCTTGACTGAAGGTCAATACTCATTGGAAGAAACACAAGCACCAACTGGTTATGCTAAATTATCA
GGTGATGTTTCGTTTAATGTTAATGCTACTTCATACAGTAAAGGTTCTGCTCAAGATATTGAGTATACCCAA
GGTTCTAAAACTAAAGATGCACAACAAGTTATCAATAAGAAGGTTACTATTCCACAAACAGGTGGTATTGGT
ACAATTTTTTTCACAATTATTGGATTAAGTATTATGCTTGGAGCGGTAGTTATCATGAAAAGACGTCAATCA
GAGGAAGTTTAA

ORF amino acid sequence (SEQ ID NO: 120):

MKKINKYFAVFSALLLTVTSLFSVAPVFAEEAKTTDTVTLHKIVMPRTAFDGFTAGTKGKDNTDYVGKQIED
LKTYFGSGEAKEIAGAYFAFKNEAGTKYITENGEEVDTLDTTDAKGCAVLKGLTTDNGFKFNTSKLTGTYQI
VELKEKSTYNNDGSILADSKAVPVKITLPLVNDNGVVKDAHVYPKNTETKPQVDKNFADKELDYANNKKDKG

TVSASVGDVKKYHVGTKILKGSDYKKLIWTDSMTKGLTFNNDIAVTLDGATLDATNYKLVADDQGFRLVLTD
KGLEAVAKAAKTKDVEIKITYSATLNGSAVVEVLETNDVKLDYGNNPTIENEPKEGIPVDKKITVNKTWAVD
GNEVNKADETVDAVFTLQVKDGDKWVNVDSAKATAATSFKHTFENLDNAKTYRVIERVSGYAPEYVSFVNGV
VTIKNNKDSNEPTPINPSEPKVVTYGRKFVKTNKDGKERLAGATFLVKKDGKYLARKSGVATDAEKAAVDST
KSALDAAVKAYNDLTKEKQEGQDGKSALATVSEKQKAYNDAFVKANYSYEWVEDKNAKNVVKLISNDKGQFE
ITGLTEGQYSLEETQAPTGYAKLSGDVSFNVNATSYSKGSAQDIEYTQGSKTKDAQQVINKKVTIPQTGGIG
TIFFTIIGLSIMLGAVVIMKRRQSEEV

Strain IC367

ORF DNA sequence (SEQ ID NO: 163):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 121):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC377

ORF DNA sequence (SEQ ID NO: 164):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA

ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 122):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC379

ORF DNA sequence (SEQ ID NO: 165):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT

ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 123):
MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC432

ORF DNA sequence (SEQ ID NO: 166):
ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 124):
MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC455

ORF DNA sequence (SEQ ID NO: 167):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTACTGACTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGATGAAGCAACAACTAATACAGTGACTTTGCACAAGATTTTGCAAACCGAATCAAAT
CTTAACAAAAGTAACTTCCCAGGAACTACAGGTCTTAACGGAAAAGACTACAAAGGTGGAGCTATTTCTGAC
CTTGCTGGTTACTTTGGCGAGGGATCTAAAGAAATCGAAGGTGCGTTCTTTGCTTTAGCTTTGAAAGAAGAT
AAAAGTGGTAAAGTGCAATATGTTAAGGCAAAAGAAGGTAACAAATTAACACCAGCCTTAATTAATAAAGAT
GGTACTCCTGAAATAACAGTAAATATTGATGAGGCCGTGTCTGGATTGACACCAGAGGGAGATACTGGACTT
GTTTTCAACACCAAAGGATTGAAAGGCGAGTTTAAAATTGTTGAAGTTAAATCAAAATCTACTTACAACAAT
AATGGTTCCCTCCTGGCTGCTTCAAAAGCGGTTCCAGTTAACATCACTCTTCCATTGGTAAATGAAGATGGT
GTTGTTGCTGATGCCCATGTTTATCCAAAGAACACTGAAGAAAAACCAGAAATTGATAAAAACTTTGCTAAA
ACAAACGATTTGACAGCATTGACAGATGTTAATAGACTTTTGACAGCTGGCGCAAATTATGGTAATTATGCA
CGTGACAAAGCAACTGCTACTGCTGAAATCGGTAAAGTTGTTCCTTATGAAGTTAAAACAAAAATTCACAAA
GGTTCTAAATACGAAAACTTGGTTTGGACAGATATAATGTCAAATGGTTTGACAATGGGTTCAACTGTTAGC
CTTAAAGCTTCAGGAACTACAGAAACTTTTGCTAAGGATACAGACTATGAACTTAGCATTGATGCCCGTGGT
TTCACATTAAAATTCACAGCTGATGGATTGGGCAAATTGGAAAAAGCAGCTAAAACAGCTGATATTGAATTT
ACATTGACTTATAGTGCTACTGTTAATGGTCAAGCAATTATTGATAATCCAGAATCCAATGATATCAAATTG
TCGTATGGTAACAAACCAGGTAAAGACTTGACTGAACTTCCTGTTACACCTTCAAAGGGTGAAGTAACAGTT
GCTAAAACTTGGTCTGACGGAATTGCACCTGATGGTGTAAACGTTGTTTACACATTGAAAGATAAAGATAAA
ACTGTTGCTTCAGTATCATTGACAAAAACATCTAAAGGTACAATCGACCTTGGAAATGGTATCAAATTTGAA
GTATCTGGTAACTTCTCGGGTAAATTCACTGGTCTAGAAAACAAATCATACATGATCTCAGAACGTGTTTCT
GGTTACGGAAGTGCAATAAATCTAGAAAATGGTAAAGTAACCATTACCAATACCAAAGATTCTGATAACCCA
ACACCATTGAACCCAACTGAACCAAAAGTTGAAACTCATGGTAAGAAATTTGTCAAAACTAATGAACAAGGT
GACCGTTTGGCTGGTGCACAATTCGTTGTGAAAAACTCAGCAGGTAAATACCTTGCTCTTAAAGCAGATCAA
TCAGAAGGTCAAAAAACTTTAGCTGCTAAGAAAATAGCTTTAGATGAAGCTATCGCTGCTTATAACAAGTTG
TCTGCAACAGACCAAAAAGGTGAAAAAGGAATTACTGCAAAAGAACTTATCAAAACTAAACAAGCAGATTAC
GATGCAGCCTTCATTGAGGCTCGTACAGCTTATGAGTGGATAACAGATAAGGCTAGAGCCATTACCTACACT
TCAAACGATCAAGGTCAATTTGAAGTTACAGGTCTTGCAGACGGTACTTACAACCTTGAAGAAACACTTGCT
CCAGCAGGATTTGCTAAGTTGGCAGGTAATATTAAGTTTGTAGTTAATCAAGGGTCATACATAACAGGTGGT
AACATTGACTACGTTGCTAACAGCAACCAAAAAGATGCGACACGTGTAGAAAATAAAAAGGTAACAATCCCA
CAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATC
ATGAAAAGACGCCAATCAAAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 125):

MKRINKYFAMFSALLLTLTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGKDYKGGAISD
LAGYFGEGSKEIEGAFFALALKEDKSGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGL
VFNTKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADAHVYPKNTEEKPEIDKNFAK
TNDLTALTDVNRLLTAGANYGNYARDKATATAEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVS
LKASGTTETFAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQAIIDNPESNDIKL
SYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGVNVVYTLKDKDKTVASVSLTKTSKGTIDLGNGIKFE
VSGNFSGKFTGLENKSYMISERVSGYGSAINLENGKVTITNTKDSDNPTPLNPTEPKVETHGKKFVKTNEQG
DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAKKIALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADY
DAAFIEARTAYEWITDKARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFVVNQGSYITGG
NIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSKEA

Strain IC457

ORF DNA sequence (SEQ ID NO: 168):

ATGAAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA

GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 126):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC458

ORF DNA sequence (SEQ ID NO: 169):

ATGAAAAAAATCAACAAATATTTTGCAGTCTTCTCGGCCTTGCTACTGACCGTAACATCATTGCTCTCAGTT
GCACCAGCGTTTGCGGACGAAGCAACAACTAATACAGTGACTTTGCACAAGATCTTGCAAACTGAATCAAAT
CTTAATAAAAGTAACTTCCCAGGAACTACAGGCCTTAACGGAGATGACTATAAAGGTGAATCTATTTCTGAC
CTTGCTGAATACTTTGGATCAGGTTCTAAAGAAATTGACGGTGCTTTCTTTGCTTTGGCTTTAGAAGAGGAA
AAAGATGGTGTCGTACAATATGTTAAGGCAAAAGCAAATGACAAATTAACACCAGACTTAATTACTAAAGGT
ACACCTGCAACAACAACAAAAGTTGAAGAAGCTGTAGGTGGTTTGACAACTGGTACGGGTATTGTTTTCAAT
ACAGCTGGTTTGAAAGGTAATTTCAAAATTATTGAATTGAAAGACAAATCAACTTACAACAATAATGGTTCC
CTCTTAGCAGCTTCAAAAGCAGTTCCGGTGAAAATCACTCTTCCATTGGTAAGCAAAGATGGTGTTGTTAAA
GATGCACACGTTTATCCAAAGAACACTGAAACAAAACCAGAAGTAGACAAGAACTTCGCTAAAACAAACGAT
TTGACAGCTCTCAAAGACGCTACTCTTCTTAAGGCTGGTGCAGACTACAAAAACTATTCAGCGACTAAAGCT
ACTGTAACAGCTGAAATCGGTAAAGTTATCCCTTACGAAGTTAAAACAAAAGTTCTTAAAGGTTCTAAATAC
GAAAAACTGGTTTGGACCGATACCATGTCAAATGGTTTGACAATGGGTGATGATGTTAACCTTGCAGTTTCA
GGGACTACAACAACTTTCATTAAAGATATAGATTACACTCTTAGCATTGATGACCGTGGTTTCACATTGAAA
TTCAAAGCTACTGGATTGGACAAATTGGAAGAAGCAGCTAAAGCATCTGATGTTGAATTTACATTGACTTAT
AAAGCTACTGTTAATGGCCAAGCAATTATTGACAACCCAGAAGTCAATGACATCAAATTGGACTATGGTAAT
AAACCTGGTACAGATTTATCAGAACAACCTGTGACACCTGAAGATGGTGAAGTTAAAGTCACTAAAACATGG
GCAGCAGGTGCTAATAAAGCAGACGCTAAAGTTGTCTACACACTTAAAAATGCTACTAAACAAGTCGTAGCT
TCTGTCGCATTGACCGCAGCTGATACAAAAGGTACGATTAATCTTGGTAAAGGCATGACCTTTGAAATCACA
GGAGCTTTCTCAGGTACATTCAAAGGCCTTCAAAATAAAGCTTACACTGTTTCTGAACGTGTTGCAGGTTAT
ACTAATGCTATTAATGTTACTGGTAATGCTGTTGCTATCACCAATACACCAGACAGTGACAATCCAACGCCA
CTTAACCCAACTCAACCAAAAGTTGAAACACATGGTAAGAAATTTGTCAAAGTTGGCGATGCAGATGCCCGC
TTAGCTGGTGCACAATTCGTTGTGAAAAATTCAGCTGGTAAATTCCTTGCTCTTAAAGAAGATGCAGCTGTA
TCAGGAGCTCAAACTGAATTGGCAACTGCTAAAACAGACTTGGATAATGCCATCAAAGCTTACAACGGTTTG
ACAAAAGCGCAGCAAGAAGGTGCTGATGGTACATCAGCAAAAGAACTTATCAACACTAAACAGTCAGCTTAC
GACGCAGCCTTCATCAAAGCACGTACAGCTTATACATGGGTAGATGAAAAAACTAAAGCTATTACCTTCACT
TCAAATAATCAAGGTCAATTTGAAGTTACTGGTCTTGAAGTAGGTTCTTACAAACTTGAAGAAACTCTTGCA
CCAGCAGGTTATGCTAAATTGTCAGGCGACATTGAGTTTACAGTTGGACACGATTCTTACACAAGTGGTGAC
ATCAAGTACAAGACAGATGATGCTAGCAACAATGCACAAAAAGTTTTCAATAAAAAAGTAACCATCCCACAA
ACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCGGTAGTTATCATG
AAAAGACGTCAATCAGAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 127):

MKKINKYFAVFSALLLTVTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGDDYKGESISD
LAEYFGSGSKEIDGAFFALALEEEKDGVVQYVKAKANDKLTPDLITKGTPATTTKVEEAVGGLTTGTGIVFN
TAGLKGNFKIIELKDKSTYNNNGSLLAASKAVPVKITLPLVSKDGVVKDAHVYPKNTETKPEVDKNFAKTND
LTALKDATLLKAGADYKNYSATKATVTAEIGKVIPYEVKTKVLKGSKYEKLVWTDTMSNGLTMGDDVNLAVS
GTTTTFIKDIDYTLSIDDRGFTLKFKATGLDKLEEAAKASDVEFTLTYKATVNGQAIIDNPEVNDIKLDYGN
KPGTDLSEQPVTPEDGEVKVTKTWAAGANKADAKVVYTLKNATKQVVASVALTAADTKGTINLGKGMTFEIT
GAFSGTFKGLQNKAYTVSERVAGYTNAINVTGNAVAITNTPDSDNPTPLNPTQPKVETHGKKFVKVGDADAR
LAGAQFVVKNSAGKFLALKEDAAVSGAQTELATAKTDLDNAIKAYNGLTKAQQEGADGTSAKELINTKQSAY
DAAFIKARTAYTWVDEKTKAITFTSNNQGQFEVTGLEVGSYKLEETLAPAGYAKLSGDIEFTVGHDSYTSGD
IKYKTDDASNNAQKVFNKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSEEA

Strain IC459

ORF DNA sequence (SEQ ID NO: 170):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 128):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC460

ORF DNA sequence (SEQ ID NO: 171):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTACTGACTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGATGAAGCAACAACTAATACAGTGACTTTGCACAAGATTTTGCAAACCGAATCAAAT
CTTAACAAAAGTAACTTCCCAGGAACTACAGGTCTTAACGGAAAAGACTACAAAGGTGGAGCTATTTCTGAC
CTTGCTGGTTACTTTGGCGAGGGATCTAAAGAAATCGAAGGTGCGTTCTTTGCTTTAGCTTTGAAAGAAGAT

AAAAGTGGTAAAGTGCAATATGTTAAGGCAAAAGAAGGTAACAAATTAACACCAGCCTTAATTAATAAAGAT
GGTACTCCTGAAATAACAGTAAATATTGATGAGGCCGTGTCTGGATTGACACCAGAGGGAGATACTGGACTT
GTTTTCAACACCAAAGGATTGAAAGGCGAGTTTAAAATTGTTGAAGTTAAATCAAAATCTACTTACAACAAT
AATGGTTCCCTCCTGGCTGCTTCAAAAGCGGTTCCAGTTAACATCACTCTTCCATTGGTAAATGAAGATGGT
GTTGTTGCTGATGCCCATGTTTATCCAAAGAACACTGAAGAAAAACCAGAAATTGATAAAAACTTTGCTAAA
ACAAACGATTTGACAGCATTGACAGATGTTAATAGACTTTTGACAGCTGGCGCAAATTATGGTAATTATGCA
CGTGACAAAGCAACTGCTACTGCTGAAATCGGTAAAGTTGTTCCTTATGAAGTTAAAACAAAAATTCACAAA
GGTTCTAAATACGAAAACTTGGTTTGGACAGATATAATGTCAAATGGTTTGACAATGGGTTCAACTGTTAGC
CTTAAAGCTTCAGGAACTACAGAAACTTTTGCTAAGGATACAGACTATGAACTTAGCATTGATGCCCGTGGT
TTCACATTAAAATTCACAGCTGATGGATTGGGCAAATTGGAAAAAGCAGCTAAAACAGCTGATATTGAATTT
ACATTGACTTATAGTGCTACTGTTAATGGTCAAGCAATTATTGATAATCCAGAATCCAATGATATCAAATTG
TCGTATGGTAACAAACCAGGTAAAGACTTGACTGAACTTCCTGTTACACCTTCAAAGGGTGAAGTAACAGTT
GCTAAAACTTGGTCTGACGGAATTGCACCTGATGGTGTAAACGTTGTTTACACATTGAAAGATAAAGATAAA
ACTGTTGCTTCAGTATCATTGACAAAAACATCTAAAGGTACAATCGACCTTGGAAATGGTATCAAATTTGAA
GTATCTGGTAACTTCTCGGGTAAATTCACTGGTCTAGAAAACAAATCATACATGATCTCAGAACGTGTTTCT
GGTTACGGAAGTGCAATAAATCTAGAAAATGGTAAAGTAACCATTACCAATACCAAAGATTCTGATAACCCA
ACACCATTGAACCCAACTGAACCAAAAGTTGAAACTCATGGTAAGAAATTTGTCAAAACTAATGAACAAGGT
GACCGTTTGGCTGGTGCACAATTCGTTGTGAAAAACTCAGCAGGTAAATACCTTGCTCTTAAAGCAGATCAA
TCAGAAGGTCAAAAAACTTTAGCTGCTAAGAAAATAGCTTTAGATGAAGCTATCGCTGCTTATAACAAGTTG
TCTGCAACAGACCAAAAAGGTGAAAAAGGAATTACTGCAAAAGAACTTATCAAAACTAAACAAGCAGATTAC
GATGCAGCCTTCATTGAGGCTCGTACAGCTTATGAGTGGATAACAGATAAGGCTAGAGCCATTACCTACACT
TCAAACGATCAAGGTCAATTTGAAGTTACAGGTCTTGCAGACGGTACTTACAACCTTGAAGAAACACTTGCT
CCAGCAGGATTTGCTAAGTTGGCAGGTAATATTAAGTTTGTAGTTAATCAAGGGTCATACATAACAGGTGGT
AACATTGACTACGTTGCTAACAGCAACCAAAAAGATGCGACACGTGTAGAAAATAAAAAGGTAACAATCCCA
CAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATC
ATGAAAAGACGCCAATCAAAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 129):

MKRINKYFAMFSALLLTLTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGKDYKGGAISD
LAGYFGEGSKEIEGAFFALALKEDKSGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGL
VFNTKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADAHVYPKNTEEKPEIDKNFAK
TNDLTALTDVNRLLTAGANYGNYARDKATATAEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVS
LKASGTTETFAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQAIIDNPESNDIKL
SYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGVNVVYTLKDKDKTVASVSLTKTSKGTIDLGNGIKFE
VSGNFSGKFTGLENKSYMISERVSGYGSAINLENGKVTITNTKDSDNPTPLNPTEPKVETHGKKFVKTNEQG
DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAKKIALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADY
DAAFIEARTAYEWITDKARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFVVNQGSYITGG
NIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSKEA

Strain IC461

ORF DNA sequence (SEQ ID NO: 172):

ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA

GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 130):

MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Strain IC462

ORF DNA sequence (SEQ ID NO: 173):

ATGAAAAGAATCAACAAATATTTTGCAATGTTCTCGGCATTGTTACTGACTTTAACGTCATTGCTCTCAGTT
GCACCAGCGTTTGCGGATGAAGCAACAACTAATACAGTGACTTTGCACAAGATTTTGCAAACCGAATCAAAT
CTTAACAAAAGTAACTTCCCAGGAACTACAGGTCTTAACGGAAAAGACTACAAAGGTGGAGCTATTTCTGAC
CTTGCTGGTTACTTTGGCGAGGGATCTAAAGAAATCGAAGGTGCGTTCTTTGCTTTAGCTTTGAAAGAAGAT
AAAAGTGGTAAAGTGCAATATGTTAAGGCAAAAGAAGGTAACAAATTAACACCAGCCTTAATTAATAAAGAT
GGTACTCCTGAAATAACAGTAAATATTGATGAGGCCGTGTCTGGATTGACACCAGAGGGAGATACTGGACTT
GTTTTCAACACCAAAGGATTGAAAGGCGAGTTTAAAATTGTTGAAGTTAAATCAAAATCTACTTACAACAAT
AATGGTTCCCTCCTGGCTGCTTCAAAAGCGGTTCCAGTTAACATCACTCTTCCATTGGTAAATGAAGATGGT
GTTGTTGCTGATGCCCATGTTTATCCAAAGAACACTGAAGAAAAACCAGAAATTGATAAAAACTTTGCTAAA
ACAAACGATTTGACAGCATTGACAGATGTTAATAGACTTTTGACAGCTGGCGCAAATTATGGTAATTATGCA
CGTGACAAAGCAACTGCTACTGCTGAAATCGGTAAAGTTGTTCCTTATGAAGTTAAAACAAAAATTCACAAA
GGTTCTAAATACGAAAACTTGGTTTGGACAGATATAATGTCAAATGGTTTGACAATGGGTTCAACTGTTAGC
CTTAAAGCTTCAGGAACTACAGAAACTTTTGCTAAGGATACAGACTATGAACTTAGCATTGATGCCCGTGGT
TTCACATTAAAATTCACAGCTGATGGATTGGGCAAATTGGAAAAAGCAGCTAAAACAGCTGATATTGAATTT
ACATTGACTTATAGTGCTACTGTTAATGGTCAAGCAATTATTGATAATCCAGAATCCAATGATATCAAATTG
TCGTATGGTAACAAACCAGGTAAAGACTTGACTGAACTTCCTGTTACACCTTCAAAGGGTGAAGTAACAGTT
GCTAAAACTTGGTCTGACGGAATTGCACCTGATGGTGTAAACGTTGTTTACACATTGAAAGATAAAGATAAA
ACTGTTGCTTCAGTATCATTGACAAAAACATCTAAAGGTACAATCGACCTTGGAAATGGTATCAAATTTGAA
GTATCTGGTAACTTCTCGGGTAAATTCACTGGTCTAGAAAACAAATCATACATGATCTCAGAACGTGTTTCT
GGTTACGGAAGTGCAATAAATCTAGAAAATGGTAAAGTAACCATTACCAATACCAAAGATTCTGATAACCCA
ACACCATTGAACCCAACTGAACCAAAAGTTGAAACTCATGGTAAGAAATTTGTCAAAACTAATGAACAAGGT
GACCGTTTGGCTGGTGCACAATTCGTTGTGAAAAACTCAGCAGGTAAATACCTTGCTCTTAAAGCAGATCAA
TCAGAAGGTCAAAAAACTTTAGCTGCTAAGAAAATAGCTTTAGATGAAGCTATCGCTGCTTATAACAAGTTG
TCTGCAACAGACCAAAAAGGTGAAAAAGGAATTACTGCAAAAGAACTTATCAAAACTAAACAAGCAGATTAC
GATGCAGCCTTCATTGAGGCTCGTACAGCTTATGAGTGGATAACAGATAAGGCTAGAGCCATTACCTACACT
TCAAACGATCAAGGTCAATTTGAAGTTACAGGTCTTGCAGACGGTACTTACAACCTTGAAGAAACACTTGCT
CCAGCAGGATTTGCTAAGTTGGCAGGTAATATTAAGTTTGTAGTTAATCAAGGGTCATACATAACAGGTGGT
AACATTGACTACGTTGCTAACAGCAACCAAAAAGATGCGACACGTGTAGAAAATAAAAAGGTAACAATCCCA
CAAACAGGTGGTATTGGTACAATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATC
ATGAAAAGACGCCAATCAAAGGAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 131):

MKRINKYFAMFSALLLTLTSLLSVAPAFADEATTNTVTLHKILQTESNLNKSNFPGTTGLNGKDYKGGAISD
LAGYFGEGSKEIEGAFFALALKEDKSGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGL
VFNTKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADAHVYPKNTEEKPEIDKNFAK
TNDLTALTDVNRLLTAGANYGNYARDKATATAEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVS
LKASGTTETFAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQAIIDNPESNDIKL
SYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGVNVVYTLKDKDKTVASVSLTKTSKGTIDLGNGIKFE

VSGNFSGKFTGLENKSYMISERVSGYGSAINLENGKVTITNTKDSDNPTPLNPTEPKVETHGKKFVKTNEQG
DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAKKIALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADY
DAAFIEARTAYEWITDKARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFVVNQGSYITGG
NIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIGLSIMLGAVVIMKRRQSKEA

Strain IC470

ORF DNA sequence (SEQ ID NO: 174):
ATGAAAAAAATCAACAAATGTCTTACAATGTTCTCGACACTGCTATTGATCTTAACGTCACTATTCTCAGTT
GCACCAGCGTTTGCGGACGACGCAACAACTGATACTGTGACCTTGCACAAGATTGTCATGCCACAAGCTGCA
TTTGATAACTTTACTGAAGGTACAAAAGGTAAGAATGATAGCGATTATGTTGGTAAACAAATTAATGACCTT
AAATCTTATTTTGGCTCAACCGATGCTAAAGAAATCAAGGGTGCTTTCTTTGTTTTCAAAAATGAAACTGGT
ACAAAATTCATTACTGAAAATGGTAAGGAAGTCGATACTTTGGAAGCTAAAGATGCTGAAGGTGGTGCTGTT
CTTTCAGGGTTAACAAAAGACAATGGTTTTGTTTTTAACACTGCTAAGTTAAAAGGAATTTACCAAATCGTT
GAATTGAAAGAAAAATCAAACTACGATAACAACGGTTCTATCTTGGCTGATTCAAAAGCAGTTCCAGTTAAA
ATCACTCTGCCATTGGTAAACAACCAAGGTGTTGTTAAAGATGCTCACATTTATCCAAAGAATACTGAAACA
AAACCACAAGTAGATAAGAACTTTGCAGATAAAGATCTTGATTATACTGACAACCGAAAAGACAAAGGTGTT
GTCTCAGCGACAGTTGGTGACAAAAAAGAATACATAGTTGGAACAAAAATTCTTAAAGGCTCAGACTATAAG
AAACTGGTTTGGACTGATAGCATGACTAAAGGTTTGACGTTCAACAACAACGTTAAAGTAACATTGGATGGT
GAAGATTTTCCTGTTTTAAACTACAAACTCGTAACAGATGACCAAGGTTTCCGTCTTGCCTTGAATGCAACA
GGTCTTGCAGCAGTAGCAGCAGCTGCAAAAGACAAAGATGTTGAAATCAAGATCACTTACTCAGCTACGGTG
AACGGCTCCACTACTGTTGAAATTCCAGAAACCAATGATGTTAAATTGGACTATGGTAATAACCCAACGGAA
GAAAGTGAACCACAAGAAGGTACTCCAGCTAACCAAGAAATTAAAGTCATTAAAGACTGGGCAGTAGATGGT
ACAATTACTGATGCTAATGTTGCAGTTAAAGCTATCTTTACCTTGCAAGAAAAACAAACGGATGGTACATGG
GTGAACGTTGCTTCACACGAAGCAACAAAACCATCACGCTTTGAACATACTTTCACAGGTTTGGATAATGCT
AAAACTTACCGCGTTGTCGAACGTGTTAGCGGCTACACTCCAGAATACGTATCATTTAAAAATGGTGTTGTG
ACTATCAAGAACAACAAAAACTCAAATGATCCAACTCCAATCAACCCATCAGAACCAAAAGTGGTGACTTAT
GGACGTAAATTTGTGAAAACAAATCAAGCTAACACTGAACGCTTGGCAGGAGCTACCTTCCTCGTTAAGAAA
GAAGGCAAATACTTGGCACGTAAAGCAGGTGCAGCAACTGCTGAAGCAAAGGCAGCTGTAAAAACTGCTAAA
CTAGCATTGGATGAAGCTGTTAAAGCTTATAACGACTTGACTAAAGAAAAACAAGAAGGCCAAGAAGGTAAA
ACAGCATTGGCTACTGTTGATCAAAAACAAAAAGCTTACAATGACGCTTTTGTTAAAGCTAACTACTCATAT
GAATGGGTTGCAGATAAAAAGGCTGATAATGTTGTTAAATTGATCTCTAACGCCGGTGGTCAATTTGAAATT
ACTGGTTTGGATAAAGGCACTTATGGCTTGGAAGAAACTCAAGCACCAGCAGGTTATGCGACATTGTCAGGT
GATGTAAACTTTGAAGTAACTGCCACATCATATAGCAAAGGGGCTACAACTGACATCGCATATGATAAAGGC
TCTGTAAAAAAAGATGCCCAACAAGTTCAAAACAAAAAAGTAACCATCCCACAAACAGGTGGTATTGGTACA
ATTCTTTTCACAATTATTGGTTTAAGCATTATGCTTGGAGCAGTAGTTATCATGAAAAAACGTCAATCAGAG
GAAGCTTAA

ORF amino acid sequence (SEQ ID NO: 132):
MKKINKCLTMFSTLLLILTSLFSVAPAFADDATTDTVTLHKIVMPQAAFDNFTEGTKGKNDSDYVGKQINDL
KSYFGSTDAKEIKGAFFVFKNETGTKFITENGKEVDTLEAKDAEGGAVLSGLTKDNGFVFNTAKLKGIYQIV
ELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDAHIYPKNTETKPQVDKNFADKDLDYTDNRKDKGV
VSATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLDGEDFPVLNYKLVTDDQGFRLALNAT
GLAAVAAAAKDKDVEIKITYSATVNGSTTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG
TITDANVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLDNAKTYRVVERVSGYTPEYVSFKNGVV
TIKNNKNSNDPTPINPSEPKVVTYGRKFVKTNQANTERLAGATFLVKKEGKYLARKAGAATAEAKAAVKTAK
LALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWVADKKADNVVKLISNAGGQFEI
TGLDKGTYGLEETQAPAGYATLSGDVNFEVTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGT
ILFTIIGLSIMLGAVVIMKKRQSEEA

Table 11: Amino acid and encoding DNA sequences of gbs1478 proteins derived from different strains of *S. agalactiae*

Strain 12401

ORF DNA sequence (SEQ ID NO: 204):
ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAACCTACTTCACACTCAGAAAGCAAAGTAGAA
AAAGTAACTACTGAGGTAACAGGTGAAGCTACTTTTGATAATCTCACACCTGGAGATTACACTTTATCAGAA
GAAACGGCACCCGAAGGATACAAAAAGACTACCCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT

ACGATACAAAATAGTGATGATAAAAAATCTATAATTGAACAAAGGCAAGAGGAACTAGATAAGCAGTATCCC
CTTACAGGAGCTTATGAAGATACAAAAGAATCTTATAATCTTGAGCATGTTAAAAATTCAATTCCAAATGGG
AAATTAGAGGCAAAAGCAGTTAATCCATATTCAAGTGAAGGTGAGCACATAAGAGAAATTCAAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAAATGATTTGGATCATAATAAATATAAAATTGAGTTAACTGTTAGCGGT
AAATCCATAATAAAAACTATAAATAAAGATGAACCTCTGGATGTTGTTTTTGTTCTTGATAATTCAAATTCT
ATGAAGAATAATGGAAAAAATAACAAGGCAAAAAAGGCAGGTGAAGCAGTAGAAACAATTATAAAAGATGTT
TTAGGAGCAAATGTTGAAAACCGAGCAGCTTTAGTTACTTATGGTTCAGATATTTTTGATGGAAGGACAGTT
AAAGTTATAAAAGGTTTTAAAGAGGATCCTTATTATGGACTTGAAACTAGTTTCACAGTTCAGACAAATGAT
TATAGCTATAAAAAGTTCACTAATATTGCTGCTGATATTATAAAAAAGATCCCTAAAGAAGCTCCAGAAGCT
AAGTGGGGGGGGACAAGTCTAGGATTAACTCCAGAAAAAAAGAGGGAATATGATTTAAGTAAAGTAGGTGAG
ACCTTTACAATGAAAGCTTTTATGGAGGCAGATACCTTGTTAAGTAGTATACAGCGTAAGAGTAGAAAGATT
ATTGTTCATCTAACTGACGGTGTTCCAACAAGATCATATGCCATTAATAGTTTTGTAAAAGGTTCAACATAC
GCAAATCAATTTGAGAGAATAAAAGAAAAAGGTTATTTAGACAAAAATAATTATTTTATAACTGATGATCCA
GAAAAGATCAAAGGCAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAAACACAGATAATTTCT
GGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACAATTTATAGAAATGGA
CCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAAAATTATGACATCTTT
AATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAAAATCAAGATGGTACT
TTTCAAAAATTGAAGGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTAATGAATTCATTCTCT
TCTAAACCTGAGTATTATACCCCGATAGTAACTTCAGCTGATGTATCTAATAATGAAATTTTATCTAAAATT
CAGCAACAATTTGAAAAGATTTTAACAAAGGAAAACTCAATTGTTAATGGAACTATAGAAGATCCTATGGGT
GATAAAATCAATTTACATCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACTTTACAGGGAAATGAT
GGAAGTATAATGAAAGATAGCATTGCAACTGGAGGGCCTAATAATGATGGTGGGATACTTAAAGGGGTTAAA
TTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGGCAAAAAGTAACACTCACA
TATGATGTGAAACTAGATGACAGTTTTATTAGTAACAAATTCTATGACACTAATGGTAGAACAACATTGAAT
CCTAAATCAGAGGAACCCGATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGATGTGAGAGAATATCCT
ACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGATAAAGATAATAATAAG
TTGCTTCTCAAAGGAGCTACATTTGAACTTCAAGAATTTAATGAAGATTATAAACTTTATTTACCAATAAAA
AATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTGAAAGATGGCAAATAT
CAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATTTTAACTTTTGAAGTT
GTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCATGAGGAAGGTGACAAG
CATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGGAAAGGAATTCTATCT
TTCATTTTAATAGGTGGAGCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAAAGACATAAGAAATCT
AGTGATGCATCAATCGAGAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 185):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKPTSHSESKVE
KVTTEVTGEATFDNLTPGDYTLSEETAPEGYKKTTQTWQVKVESNGKTTIQNSDDKKSIIEQRQEELDKQYP
LTGAYEDTKESYNLEHVKNSIPNGKLEAKAVNPYSSEGEHIREIQEGTLSKRISEVNDLDHNKYKIELTVSG
KSIIKTINKDEPLDVVFVLDNSNSMKNNGKNNKAKKAGEAVETIIKDVLGANVENRAALVTYGSDIFDGRTV
KVIKGFKEDPYYGLETSFTVQTNDYSYKKFTNIAADIIKKIPKEAPEAKWGGTSLGLTPEKKREYDLSKVGE
TFTMKAFMEADTLLSSIQRKSRKIIVHLTDGVPTRSYAINSFVKGSTYANQFERIKEKGYLDKNNYFITDDP
EKIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQKNYDIF
NFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMNSFSSKPEYYTPIVTSADVSNNEILSKI
QQQFEKILTKENSIVNGTIEDPMGDKINLHLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGILKGVK
LEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEEPDTLRDFPIPKIRDVREYP
TITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDLKDGKY
QLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGGKGILS
FILIGGAMMSIAGGIYIWKRHKKSSDASIEKD

Strain BAA23

ORF DNA sequence (SEQ ID NO: 205):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA

ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA
GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 186):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC98

ORF DNA sequence (SEQ ID NO: 206):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA

ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 187):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC105

ORF DNA sequence (SEQ ID NO: 207):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGGTAACAGGTGAAGCTACTTTTGATAATCTCACACCTGGAGATTACACTTTATCAGAA
GAAACGGCACCCGAAGGATACAAAAAGACTACCCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGATGATAAAAAATCTATAATTGAACAAAGGCAAGAGGAACTAGATAAGCAGTATCCC
CTTACAGGAGCTTATGAAGATACAAAAGAATCTTATAATCTTGAGCATGTTAAAAATTCAATTCCAAATGGG
AAATTAGAGGCAAAAGCAGTTAATCCATATTCAAGTGAAGGTGAGCACATAAGAGAAATTCAAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAAATGATTTGGATCATAATAAATATAAAATTGAGTTAACTGTTAGCGGT
AAATCCATAATAAAAACTATAAATAAAGATGAACCTCTGGATGTTGTTTTTGTTCTTGATAATTCAAATTCT
ATGAAGAATAATGGAAAAAATAACAAGGCAAAAAAGGCAGGTGAAGCAGTAGAAACAATTATAAAAGATGTT
TTAGGAGCAAATGTTGAAAACCGAGCAGCTTTAGTTACTTATGGTTCAGATATTTTTGATGGAAGGACAGTT
AAAGTTATAAAAGGTTTTAAAGAGGATCCTTATTATGGACTTGAAACTAGTTTCACAGTTCAGACAAATGAT
TATAGCTATAAAAAGTTCACTAATATTGCTGCTGATATTATAAAAAAGATCCCTAAAGAAGCTCCAGAAGCT
AAGTGGGGGGGGACAAGTCTAGGATTAACTCCAGAAAAAAAGAGGGAATATGATTTAAGTAAAGTAGGTGAG
ACCTTTACAATGAAAGCTTTTATGGAGGCAGATACCTTGTTAAGTAGTATACAGCGTAAGAGTAGAAAGATT
ATTGTTCATCTAACTGACGGTGTTCCAACAAGATCATATGCCATTAATAGTTTTGTAACAGGTTCAACATAC
GCAAATCAATTTGAGAGAATAAAAGAAAAAGGTTATTTAGACAAAAATAATTATTTTATAACTGATGATCCA
GAAAAGATCAAAGGCAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAAACACAGATAATTTCT
GGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACAATTTATAGAAATGGA

CCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAAAATTATGACATCTTT
AATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAAAATCAAGATGGTACT
TTTCAAAAATTGAAGGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTAATGAATTCATTCTCT
TCTAAACCTGAGTATTATACCCCGATAGTAACTTCAGCTGATGTATCTAATAATGAAATTTTATCTAAAATT
CAGCAACAATTTGAAAAGATTTTAACAAAGGAAAACTCAATTGTTAATGGAACTATAGAAGATCCTATGGGT
GATAAAATCAATTTACATCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACTTTACAGGGAAATGAT
GGAAGTATAATGAAAGATAGCATTGCAACTGGAGGGCCTAATAATGATGGTGGGATACTTAAAGGGGTTAAA
TTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGGCAAAAAGTAACACTCACA
TATGATGTGAAACTAGATGACAGTTTTATTAGTAACAAATTCTATGACACTAATGGTAGAACAACATTGAAT
CCTAAATCAGAGGAACCCGATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGATGTGAGAGAATATCCT
ACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGATAAAGATAATAATAAG
TTGCTTCTCAAAGGAGCTACATTTGAACTTCAAGAATTTAATGAAGATTATAAACTTTATTTACCAATAAAA
AATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTGAAAGATGGCAAATAT
CAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATTTTAACTTTTGAAGTT
GTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCATGAGGAAGGTGACAAG
CATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGGAAAGGAATTCTATCT
TTCATTTTAATAGGTGGAGCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAAAGACATAAGAAATCT
AGTGATGCATCAATCGAGAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 188):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAEVTGEATFDNLTPGDYTLSEETAPEGYKKTTQTWQVKVESNGKTTIQNSDDKKSIIEQRQEELDKQYP
LTGAYEDTKESYNLEHVKNSIPNGKLEAKAVNPYSSEGEHIREIQEGTLSKRISEVNDLDHNKYKIELTVSG
KSIIKTINKDEPLDVVFVLDNSNSMKNNGKNNKAKKAGEAVETIIKDVLGANVENRAALVTYGSDIFDGRTV
KVIKGFKEDPYYGLETSFTVQTNDYSYKKFTNIAADIIKKIPKEAPEAKWGGTSLGLTPEKKREYDLSKVGE
TFTMKAFMEADTLLSSIQRKSRKIIVHLTDGVPTRSYAINSFVTGSTYANQFERIKEKGYLDKNNYFITDDP
EKIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQKNYDIF
NFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMNSFSSKPEYYTPIVTSADVSNNEILSKI
QQQFEKILTKENSIVNGTIEDPMGDKINLHLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGILKGVK
LEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEEPDTLRDFPIPKIRDVREYP
TITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDLKDGKY
QLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGGKGILS
FILIGGAMMSIAGGIYIWKRHKKSSDASIEKD

Strain IC108

ORF DNA sequence (SEQ ID NO: 208):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA

GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 189):

MKKRQKIWRGLSVTLLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC216

ORF DNA sequence (SEQ ID NO: 209):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT

GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 190):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC244

ORF DNA sequence (SEQ ID NO: 210):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT

GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 191):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC245

ORF DNA sequence (SEQ ID NO: 211):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 192):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC246

ORF DNA sequence (SEQ ID NO: 212):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAAATACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 193):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKNTGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL

MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC247

ORF DNA sequence (SEQ ID NO: 213):

ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 194):

MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR

EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC250

ORF DNA sequence (SEQ ID NO: 214):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCAACCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA
GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 195):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAQPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC251

ORF DNA sequence (SEQ ID NO: 215):
ATGAAAAAGAGACAAAAAATATGGAGAGGGTTATCAGTTACTTTACTAATCCTGTCCCAAATTCCATTTGGT
ATATTGGTACAAGGTGAAACCCAAGATACCAATCAAGCACTTGGAAAAGTAATTGTTAAAAAAACGGGAGAC
AATGCTACACCATTAGGCAAAGCGACTTTTGTGTTAAAAAATGACAATGATAAGTCAGAAACAAGTCACGAA
ACGGTAGAGGGTTCTGGAGAAGCAACCTTTGAAAACATAAAACCTGGAGACTACACATTAAGAGAAGAAACA
GCACCAATTGGTTATAAAAAAACTGATAAAACCTGGAAAGTTAAAGTTGCAGATAACGGAGCAACAATAATC
GAGGGTATGGATGCAGATAAAGCAGAGAAACGAAAAGAAGTTTTGAATGCCCAATATCCAAAATCAGCTATT
TATGAGGATACAAAAGAAAATTACCCATTAGTTAATGTAGAGGGTTCCAAAGTTGGTGAACAATACAAAGCA
TTGAATCCAATAAATGGAAAAGATGGTCGAAGAGAGATTGCTGAAGGTTGGTTATCAAAAAAAATTACAGGG
GTCAATGATCTCGATAAGAATAAATATAAAATTGAATTAACTGTTGAGGGTAAAACCACTGTTGAAACGAAA
GAACTTAATCAACCACTAGATGTCGTTGTGCTATTAGATAATTCAAATAGTATGAATAATGAAAGAGCCAAT
AATTCTCAAAGAGCATTAAAAGCTGGGGAAGCAGTTGAAAAGCTGATTGATAAAATTACATCAAATAAAGAC
AATAGAGTAGCTCTTGTGACATATGCCTCAACCATTTTTGATGGTACTGAAGCGACCGTATCAAAGGGAGTT
GCCGATCAAAATGGTAAAGCGCTGAATGATAGTGTATCATGGGATTATCATAAAACTACTTTTACAGCAACT
ACACATAATTACAGTTATTTAAATTTAACAAATGATGCTAACGAAGTTAATATTCTAAAGTCAAGAATTCCA
AAGGAAGCGGAGCATATAAATGGGGATCGCACGCTCTATCAATTTGGTGCGACATTTACTCAAAAAGCTCTA
ATGAAAGCAAATGAAATTTTAGAGACACAAAGTTCTAATGCTAGAAAAAAACTTATTTTTCACGTAACTGAT
GGTGTCCCTACGATGTCTTATGCCATAAATTTTAATCCTTATATATCAACATCTTACCAAAACCAGTTTAAT
TCTTTTTTAAATAAAATACCAGATAGAAGTGGTATTCTCCAAGAGGATTTTATAATCAATGGTGATGATTAT
CAAATAGTAAAAGGAGATGGAGAGAGTTTTAAACTGTTTTCGGATAGAAAAGTTCCTGTTACTGGAGGAACG
ACACAAGCAGCTTATCGAGTACCGCAAAATCAACTCTCTGTAATGAGTAATGAGGGATATGCAATTAATAGT
GGATATATTTATCTCTATTGGAGAGATTACAACTGGGTCTATCCATTTGATCCTAAGACAAAGAAAGTTTCT
GCAACGAAACAAATCAAAACTCATGGTGAGCCAACAACATTATACTTTAATGGAAATATAAGACCTAAAGGT
TATGACATTTTTACTGTTGGGATTGGTGTAAACGGAGATCCTGGTGCAACTCCTCTTGAAGCTGAGAAATTT
ATGCAATCAATATCAAGTAAAACAGAAAATTATACTAATGTTGATGATACAAATAAAATTTATGATGAGCTA
AATAAATACTTTAAAACAATTGTTGAGGAAAAACATTCTATTGTTGATGGAAATGTGACTGATCCTATGGGA
GAGATGATTGAATTCCAATTAAAAAATGGTCAAAGTTTTACACATGATGATTACGTTTTGGTTGGAAATGAT
GGCAGTCAATTAAAAAATGGTGTGGCTCTTGGTGGACCAAACAGTGATGGGGGAATTTTAAAAGATGTTACA
GTGACTTATGATAAGACATCTCAAACCATCAAAATCAATCATTTGAACTTAGGAAGTGGACAAAAAGTAGTT
CTTACCTATGATGTACGTTTAAAAGATAACTATATAAGTAACAAATTTTACAATACAAATAATCGTACAACG
CTAAGTCCGAAGAGTGAAAAAGAACCAAATACTATTCGTGATTTCCCAATTCCCAAAATTCGTGATGTTCGT
GAGTTTCCGGTACTAACCATCAGTAATCAGAAGAAAATGGGTGAGGTTGAATTTATTAAAGTTAATAAAGAC
AAACATTCAGAATCGCTTTTGGGAGCTAAGTTTCAACTTCAGATAGAAAAAGATTTTTCTGGGTATAAGCAA
TTTGTTCCAGAGGGAAGTGATGTTACAACAAAGAATGATGGTAAAATTTATTTTAAAGCACTTCAAGATGGT
AACTATAAATTATATGAAATTTCAAGTCCAGATGGCTATATAGAGGTTAAAACGAAACCTGTTGTGACATTT
ACAATTCAAAATGGAGAAGTTACGAACCTGAAAGCAGATCCAAATGCTAATAAAAATCAAATCGGGTATCTT
GAAGGAAATGGTAAACATCTTATTACCAACACTCCCAAACGCCCACCAGGTGTTTTTCCTAAAACAGGGGGA
ATTGGTACAATTGTCTATATATTAGTTGGTTCTACTTTTATGATACTTACCATTTGTTCTTTCCGTCGTAAA
CAATTGTAA

ORF amino acid sequence (SEQ ID NO: 196):
MKKRQKIWRGLSVTLLILSQIPFGILVQGETQDTNQALGKVIVKKTGDNATPLGKATFVLKNDNDKSETSHE
TVEGSGEATFENIKPGDYTLREETAPIGYKKTDKTWKVKVADNGATIIEGMDADKAEKRKEVLNAQYPKSAI
YEDTKENYPLVNVEGSKVGEQYKALNPINGKDGRREIAEGWLSKKITGVNDLDKNKYKIELTVEGKTTVETK
ELNQPLDVVVLLDNSNSMNNERANNSQRALKAGEAVEKLIDKITSNKDNRVALVTYASTIFDGTEATVSKGV
ADQNGKALNDSVSWDYHKTTFTATTHNYSYLNLTNDANEVNILKSRIPKEAEHINGDRTLYQFGATFTQKAL
MKANEILETQSSNARKKLIFHVTDGVPTMSYAINFNPYISTSYQNQFNSFLNKIPDRSGILQEDFIINGDDY
QIVKGDGESFKLFSDRKVPVTGGTTQAAYRVPQNQLSVMSNEGYAINSGYIYLYWRDYNWVYPFDPKTKKVS
ATKQIKTHGEPTTLYFNGNIRPKGYDIFTVGIGVNGDPGATPLEAEKFMQSISSKTENYTNVDDTNKIYDEL
NKYFKTIVEEKHSIVDGNVTDPMGEMIEFQLKNGQSFTHDDYVLVGNDGSQLKNGVALGGPNSDGGILKDVT
VTYDKTSQTIKINHLNLGSGQKVVLTYDVRLKDNYISNKFYNTNNRTTLSPKSEKEPNTIRDFPIPKIRDVR
EFPVLTISNQKKMGEVEFIKVNKDKHSESLLGAKFQLQIEKDFSGYKQFVPEGSDVTTKNDGKIYFKALQDG
NYKLYEISSPDGYIEVKTKPVVTFTIQNGEVTNLKADPNANKNQIGYLEGNGKHLITNTPKRPPGVFPKTGG
IGTIVYILVGSTFMILTICSFRRKQL

Strain IC253

ORF DNA sequence (SEQ ID NO: 216):
ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA

GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCACGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCTACA
GAAGCTCCTAGAGCTAAATGGGGATCAACTACAAACGGACTTACTCCAGAGCAACAAAAGCAGTACTATCTT
AGTAAAGTAGGGGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAGATCGA
AATAGTCAAAAAATTATTGTTCATATAACTGATGGTGTTCCAACAAGATCATATGCTATTAATAATTTTAAA
TTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
ATTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGCTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGGTTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 197):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNHEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPRAKWGSTTNGLTPEQQKQYYL
SKVGETFTMKAFMEADDILSQVDRNSQKIIVHITDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISAFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKVLTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC289

ORF DNA sequence (SEQ ID NO: 217):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAACCTACTTCACACTCAGAAAGCAAAGTAGAA
AAAGTAACTACTGAGGTAACAGGTGAAGCTACTTTTGATAATCTCACACCTGGAGATTACACTTTATCAGAA
GAAACGGCACCCGAAGGATACAAAAAGACTACCCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGATGATAAAAAATCTATAATTGAACAAAGGCAAGAGGAACTAGATAAGCAGTATCCC
CTTACAGGAGCTTATGAAGATACAAAAGAATCTTATAATCTTGAGCATGTTAAAAATTCAATTCCAAATGGG
AAATTAGAGGCAAAAGCAGTTAATCCATATTCAAGTGAAGGTGAGCACATAAGAGAAATTCAAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAAATGATTTGGATCATAATAAATATAAAATTGAGTTAACTGTTAGCGGT

AAATCCATAATAAAAACTATAAATAAAGATGAACCTCTGGATGTTGTTTTTGTTCTTGATAATTCAAATTCT
ATGAAGAATAATGGAAAAAATAACAAGGCAAAAAAGGCAGGTGAAGCAGTAGAAACAATTATAAAAGATGTT
TTAGGAGCAAATGTTGAAAACCGAGCAGCTTTAGTTACTTATGGTTCAGATATTTTTGATGGAAGGACAGTT
AAAGTTATAAAAGGTTTTAAAGAGGATCCTTATTATGGACTTGAAACTAGTTTCACAGTTCAGACAAATGAT
TATAGCTATAAAAAGTTCACTAATATTGCTGCTGATATTATAAAAAAGATCCCTAAAGAAGCTCCAGAAGCT
AAGTGGGGGGGGACAAGTCTAGGATTAACTCCAGAAAAAAAGAGGGAATATGATTTAAGTAAAGTAGGTGAG
ACCTTTACAATGAAAGCTTTTATGGAGGCAGATACCTTGTTAAGTAGTATACAGCGTAAGAGTAGAAAGATT
ATTGTTCATCTAACTGACGGTGTTCCAACAAGATCATATGCCATTAATAGTTTTGTAAAAGGTTCAACATAC
GCAAATCAATTTGAGAGAATAAAAGAAAAAGGTTATTTAGACAAAAATAATTATTTTATAACTGATGATCCA
GAAAAGATCAAAGGCAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAAACACAGATAATTTCT
GGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACAATTTATAGAAATGGA
CCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAAAATTATGACATCTTT
AATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAAAATCAAGATGGTACT
TTTCAAAAATTGAAGGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTAATGAATTCATTCTCT
TCTAAACCTGAGTATTATACCCCGATAGTAACTTCAGCTGATGTATCTAATAATGAAATTTTATCTAAAATT
CAGCAACAATTTGAAAAGATTTTAACAAAGGAAAACTCAATTGTTAATGGAACTATAGAAGATCCTATGGGT
GATAAAATCAATTTACATCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACTTTACAGGGAAATGAT
GGAAGTATAATGAAAGATAGCATTGCAACTGGAGGGCCTAATAATGATGGTGGGATACTTAAAGGGGTTAAA
TTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGGCAAAAAGTAACACTCACA
TATGATGTGAAACTAGATGACAGTTTTATTAGTAACAAATTCTATGACACTAATGGTAGAACAACATTGAAT
CCTAAATCAGAGGAACCCGATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGATGTGAGAGAATATCCT
ACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGATAAAGATAATAATAAG
TTGCTTCTCAAAGGAGCTACATTTGAACTTCAAGAATTTAATGAAGATTATAAACTTTATTTACCAATAAAA
AATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTGAAAGATGGCAAATAT
CAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATTTTAACTTTTGAAGTT
GTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCATGAGGAAGGTGACAAG
CATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGGAAAGGAATTCTATCT
TTCATTTTAATAGGTGGAGCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAAAGACATAAGAAATCT
AGTGATGCATCAATCGAGAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 198):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKPTSHSESKVE
KVTTEVTGEATFDNLTPGDYTLSEETAPEGYKKTTQTWQVKVESNGKTTIQNSDDKKSIIEQRQEELDKQYP
LTGAYEDTKESYNLEHVKNSIPNGKLEAKAVNPYSSEGEHIREIQEGTLSKRISEVNDLDHNKYKIELTVSG
KSIIKTINKDEPLDVVFVLDNSNSMKNNGKNNKAKKAGEAVETIIKDVLGANVENRAALVTYGSDIFDGRTV
KVIKGFKEDPYYGLETSFTVQTNDYSYKKFTNIAADIIKKIPKEAPEAKWGGTSLGLTPEKKREYDLSKVGE
TFTMKAFMEADTLLSSIQRKSRKIIVHLTDGVPTRSYAINSFVKGSTYANQFERIKEKGYLDKNNYFITDDP
EKIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQKNYDIF
NFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMNSFSSKPEYYTPIVTSADVSNNEILSKI
QQQFEKILTKENSIVNGTIEDPMGDKINLHLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGILKGVK
LEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEEPDTLRDFPIPKIRDVREYP
TITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDLKDGKY
QLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGGKGILS
FILIGGAMMSIAGGIYIWKRHKKSSDASIEKD

Strain IC291

ORF DNA sequence (SEQ ID NO: 218):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA

GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 199):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC304

ORF DNA sequence (SEQ ID NO: 219):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCAACCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA
GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA

ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

<u>ORF amino acid sequence (SEQ ID NO: 200):</u>

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAQPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC305

<u>ORF DNA sequence (SEQ ID NO: 220):</u>

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA
GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA

ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT
AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 201):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC306

ORF DNA sequence (SEQ ID NO: 221):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGCTAACAGGTGAAGCTACTTTTGATAATCTCATACCTGGAGATTATACTTTATCAGAA
GAAACAGCGCCCGAAGGTTATAAAAAGACTAACCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGGTGATAAAAATTCCACAATTGGACAAAATCAGGAAGAACTAGATAAGCAGTATCCC
CCCACAGGAATTTATGAAGATACAAAGGAATCTTATAAACTTGAGCATGTTAAAGGTTCAGTTCCAAATGGA
AAGTCAGAGGCAAAAGCAGTTAACCCATATTCAAGTGAAGGTGAGCATATAAGAGAAATTCCAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAGGTGATTTAGCTCATAATAAATATAAAATTGAGTTAACTGTCAGTGGA
AAAACCATAGTAAAACCAGTGGACAAACAAAAGCCGTTAGATGTTGTCTTCGTACTCGATAATTCTAACTCA
ATGAATAACGATGGCCCAAATTTTCAAAGGCATAATAAAGCCAAGAAAGCTGCCGAAGCTCTTGGGACCGCA
GTAAAAGATATTTTAGGAGCAAACAGTGATAATAGGGTTGCATTAGTTACCTATGGTTCAGATATTTTTGAT
GGTAGGAGTGTAGATGTCGTAAAAGGATTTAAAGAAGATGATAAATATTATGGCCTTCAAACTAAGTTCACA
ATTCAGACAGAGAATTATAGTCATAAACAATTAACAAATAATGCTGAAGAGATTATAAAAAGGATTCCGACA
GAAGCTCCTAAAGCTAAGTGGGGATCTACTACCAATGGATTAACTCCAGAGCAACAAAAGGAGTACTATCTT
AGTAAAGTAGGAGAAACATTTACTATGAAAGCCTTCATGGAGGCAGATGATATTTTGAGTCAAGTAAATCGA
AATAGTCAAAAAATTATTGTTCATGTAACTGATGGTGTTCCTACGAGATCATATGCTATTAATAATTTTAAA
CTGGGTGCATCATATGAAAGCCAATTTGAACAAATGAAAAAAAATGGATATCTAAATAAAAGTAATTTTCTA
CTTACTGATAAGCCCGAGGATATAAAAGGAAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAA
ACACAGATAATCTCTGGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACA
TTTTATCGAAATGGACCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAA
AATTATGACATCTTTAATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAA
AATCAAGATGGTACTTTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGATGGGGAAATAACAGAACTA
ATGAAGTCATTCTCTTCTAAACCTGAGTATTATACCCCGATAGTAACTTCATCCGATGCATCTAACAATGAA
ATTTTATCTAAAATTCAGCAACAATTTGAAAAGATTTTAACAAAAGAAAACTCAATTGTTAATGGAACTATA
GAAGATCCTATGGGTGACAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACT
TTACAGGGAAATGATGGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGTGGAATA
CTTAAAGGGGTTAAATTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGACAA
AAAGTAACACTCACATATGATGTGAAACTAGATGACAGTTTTATAAGTAACAAATTCTATGACACTAATGGT

AGAACAACATTGAATCCTAAATCAGAGGATCCTAATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGAT
GTGAGAGAATATCCTACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGAT
AAAGATAATAATAAGTTGCTTCTCAAAGGAGCTACGTTTGAACTTCAAGAATTTAATGAAGATTATAAACTT
TATTTACCAATAAAAAATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTG
AAAGATGGCAAATATCAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATT
TTAACTTTTGAAGTTGTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCAT
GAGGAAGGTGACAAGCATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGG
AAAGGAATTCTATCTTTCATTTTAATAGGTGGATCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAA
AGATATAAGAAATCTAGTGATATATCTAGAGAAAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 202):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAELTGEATFDNLIPGDYTLSEETAPEGYKKTNQTWQVKVESNGKTTIQNSGDKNSTIGQNQEELDKQYP
PTGIYEDTKESYKLEHVKGSVPNGKSEAKAVNPYSSEGEHIREIPEGTLSKRISEVGDLAHNKYKIELTVSG
KTIVKPVDKQKPLDVVFVLDNSNSMNNDGPNFQRHNKAKKAAEALGTAVKDILGANSDNRVALVTYGSDIFD
GRSVDVVKGFKEDDKYYGLQTKFTIQTENYSHKQLTNNAEEIIKRIPTEAPKAKWGSTTNGLTPEQQKEYYL
SKVGETFTMKAFMEADDILSQVNRNSQKIIVHVTDGVPTRSYAINNFKLGASYESQFEQMKKNGYLNKSNFL
LTDKPEDIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTFYRNGPVREHGTPTKLYINSLKQK
NYDIFNFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSDGEITELMKSFSSKPEYYTPIVTSSDASNNE
ILSKIQQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGI
LKGVKLEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEDPNTLRDFPIPKIRD
VREYPTITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDL
KDGKYQLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGG
KGILSFILIGGSMMSIAGGIYIWKRYKKSSDISREKD

Strain IC458

ORF DNA sequence (SEQ ID NO: 222):

ATGAGAAAATACCAAAAATTTTCTAAAATATTGACGTTAAGTCTTTTTTGTTTGTCGCAAATACCGCTTAAT
ACCAATGTTTTAGGGGAAAGTACCGTACCGGAAAATGGTGCTAAAGGAAAGTTAGTTGTTAAAAAGACAGAT
GACCAGAACAAACCACTTTCAAAAGCTACCTTTGTTTTAAAAACTACTGCTCATCCAGAAAGTAAAATAGAA
AAAGTAACTGCTGAGGTAACAGGTGAAGCTACTTTTGATAATCTCACACCTGGAGATTACACTTTATCAGAA
GAAACGGCACCCGAAGGATACAAAAAGACTACCCAGACTTGGCAAGTTAAGGTTGAGAGTAATGGAAAAACT
ACGATACAAAATAGTGATGATAAAAAAATCTATAATTGAACAAAGGCAAGAGGAACTAGATAAGCAGTATCCC
CTTACAGGAGCTTATGAAGATACAAAAGAATCTTATAATCTTGAGCATGTTAAAAAATTCAATTCCAAATGGG
AAATTAGAGGCAAAAGCAGTTAATCCATATTCAAGTGAAGGTGAGCACATAAGAGAAATTCAAGAGGGAACA
TTATCTAAACGTATTTCAGAAGTAAATGATTTGGATCATAATAAATATAAAATTGAGTTAACTGTTAGCGGT
AAATCCATAATAAAAACTATAAATAAAGATGAACCTCTGGATGTTGTTTTTGTTCTTGATAATTCAAATTCT
ATGAAGAATAATGGAAAAAATAACAAGGCAAAAAAGGCAGGTGAAGCAGTAGAAACAATTATAAAAGATGTT
TTAGGAGCAAATGTTGAAAACCGAGCAGCTTTAGTTACTTATGGTTCAGATATTTTTGATGGAAGGACAGTT
AAAGTTATAAAAGGTTTTAAAGAGGATCCTTATCATGGACTTGAAACTAGTTTCACAGTTCAGACAAATGAT
TATAGCTATAAAAAGTTCACTAATATTGCTGCTGATATTATAAAAAAGATCCCTAAAGAAGCTCCAGAAGCT
AAGTGGGGGGGGGACAAGTCTAGGATTAACTCCAGAAAAAAAGAGGGAATATGATTTAAGTAAAGTAGGTGAG
ACCTTTACAATGAAAGCTTTTATGGAGGCAGATACCTTGTTAAGTAGTATACAGCGTAAGAGTAGAAAGATT
ATTGTTCATCTAACTGACGGTGTTCCAACAAGATCATATGCTATTAATAGTTTTGTAACAGGTTCAACATAC
GCAAATCAATTTGAGAGAATAAAAGAAAAAGGTTATTTAGACAAAAATAATTATTTTATAACTGATGATCCA
GAAAAGATCAAAGGCAATGGGGAGAGTTACTTTTTGTTTCCCTTAGATAGTTATCAAACACAGATAATTTCT
GGAAACTTACAAAAACTTCATTATTTAGATTTAAATCTTAATTACCCTAAAGGTACAATTTATAGAAATGGA
CCAGTAAGAGAACATGGAACACCAACCAAACTTTATATAAATAGTTTAAAACAGAAAAATTATGACATCTTT
AATTTTGGTATAGATATATCTGGTTTTAGACAAGTTTATAATGAGGATTATAAGAAAAATCAAGATGGTACT
TTTCAAAAATTGAAAGAGGAAGCTTTTGAACTTTCAGGTGGGGAAATAACAGAACTAATGAAGTCATTCTCT
TCTAAACCTGAGTATTATACCCCGATAGTAACTTCAGCTGATGTATCTAATAATGAAATTTTATCTAAAATT
CAGCAACAATTTGAAAAGATTTTAACAAAGGAAAACTCAATTGTTAATGGAACTATAGAAGATCCTATGGGT
GATAAAATCAATTTACAGCTTGGCAACGGACAAACATTGCAACCAAGTGATTATACTTTACAGGGAAATGAT
GGAAGTATAATGAAAGATAGCATTGCAACTGGTGGGCCTAATAATGATGGCGGGATACTTAAAGGGGTTAAA
TTAGAATACATCAAAAATAAACTCTACGTTAGAGGTTTGAACTTAGGGGAGGGGCAAAAAGTAACACTCACA
TATGATGTGAAACTAGATGACAGTTTTATTAGTAACAAATTCTATGACACTAATGGTAGAACAACATTGAAT
CCTAAATCAGAGGAACCTGATACACTTAGAGATTTTCCAATCCCTAAAATTCGTGATGTGAGAGAATATCCT
ACAATAACGATTAAAAACGAGAAGAAGTTAGGTGAAATTGAATTTACAAAAGTTGATAAAGATAATAATAAG
TTGCTTCTCAAAGGAGCTACATTTGAACTTCAAGAATTTAATGAAGATTATAAACTTTATTTACCAATAAAA
AATAATAATTCAAAAGTAGTGACGGGAGAAAACGGCAAAATTTCTTACAAAGATTTGAAAGATGGCAAATAT
CAGTTAATAGAAGCAGTTTCGCCGAAGGATTATCAAAAAATTACTAATAAACCAATTTTAACTTTTGAAGTT

GTTAAAGGATCGATACAAAATATAATAGCTGTTAATAAACAGATTTCTGAATATCATGAGGAAGGTGACAAG
CATTTAATTACCAACACGCATATTCCACCAAAAGGAATTATTCCGATGACAGGTGGGAAAGGAATTCTATCT
TTCATTTTAATAGGTGGAGCTATGATGTCTATTGCAGGTGGAATTTATATTTGGAAAAAACATAAGAAATCT
AGTGATGCATCAATCGAGAAAGATTAA

ORF amino acid sequence (SEQ ID NO: 203):

MRKYQKFSKILTLSLFCLSQIPLNTNVLGESTVPENGAKGKLVVKKTDDQNKPLSKATFVLKTTAHPESKIE
KVTAEVTGEATFDNLTPGDYTLSEETAPEGYKKTTQTWQVKVESNGKTTIQNSDDKKSIIEQRQEELDKQYP
LTGAYEDTKESYNLEHVKNSIPNGKLEAKAVNPYSSEGEHIREIQEGTLSKRISEVNDLDHNKYKIELTVSG
KSIIKTINKDEPLDVVFVLDNSNSMKNNGKNNKAKKAGEAVETIIKDVLGANVENRAALVTYGSDIFDGRTV
KVIKGFKEDPYHGLETSFTVQTNDYSYKKFTNIAADIIKKIPKEAPEAKWGGTSLGLTPEKKREYDLSKVGE
TFTMKAFMEADTLLSSIQRKSRKIIVHLTDGVPTRSYAINSFVTGSTYANQFERIKEKGYLDKNNYFITDDP
EKIKGNGESYFLFPLDSYQTQIISGNLQKLHYLDLNLNYPKGTIYRNGPVREHGTPTKLYINSLKQKNYDIF
NFGIDISGFRQVYNEDYKKNQDGTFQKLKEEAFELSGGEITELMKSFSSKPEYYTPIVTSADVSNNEILSKI
QQQFEKILTKENSIVNGTIEDPMGDKINLQLGNGQTLQPSDYTLQGNDGSIMKDSIATGGPNNDGGILKGVK
LEYIKNKLYVRGLNLGEGQKVTLTYDVKLDDSFISNKFYDTNGRTTLNPKSEEPDTLRDFPIPKIRDVREYP
TITIKNEKKLGEIEFTKVDKDNNKLLLKGATFELQEFNEDYKLYLPIKNNNSKVVTGENGKISYKDLKDGKY
QLIEAVSPKDYQKITNKPILTFEVVKGSIQNIIAVNKQISEYHEEGDKHLITNTHIPPKGIIPMTGGKGILS
FILIGGAMMSIAGGIYIWKKHKKSSDASIEKD

Table 12: Amino acid and encoding DNA sequences of gbs2018 proteins derived from different strains of *S. agalactiae*

Strain 0176H4A

ORF DNA sequence (SEQ ID NO: 180):

ATGAATAATAACGAAAAAAAAGTAAAATACTTTTTAAGAAAAACAGCTTATGGTTTGGCCTCAATGTCAGCA
GCGTTTGCTGTATGTAGTGGTATTGTACACGCGGATACTAGTTCAGGAATATCGGATTCAATTCCTCATAAG
AAACAAGTTAATTTAGGGGCGGTTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATT
GCTATACTTCTAAGTAGAGTAGATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT
ACTGAAGCAGAAATTAACAATACTTTACCTCAGGGACGAATTATTAAACAGAGTATACCAGTCGTAAGATTA
AAAGTTGAGAGATTGGGAAGTGGTGCAATTAAGGCTGAGTCGATTAATAATATTAAAGCTGAATCAATTAAT
AAAATTCAGGGTAAATCAACTAATACAATTAAGGCTGAGTCCATTAATAAAATTAAAGTAGAGTCTATTAAT
ACAATCAAAGCCGAATCAATTAATAAAATTCAAGCTAAGCCAATTAACACAATCAAAGCCGAGTCTATTAAT
ACAATTAAGGCTGAATCAATTCATAAAATTAAACCTCAATCAATAAAAAGTACTAGTGCTACACATGTTAAA
GTTAGTGATCAAGAACTAGCTAAGCAGTCAAGACGTTCTCAAGATATCATTAAATCATTAGGTTTCCTTTCA
TCAGACCAAAAAGATATTTTAGTTAAATCTATTAGCTCTTCAAAAGATTCGCAACTTATTCTTAAATTTGTA
ACACAAGCCACGCAACTGAATAATGCTGAATCAACAAAAGCTAAGCACATGGCTCAAAATGACGTGGCTTCA
ATAAAAAATATAAGCCTCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACTAAGAGTCAA
GTTGATGAGCTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACATTGGTAAATCAGGCCAAT
GGTAAAAAGCAAGAAATTGCTAAGTTAGAAAATTTATCTAACGATGAAATGTTGAGATATAATACTGCAATT
GATAATGTAGTGAAACAGTATAATGAAGGTAAGCTCAATATTACTGATGCAATGAATGCTTTAAATAGTATT
AAGCAAGCAGCACAGGAAGTTGCCCAGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAAAGAATAAGT
TTAAAAGGATTAGCGTTATCCAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTGCCTACACCT
GGATATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACGAACTTTCGGAAATAGAAGT
GTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGTCAAAAAGCTTTTAAAAGAA
CTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCAGACGTTAAGCCAGAAGCCAAACCAGAGGCC
AAACCAAATATTCAAGTACCTAAACAAGCACCTACAGAAGCTGCAAAACCAGCTTTGTCACCAGAAGCCTTG
ACAAGATTGACTACATGGTATAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGACAAATATGTA
GATATACTTGCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTTATTACCACT
GATCAAGCAAATCAATTAGCTAACAAGCTACGTGATGCTTTACAAAGTTTAGAATTAAAAGATAAAAAAGTA
GCCAAACCAGAAGCTAAGCCAGAAGTTAAACCAGAAGCCAAACCAGATGTTAAGCCAGACGTTAAGCCAGAA
GCTAAGCCAGAAGCCAAACCAGAGGCCAAACCAGAAGCCAAACCAGAGGCCAAACCAGAAGCCAAACCAGAG
GCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAAGCCAAACCAGAC
GTTAAGCCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAAGTTAAACCAGAGGCTAAACCAGAA
ATTAAACCAGACGTTAAGCCAGAGGCCAGACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAG
GCCAAACCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGAGGCTAAGCCAGAAGTTAAACCAGAC
GTTAAGCCAGAGGCTAAACCAGAAGCCAAACCAGCAACCAAAAAATCGGTTAATACTAGCGGAAACTTGGCG
GCTAAAAAAGCTATTGAAAACAAAAAGTATAGTAAAAAATTACCATCAACGGGTGAAGCCGCAAGTCCACTC

TTAGCAATTGTATCACTAATTGTTATGTTAAGTGCAGGTCTTATTACGATAGTTTTAAAGCATAAAAAAAAT
TAA

ORF amino acid sequence (SEQ ID NO: 175):

MNNNEKKVKYFLRKTAYGLASMSAAFAVCSGIVHADTSSGISDSIPHKKQVNLGAVTLKNLISKYRGNDKAI
AILLSRVDDFNRASQDTLPQLINSTEAEINNTLPQGRIIKQSIPVVRLKVERLGSGAIKAESINNIKAESIN
KIQGKSTNTIKAESINKIKVESINTIKAESINKIQAKPINTIKAESINTIKAESIHKIKPQSIKSTSATHVK
VSDQELAKQSRRSQDIIKSLGFLSSDQKDILVKSISSSKDSQLILKFVTQATQLNNAESTKAKHMAQNDVAS
IKNISLEVLEEYKEKIQRASTKSQVDELVAEAKKVVNSNKETLVNQANGKKQEIAKLENLSNDEMLRYNTAI
DNVVKQYNEGKLNITDAMNALNSIKQAAQEVAQKNLQKQYAKKIERISLKGLALSKKAKEIYEKHKSILPTP
GYYADSVGTYLNRFRDKRTFGNRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKPDVKPEAKPEA
KPNIQVPKQAPTEAAKPALSPEALTRLTTWYNQAKDLLKDDQVKDKYVDILAVQKAVDQAYDHVEEGKFITT
DQANQLANKLRDALQSLELKDKKVAKPEAKPEVKPEAKPDVKPDVKPEAKPEAKPEAKPEAKPEAKPEAKPE
AKPEVKPDVKPEAKPDVKPEAKPDVKPEAKPEVKPDVKPEVKPEAKPEIKPDVKPEARPEAKPEVKPDVKPE
AKPEVKPDVKPEAKPEAKPEVKPDVKPEAKPEAKPATKKSVNTSGNLAAKKAIENKKYSKKLPSTGEAASPL
LAIVSLIVMLSAGLITIVLKHKKN

Strain 12401

ORF DNA sequence (SEQ ID NO: 181):

ATGAATAATAACGAAAAAAAAGTAAAATACTTTTTAAGAAAAACAGCTTATGGTTTGGCCTCAATGTCAGCA
GCGTTTGCTGTATGTAGTGGTATTGTACACGCGGATACTAGTTCAGGAATATCGGATTCAATTCCTCATAAG
AAACAAGTTAATTTAGGGGCGGTTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATT
GCTATACTTTTAAGTAGAGTAAATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT
ACTGAAGCAGAAATTAACAATACTTTACCTCAGGGACGAATTATTAAACAGAGTATACCAGTCGTAAGATTA
AAAGTTGAGAGATTGGGAAGTGGTGCAATTAAGGCTGAGTCGATTAATAATATTAAAGCTGAATCAATTAAT
AAAATTCAGGGTAAATCAACTAATACAATTAAGGCTGAGTCCATTAATAAAATTAAAGTAGAGTCTATTAAT
ACAATCAAAGCCGAATCAATTAATAAAATTCAAGCTAAGCCAATTAACACAATCAAAGCCGAGTCTATTAAT
ACAATTAAGGCTGAATCAATTCATAAAATTAAACCTCAATCAATAAAAAGTACTAGTGCTACACATGTTAAA
GTTAGTGATCAAGAACTAGGTAAGCAGTCAAGACGTTCTCAAGATATCATTAAATCATTAGGTTTCCTTTCA
TCAGACCAAAAAGATATTTTAGTTAAATCTATTAGCTCTTCAAAAGATTCGCAACTTATTCTTAAATTTGTA
ACACAAGCCACGCAACTGAATAATGCTGAATCAACAAAAGCTAAGCACATGGCTCAAAATGACGTGGCTTCA
ATAAAAAATATAAGCCTCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACTAAGAGTCAA
GTTGATGAGCTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACATTGGTAAATCAGGCCAAT
GGTAAAAAGCAAGAAATTGCTAAGTTAGAAAATTTATCTAACGATGAAATGTTGAGATATAATACTGCAATT
GATAATGTAGTGAAACAGTATAATGAAGGTAAGCTCAATATTACTGATGCAATGAATGCTTTAAATAGTATT
AAGCAAGCAGCACAGGAAGTTGCCCAGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAAAGAATAAGT
TTAAAAGGATTAGCGTTATCCAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTGCCTACACCT
GGATATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACGAACTTTCGGAAATAGAAGT
GTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGTCAAAAAGCTTTTAAAAGAA
CTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCAGACGTTAAGCCAGAAGCCAAACCAGAGGCC
AAACCAAATATTCAAGTACCTAAACAAGCACCTACAGAAGCTGCAAAACCAGCTTTGTCACCAGAAGCCTTG
ACAAGATTGACTACATGGTATAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGACAAATATGTA
GATATACTTGCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTTATTACCACT
GATCAAGCAAATCAATTAGCTAACAAGCTACGTGATGCTTTACAAAGTTTAGAATTAAAAGATAAAAAAGTA
GCCAAACCAGAAGCTAAGCCAGAAGTTAAACCAGAAGCCAAACCAGAGGCCAAACCAGAAGCCAAACCAGAG
GCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAAGCCAAACCAGAC
GTTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAAGCTAAGCCAGAC
GTTAAGCCAGAAGTTAAACCAGAGGCTAAGCCAGAAGCCAAACCAGAGGCTAAACCAGAAATTAAACCAGAC
GTTAAGCCAGAGGCCAGACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGAG
GTTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCTAAACCAGAAGCCAAACCAGCAACCAAAAAAATCG
GTTAATACTAGCGGAAACTTGGCGGTTAAAAAAGCTATTGAAAACAAAAAGTATAGTAAAAAATTACCATCA
ACGGGTGAAGCCGCAAGTCCACTCTTAGCAATTGTATCACTAATTGTTATGTTAAGTGCAGGTCTTATTACG
ATAGTTTTAAAGCATAAAAAAAAATTAA

ORF amino acid sequence (SEQ ID NO: 176):

MNNNEKKVKYFLRKTAYGLASMSAAFAVCSGIVHADTSSGISDSIPHKKQVNLGAVTLKNLISKYRGNDKAI
AILLSRVNDFNRASQDTLPQLINSTEAEINNTLPQGRIIKQSIPVVRLKVERLGSGAIKAESINNIKAESIN
KIQGKSTNTIKAESINKIKVESINTIKAESINKIQAKPINTIKAESINTIKAESIHKIKPQSIKSTSATHVK
VSDQELGKQSRRSQDIIKSLGFLSSDQKDILVKSISSSKDSQLILKFVTQATQLNNAESTKAKHMAQNDVAS
IKNISLEVLEEYKEKIQRASTKSQVDELVAEAKKVVNSNKETLVNQANGKKQEIAKLENLSNDEMLRYNTAI
DNVVKQYNEGKLNITDAMNALNSIKQAAQEVAQKNLQKQYAKKIERISLKGLALSKKAKEIYEKHKSILPTP
GYYADSVGTYLNRFRDKRTFGNRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKPDVKPEAKPEA

KPNIQVPKQAPTEAAKPALSPEALTRLTTWYNQAKDLLKDDQVKDKYVDILAVQKAVDQAYDHVEEGKFITT
DQANQLANKLRDALQSLELKDKKVAKPEAKPEVKPEAKPEAKPEAKPEAKPEVKPDVKPEAKPDVKPEAKPD
VKPEVKPDVKPEAKPDVKPEAKPDVKPEVKPEAKPEAKPEAKPEIKPDVKPEARPEAKPEVKPDVKPEAKPE
VKPEVKPDVKPEAKPEAKPATKKSVNTSGNLAVKKAIENKKYSKKLPSTGEAASPLLAIVSLIVMLSAGLIT
IVLKHKKN

Strain BAA23

ORF DNA sequence (SEQ ID NO: 182):

ATGAATAATAACGAAAAAAAAGTAAAATACTTTTTAAGAAAAACAGCTTATGGTTTGGCCTCAATGTCAGCA
GCGTTTGCTGTATGTAGTGGTATTGTACACGCGGATACTAGTTCAGGAATATCGGATTCAATTCCTCATAAG
AAACAAGTTAATTTAGGGGCGGTTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATT
GCTATACTTCTAAGTAGAGTAGATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT
ACTGAAGCAGAAATTAACAATACTTTACCTCAGGGACGAATTATTAAACAGAGTATACCAGTCGTAAGATTA
AAAGTTGAGAGATTGGGAAGTGGTGCAATTAAGGCTGAGTCGATTAATAATATTAAAGCTGAATCAATTAAT
AAAATTCAGGGTAAATCAACTAATACAATTAAGGCTGAGTCCATTAATAAAATTAAAGTAGAGTCTATTAAT
ACAATCAAAGCCGAATCAATTAATAAAATTCAAGCTAAGCCAATTAACACAATCAAAGCCGAGTCTATTAAT
ACAATTAAGGCTGAATCAATTCATAAAATTAAACCTCAATCAATAAAAAGTACTAGTGCTACACATGTTAAA
GTTAGTGATCAAGAACTAGCTAAGCAGTCAAGACGTTCTCAAGATATCATTAAATCATTAGGTTTCCTTTCA
TCAGACCAAAAAGATATTTTAGTTAAATCTATTAGCTCTTCAAAAGATTCGCAACTTATTCTTAAATTTGTA
ACACAAGCCACGCAACTGAATAATGCTGAATCAACAAAAGCTAAGCACATGGCTCAAAATGACGTGGCTTCA
ATAAAAAATATAAGCCTCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACTAAGAGTCAA
GTTGATGAGCTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACATTGGTAAATCAGGCCAAT
GGTAAAAAGCAAGAAATTGCTAAGTTAGAAAATTTATCTAACGATGAAATGTTGAGATATAATACTGCAATT
GATAATGTAGTGAAACAGTATAATGAAGGTAAGCTCAATATTACTGATGCAATGAATGCTTTAAATAGTATT
AAGCAAGCAGCACAGGAAGTTGCCCAGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAAAGAATAAGT
TTAAAAGGATTAGCGTTATCCAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTGCCTACACCT
GGATATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACGAACTTTCGGAAATAGAAGT
GTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGTCAAAAAGCTTTTAAAAGAA
CTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCAGACGTTAAGCCAGAAGCCAAACCAGAGGCC
AAACCAAATATTCAAGTACCTAAACAAGCACCTACAGAAGCTGCAAAACCAGCTTTGTCACCAGAAGCCTTG
ACAAGATTGACTACATGGTATAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGACAAATATGTA
GATATATTTGCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTTATTACCACT
GATCAAGCAAATCAATTAGCTAACAAGATACGTGATGCTTTACAAAGTTTAGAATTAAAAGATAAAAAAGTA
GCCAAACCAGAGGGTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAA
GCCAAACCAGACGTTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAA
GCTAAGCCAGACGTTAAGCCAGAAGTTAAACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAG
GCCAGACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGAGGCTAAGCCAGAA
GTTAAACCAGACGTTAAGCCAGAGGCTAAACCAGAAGCCAAACCAGCAACCAAAAAATCGGTTAATACTAGC
GGAAACTTGGCGGTTAAAAAAGCTATTGAAAACAAAAAGTATAGTAAAAAATTACCATCAACGGGTGAAGCC
GCAAGTCCACTCTTAGCAATTGTATCACTAATTGTTATGTTAAGTGCAGGTCTTATTACGATAGTTTTAAAG
CATAAAAAAAATTAA

ORF amino acid sequence (SEQ ID NO: 177):

MNNNEKKVKYFLRKTAYGLASMSAAFAVCSGIVHADTSSGISDSIPHKKQVNLGAVTLKNLISKYRGNDKAI
AILLSRVDDFNRASQDTLPQLINSTEAEINNTLPQGRIIKQSIPVVRLKVERLGSGAIKAESINNIKAESIN
KIQGKSTNTIKAESINKIKVESINTIKAESINKIQAKPINTIKAESINTIKAESIHKIKPQSIKSTSATHVK
VSDQELAKQSRRSQDIIKSLGFLSSDQKDILVKSISSSKDSQLILKFVTQATQLNNAESTKAKHMAQNDVAS
IKNISLEVLEEYKEKIQRASTKSQVDELVAEAKKVVNSNKETLVNQANGKKQEIAKLENLSNDEMLRYNTAI
DNVVKQYNEGKLNITDAMNALNSIKQAAQEVAQKNLQKQYAKKIERISLKGLALSKKAKEIYEKHKSILPTP
GYYADSVGTYLNRFRDKRTFGNRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKPDVKPEAKPEA
KPNIQVPKQAPTEAAKPALSPEALTRLTTWYNQAKDLLKDDQVKDKYVDIFAVQKAVDQAYDHVEEGKFITT
DQANQLANKIRDALQSLELKDKKVAKPEGKPEVKPDVKPEAKPDVKPEAKPDVKPEVKPDVKPEAKPDVKPE
AKPDVKPEVKPEAKPEVKPDVKPEARPEAKPEVKPDVKPEAKPEAKPEVKPDVKPEAKPEAKPATKKSVNTS
GNLAVKKAIENKKYSKKLPSTGEAASPLLAIVSLIVMLSAGLITIVLKHKKN

Strain IC105

ORF DNA sequence (SEQ ID NO: 183):

ATGAATAATAACGAAAAAAAAGTAAAATACTTTTTAAGAAAAACAGCTTATGGTTTGGCCTCAATGTCAGCA
GCGTTTGCTGTATGTAGTGGTATTGTACACGCGGATACTAGTTCAGGAATATCGGATTCAATTCCTCATAAG
AAACAAGTTAATTTAGGGGCGGTTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATT
GCTATACTTCTAAGTAGAGTAGATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT

ACTGAAGCAGAAATTAACAATACTTTACCTCAGGGACGAATTATTAAACAGAGTATACCAGTCGTAAGATTA
AAAGTTGAGAGATTGGGAAGTGGTGCAATTAAGGCTGAGTCGATTAATAATATTAAAGCTGAATCAATTAAT
AAAATTCAGGGTAAATCAACTAATACAATTAAGGCTGAGTCCATTAATAAAATTAAAGTAGAGTCTATTAAT
ACAATCAAAGCCGAATCAATTAATAAAATTCAAGCTAAGCCAATTAACACAATCAAAGCCGAGTCTATTAAT
ACAATTAAGGCTGAATCAATTCATAAAATTAAACCTCAATCAATAAAAAGTACTAGTGCTACACATGTTAAA
GTTAGTGATCAAGAACTAGGTAAGCAGTCAAGACGTTCTCAAGATATCATTAAATCATTAGGTTTCCTTTCA
TCAGACCAAAAAGATATTTTAGTTAAATCTATTAGCTCTTCAAAAGATTCGCAACTTATTCTTAAATTTGTA
ACACAAGCCACGCAACTGAATAATGCTGAATCAACAAAAGCTAAGCACATGGCTCAAAATGACGTGGCTTCA
ATAAAAAATATAAGCCTCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACTAAGAGTCAA
GTTGATGAGCTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACATTGGTAAATCAGGCCAAT
GGTAAAAAGCAAGAAATTGCTAAGTTAGAAAATTTATCTAACGATGAAATGTTGAGATATAATACTGCAATT
GATAATGTAGTGAAACAGTATAATGAAGGTAAGCTCAATATTACTGATGCAATGAATGCTTTAAATAGTATT
AAGCAAGCAGCACAGGAAGTTGCCCAGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAAAGAATAAGT
TTAAAAGGATTAGCGTTATCCAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTGCCTACACCT
GGATATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACGAACTTTCGGAAATAGAAGT
GTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGTCAAAAAGCTTTTAAAAGAA
CTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCAGACGTTAAGCCAGAAGCCAAACCAGAGGCC
AAACCAAATATTCAAGTACCTAAACAAGCACCTACAGAAGCTGCAAAACCAGCTTTGTCACCAGAAGCCTTG
ACAAGATTGACTACATGGTATAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGACAAATATGTA
GATATACTTGCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTTATTACCACT
GATCAAGCAAATCAATTAGCTAACAAGCTACGTGATGCTTTACAAAGTTTAGAATTAAAAGATAAAAAAGTA
GCCAAACCAGAAGCTAAGCCAGAAGTTAAACCAGAAGCCAAACCAGATGTTAAGCCAGACGTTAAGCCAGAA
GCTAAGCCAGAAGCCAAACCAGAGGCCAAACCAGAAGCCAAACCAGAGGCCAAACCAGAAGCCAAACCAGAG
GCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAAGCCAAACCAGAC
GTTAAGCCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGACGTTAAGCCAGAA
GCTAAGCCAGACGTTAAGCCAGAAGTTAAACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAG
GCCAGACCAGAGGCTAAGCCAGAAGTTAAACCAGACGTTAAGCCAGAGGCCAAACCAGAGGCTAAGCCAGAA
GTTAAACCAGACGTTAAGCCAGAGGCTAAACCAGAAGCTAAACCAGCAACCAAAAAATCGGTTAATACTAGC
GGAAACTTGGCGGTTAAAAAAGCTATTGAAAACAAAAAGTATAGTAAAAAATTACCATCAACGGGTGAAGCC
GCAAGTCCACTCTTAGCAATTGTATCACTAATTGTTATGTTAAGTGCAGGTCTTATTACGATAGTTTTAAAG
CATAAAAAAAATTAA

ORF amino acid sequence (SEQ ID NO: 178):

MNNNEKKVKYFLRKTAYGLASMSAAFAVCSGIVHADTSSGISDSIPHKKQVNLGAVTLKNLISKYRGNDKAI
AILLSRVDDFNRASQDTLPQLINSTEAEINNTLPQGRIIKQSIPVVRLKVERLGSGAIKAESINNIKAESIN
KIQGKSTNTIKAESINKIKVESINTIKAESINKIQAKPINTIKAESINTIKAESIHKIKPQSIKSTSATHVK
VSDQELGKQSRRSQDIIKSLGFLSSDQKDILVKSISSSKDSQLILKFVTQATQLNNAESTKAKHMAQNDVAS
IKNISLEVLEEYKEKIQRASTKSQVDELVAEAKKVVNSNKETLVNQANGKKQEIAKLENLSNDEMLRYNTAI
DNVVKQYNEGKLNITDAMNALNSIKQAAQEVAQKNLQKQYAKKIERISLKGLALSKKAKEIYEKHKSILPTP
GYYADSVGTYLNRFRDKRTFGNRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKPDVKPEAKPEA
KPNIQVPKQAPTEAAKPALSPEALTRLTTWYNQAKDLLKDDQVKDKYVDILAVQKAVDQAYDHVEEGKFITT
DQANQLANKLRDALQSLELKDKKVAKPEAKPEVKPEAKPDVKPDVKPEAKPEAKPEAKPEAKPEAKPEAKPE
AKPEVKPDVKPEAKPDVKPEAKPDVKPEAKPEVKPDVKPEAKPDVKPEAKPDVKPEVKPEAKPEVKPDVKPE
ARPEAKPEVKPDVKPEAKPEAKPEVKPDVKPEAKPEAKPATKKSVNTSGNLAVKKAIENKKYSKKLPSTGEA
ASPLLAIVSLIVMLSAGLITIVLKHKKN

Strain IC458

ORF DNA sequence (SEQ ID NO: 184):

ATGAATAATAACGAAAAAAAAGTAAAATACTTTTTAAGAAAAACAGCTTATGGTTTGGCCTCAATGTCAGCA
GCGTTTGCTGTATGTAGTGGTATTGTACACGCGGATACTAGTTCAGGAATATCGGCTTCAATTCCTCATAAG
AAACAAGTTAATTTAGGGGCGGTTACTCTGAAGAATTTGATTTCTAAATATCGTGGTAATGACAAAGCTATT
GCTATACTTTTAAGTAGAGTAAATGATTTTAATAGAGCATCACAGGATACACTTCCACAATTAATTAATAGT
ACTGAAGCAGAAATTAGAAATATTTTATATCAAGGACAAATTGGTAAGCAAAATAAACCAAGTGTAACTACA
CATGCTAAAGTTAGTGATCAAGAACTAGGTAAGCAGTCAAGACGTTCTCAAGATATCATTAAGTCATTAGGT
TTCCTTTCATCAGACCAAAAAGATATTTTAGTTAAATATATTAGCTCTTCAAAAGATTCGCAACTTATTCTT
AAATTTGTAACTCAAGCCACGCAACTGAATAATGCTGAATCAACAAAAGCTAAGCAAATGGCTCAAAATGAC
GTGGCCTTAATAAAAAATATAAGCCCCGAAGTCTTAGAAGAATATAAAGAAAAAATTCAAAGAGCTAGCACT
AAGAGTCAAGTTGATGAGTTTGTAGCAGAAGCTAAAAAAGTTGTTAATTCCAATAAAGAAACGTTGGTAAAT
CAGGCCAATGGTAAAAAGCAAGAAATTGATAAGTTAGAAAATTTATCTAACGATGAAATGTTGAGATATAAT
ACTGCAATTGATAATGTAGTGAAACAGTATAATGAAGGTAAGCTCAATATTACTGCTGCAATGAATGCTTTA
AATAGTATTAAGCAAGCAGCACAGGAAGTTGCCCAGAAAAACTTACAAAAGCAGTATGCTAAAAAAATTGAA

AGAATAAGTTCAAAAGGATTAGCGTTATCTAAAAAGGCTAAAGAAATTTATGAAAAGCATAAAAGTATTTTG
CCTACACCTGGATATTATGCAGACTCTGTGGGAACTTATTTGAATAGGTTTAGAGATAAACAAACTTTCGGA
AATAGGAGTGTTTGGACTGGTCAAAGTGGACTTGATGAAGCAAAAAAAATGCTTGATGAAGTCAAAAAGCTT
TTAAAAGAACTTCAAGACCTTACCAGAGGTACTAAAGAAGATAAAAAACCAGACGTTAAGCCAGAAGCCAAA
CCAGAGGCCAAACCAAATATTCAAGTACCTAAACAAGCACCTACAGAAGCTGCAAAACCAGCTTTGTCACCA
GAAGCCTTGACAAGATTGACTACATGGTATAATCAAGCTAAAGATCTGCTTAAAGATGATCAAGTAAAGGAC
AAATACGTAGATATACTTGCAGTTCAAAAAGCTGTTGACCAAGCTTATGATCATGTGGAAGAGGGAAAATTT
ATTACCACTGATCAAGCAAATCAATTAGCTAACAAGCTACGTGATGCTTTACAAAGTTTAGAATTAAAAGAT
AAAAAAGTAGCCAAACCAGAAGCCAAACCAGAGGCCAAACCAGAAGCTAAGCCAGAAGCTAAGCCAGAAGCT
AAGCCAGAAGCTAAGCCAGAGGCCAAACCAGAAGCTAAGCCAGACGTTAAGCCAGAAGCTAAACCAGACGTT
AAACCAGAGGCTAAGCCAGAAGCTAAACCAGAGGCTAAGTCAGAAGCTAAACCAGAGGCTAAGCTAGAAGCT
AAACCAGAGGCCAAACCAGCAACCAAAAAATCGGTTAATACTAGCGGAAACTTGGCGGCTAAAAAAGCTATT
GAAAACAAAAAGTATAGTAAAAAATTACCATCAACGGGTGAAGCCGCAAGTCCACTCTTAGCAATTGTATCA
CTAATTGTTATGTTAAGTGCAGGTCTTATTACGATAGTTTTAAAGCATAAAAAAAAATTAA

ORF amino acid sequence (SEQ ID NO: 179):

MNNNEKKVKYFLRKTAYGLASMSAAFAVCSGIVHADTSSGISASIPHKKQVNLGAVTLKNLISKYRGNDKAI
AILLSRVNDFNRASQDTLPQLINSTEAEIRNILYQGQIGKQNKPSVTTHAKVSDQELGKQSRRSQDIIKSLG
FLSSDQKDILVKYISSSKDSQLILKFVTQATQLNNAESTKAKQMAQNDVALIKNISPEVLEEYKEKIQRAST
KSQVDEFVAEAKKVVNSNKETLVNQANGKKQEIDKLENLSNDEMLRYNTAIDNVVKQYNEGKLNITAAMNAL
NSIKQAAQEVAQKNLQKQYAKKIERISSKGLALSKKAKEIYEKHKSILPTPGYYADSVGTYLNRFRDKQTFG
NRSVWTGQSGLDEAKKMLDEVKKLLKELQDLTRGTKEDKKPDVKPEAKPEAKPNIQVPKQAPTEAAKPALSP
EALTRLTTWYNQAKDLLKDDQVKDKYVDILAVQKAVDQAYDHVEEGKFITTDQANQLANKLRDALQSLELKD
KKVAKPEAKPEAKPEAKPEAKPEAKPEAKPEAKPEAKPDVKPEAKPDVKPEAKPEAKPEAKSEAKPEAKLEA
KPEAKPATKKSVNTSGNLAAKKAIENKKYSKKLPSTGEAASPLLAIVSLIVMLSAGLITIVLKHKKN

Table 13 (A and B): Overview over the two runs of sequencing of the six antigens from various GBS strains; SEQ ID NOs of the corresponding proteins are listed.

A

Strain name	Serotype	gbs0233	gbs1087	gbs1309
IC97(III)	III	SEQ ID NO: 235	n.d.	n.d.
IC98(II)	II	SEQ ID NO: 236	SEQ ID NO: 287	SEQ ID NO: 317
IC105(IV)	IV	SEQ ID NO: 59	SEQ ID NO: 71	SEQ ID NO: 83
IC108(III)	III	SEQ ID NO: 237	SEQ ID NO: 288	n.d.
IC216(Ib)	Ib	SEQ ID NO: 238	SEQ ID NO: 289	SEQ ID NO: 318
IC244(III)	III	SEQ ID NO: 239	n.d.	SEQ ID NO: 319
IC245(Ib)	Ib	SEQ ID NO: 240	SEQ ID NO: 290	SEQ ID NO: 320
IC246(III)	III	SEQ ID NO: 241	SEQ ID NO: 291	n.d.
IC247(III)	III	SEQ ID NO: 242	n.d.	SEQ ID NO: 321
IC250(Ib)	Ib	SEQ ID NO: 243	SEQ ID NO: 292	SEQ ID NO: 322
IC251(V)	V	SEQ ID NO: 244	n.d.	SEQ ID NO: 323
IC252(III)	III	SEQ ID NO: 245	SEQ ID NO: 293	SEQ ID NO: 324
IC252/2(III)	III	n.d.	n.d.	n.d.
IC253(III)	III	SEQ ID NO: 246	SEQ ID NO: 294	SEQ ID NO: 325
IC254(II)	II	SEQ ID NO: 247	n.d.	n.d.
IC255(V)	V	SEQ ID NO: 248	SEQ ID NO: 295	SEQ ID NO: 326
IC287(V)	V	SEQ ID NO: 249	n.d.	SEQ ID NO: 327
IC288(Ia)	Ia	SEQ ID NO: 250	n.d.	SEQ ID NO: 328
IC289(Ib)	Ib	SEQ ID NO: 251	SEQ ID NO: 296	SEQ ID NO: 329
IC290(III)	III	SEQ ID NO: 252	SEQ ID NO: 297	SEQ ID NO: 330
IC291(V)	V	SEQ ID NO: 253	SEQ ID NO: 298	SEQ ID NO: 331
IC304(V)	V	SEQ ID NO: 254	SEQ ID NO: 299	SEQ ID NO: 332

IC305(II)	II	SEQ ID NO: 255	SEQ ID NO: 300	SEQ ID NO: 333
IC306(Ib)	Ib	SEQ ID NO: 256	SEQ ID NO: 301	SEQ ID NO: 334
IC361(Ib)	Ib	SEQ ID NO: 257	SEQ ID NO: 302	SEQ ID NO: 335
IC363(III)	III	SEQ ID NO: 258	n.d.	SEQ ID NO: 336
IC364(III)	III	SEQ ID NO: 259	SEQ ID NO: 303	SEQ ID NO: 337
IC365(Ia)	Ia	SEQ ID NO: 260	SEQ ID NO: 304	SEQ ID NO: 338
IC366(n.t.)	non typeable	SEQ ID NO: 261	n.d.	SEQ ID NO: 339
IC367(II)	II	SEQ ID NO: 262	n.d.	n.d.
IC368(Ia)	Ia	SEQ ID NO: 263	SEQ ID NO: 305	SEQ ID NO: 340
IC377(V)	V	SEQ ID NO: 264	SEQ ID NO: 306	SEQ ID NO: 341
IC379(Ib)	Ib	SEQ ID NO: 265	SEQ ID NO: 307	SEQ ID NO: 342
IC432(Ib)	Ib	SEQ ID NO: 266	n.d.	SEQ ID NO: 343
IC434(III)	III	SEQ ID NO: 267	SEQ ID NO: 308	n.d.
IC455(III)	III	SEQ ID NO: 268	n.d.	SEQ ID NO: 344
IC457(II)	II	SEQ ID NO: 269	SEQ ID NO: 309	SEQ ID NO: 345
IC458(Ia)	Ia	SEQ ID NO: 60	SEQ ID NO: 72	SEQ ID NO: 84
IC459(Ib)	Ib	SEQ ID NO: 270	n.d.	SEQ ID NO: 346
IC460(II)	II	SEQ ID NO: 271	n.d.	SEQ ID NO: 347
IC461(Ib)	Ib	SEQ ID NO: 272	SEQ ID NO: 310	SEQ ID NO: 348
IC462(II)	II	SEQ ID NO: 273	n.d.	n.d.
IC463(Ib)	Ib	SEQ ID NO: 274	n.d.	SEQ ID NO: 349
IC469(V)	V	SEQ ID NO: 275	SEQ ID NO: 311	SEQ ID NO: 350
IC470(V)	V	SEQ ID NO: 276	n.d.	n.d.
126H4A(Ia)	Ia	SEQ ID NO: 277	n.d.	SEQ ID NO: 351
5095S2(Ib)	Ib	SEQ ID NO: 278	n.d.	n.d.
6313(III)	III	SEQ ID NO: 279	SEQ ID NO: 230	SEQ ID NO: 352
12351(IV)	IV	SEQ ID NO: 280	n.d.	SEQ ID NO: 353
NEM316, 12403(III)	III	SEQ ID NO: 229	n.d.	SEQ ID NO: 231
12403/2(III)	III	SEQ ID NO: 281	n.d.	SEQ ID NO: 354
12401(Ib)	Ib	SEQ ID NO: 56	SEQ ID NO: 68	SEQ ID NO: 80
COH1(III)	III	SEQ ID NO: 58	SEQ ID NO: 70	SEQ ID NO: 82
BAA23(V)	V	SEQ ID NO: 57	SEQ ID NO: 69	SEQ ID NO: 81
0176H4A(II)	II	SEQ ID NO: 55	SEQ ID NO: 67	SEQ ID NO: 79
A909(Ia/c)	Ia/c	SEQ ID NO: 282	SEQ ID NO: 312	SEQ ID NO: 355
C388/90(Ia/c)	Ia/c	SEQ ID NO: 283	SEQ ID NO: 313	SEQ ID NO: 356
BAA22(III)	III	SEQ ID NO: 284	SEQ ID NO: 314	SEQ ID NO: 357
2603V/R(V)	V	SEQ ID NO: 285	SEQ ID NO: 315	SEQ ID NO: 358
49447(V)	V	SEQ ID NO: 286	SEQ ID NO: 316	SEQ ID NO: 359
BAA611(V)	V	n.d.	n.d.	n.d.

B

Strain name	Serotype	gbs1477	gbs1478	gbs2018
IC97(III)	III	SEQ ID NO: 101	n.d.	SEQ ID NO: 379
IC98(II)	II	SEQ ID NO: 102	SEQ ID NO: 187	SEQ ID NO: 380
IC105(IV)	IV	SEQ ID NO: 103	SEQ ID NO: 188	SEQ ID NO: 178
IC108(III)	III	n.d.	SEQ ID NO: 189	n.d.

IC216(Ib)	Ib	SEQ ID NO: 104	SEQ ID NO: 190	SEQ ID NO: 381
IC244(III)	III	n.d.	SEQ ID NO: 191	SEQ ID NO: 382
IC245(Ib)	Ib	SEQ ID NO: 105	SEQ ID NO: 192	SEQ ID NO: 383
IC246(III)	III	n.d.	SEQ ID NO: 193	n.d.
IC247(III)	III	n.d.	SEQ ID NO: 194	SEQ ID NO: 384
IC250(Ib)	Ib	SEQ ID NO: 106	SEQ ID NO: 195	SEQ ID NO: 385
IC251(V)	V	SEQ ID NO: 107	SEQ ID NO: 196	SEQ ID NO: 386
IC252(III)	III	SEQ ID NO: 108	n.d.	SEQ ID NO: 387
IC252/2(III)	III	SEQ ID NO: 360	n.d.	n.d.
IC253(III)	III	SEQ ID NO: 109	SEQ ID NO: 197	SEQ ID NO: 388
IC254(II)	II	SEQ ID NO: 110	n.d.	SEQ ID NO: 389
IC255(V)	V	SEQ ID NO: 111	n.d.	SEQ ID NO: 390
IC287(V)	V	SEQ ID NO: 112	n.d.	SEQ ID NO: 391
IC288(Ia)	Ia	n.d.	n.d.	n.d.
IC289(Ib)	Ib	SEQ ID NO: 113	SEQ ID NO: 198	SEQ ID NO: 392
IC290(III)	III	n.d.	n.d.	SEQ ID NO: 393
IC291(V)	V	SEQ ID NO: 114	SEQ ID NO: 199	SEQ ID NO: 394
IC304(V)	V	SEQ ID NO: 115	SEQ ID NO: 200	SEQ ID NO: 395
IC305(II)	II	SEQ ID NO: 116	SEQ ID NO: 201	SEQ ID NO: 396
IC306(Ib)	Ib	SEQ ID NO: 117	SEQ ID NO: 202	SEQ ID NO: 397
IC361(Ib)	Ib	SEQ ID NO: 118	n.d.	SEQ ID NO: 398
IC363(III)	III	SEQ ID NO: 119	n.d.	SEQ ID NO: 399
IC364(III)	III	n.d.	n.d.	n.d.
IC365(Ia)	Ia	SEQ ID NO: 120	SEQ ID NO: 363	SEQ ID NO: 400
IC366(n.t.)	non typeable	n.d.	SEQ ID NO: 364	SEQ ID NO: 401
IC367(II)	II	SEQ ID NO: 121	SEQ ID NO: 365	SEQ ID NO: 402
IC368(Ia)	Ia	n.d.	n.d.	SEQ ID NO: 403
IC377(V)	V	SEQ ID NO: 122	SEQ ID NO: 366	SEQ ID NO: 404
IC379(Ib)	Ib	SEQ ID NO: 123	SEQ ID NO: 367	SEQ ID NO: 405
IC432(Ib)	Ib	SEQ ID NO: 124	SEQ ID NO: 368	SEQ ID NO: 406
IC434(III)	III	n.d.	n.d.	n.d.
IC455(III)	III	SEQ ID NO: 125	SEQ ID NO: 369	SEQ ID NO: 407
IC457(II)	II	SEQ ID NO: 126	SEQ ID NO: 370	SEQ ID NO: 408
IC458(Ia)	Ia	SEQ ID NO: 127	SEQ ID NO: 203	SEQ ID NO: 179
IC459(Ib)	Ib	SEQ ID NO: 128	SEQ ID NO: 371	SEQ ID NO: 409
IC460(II)	II	SEQ ID NO: 129	SEQ ID NO: 372	SEQ ID NO: 410
IC461(Ib)	Ib	SEQ ID NO: 130	SEQ ID NO: 373	SEQ ID NO: 411
IC462(II)	II	SEQ ID NO: 131	SEQ ID NO: 374	SEQ ID NO: 412
IC463(Ib)	Ib	n.d.	n.d.	SEQ ID NO: 413
IC469(V)	V	n.d.	SEQ ID NO: 375	SEQ ID NO: 414
IC470(V)	V	SEQ ID NO: 132	SEQ ID NO: 376	SEQ ID NO: 415
126H4A(Ia)	Ia	SEQ ID NO: 94	n.d.	SEQ ID NO: 416
5095S2(Ib)	Ib	SEQ ID NO: 96	n.d.	SEQ ID NO: 417
6313(III)	III	SEQ ID NO: 97, SEQ ID NO: 232	SEQ ID NO: 233	SEQ ID NO: 418
12351(IV)	IV	SEQ ID NO: 92	n.d.	SEQ ID NO: 419
NEM316, 12403(III)	III	n.d.	n.d.	SEQ ID NO: 234

12403/2(III)	III	SEQ ID NO: 361	n.d.	SEQ ID NO: 420
12401(Ib)	Ib	SEQ ID NO: 93	SEQ ID NO: 185	SEQ ID NO: 176
COH1(III)	III	n.d.	n.d.	SEQ ID NO: 421
BAA23(V)	V	SEQ ID NO: 98	SEQ ID NO: 186	SEQ ID NO: 177
0176H4A(II)	II	SEQ ID NO: 91	SEQ ID NO: 377	SEQ ID NO: 175
A909(Ia/c)	Ia/c	n.d.	n.d.	n.d.
C388/90(Ia/c)	Ia/c	SEQ ID NO: 100	n.d.	SEQ ID NO: 422
BAA22(III)	III	n.d.	n.d.	SEQ ID NO: 423
2603V/R(V)	V	SEQ ID NO: 362	SEQ ID NO: 378	SEQ ID NO: 424
49447(V)	V	SEQ ID NO: 95	n.d.	SEQ ID NO: 425
BAA611(V)	V	SEQ ID NO: 99	n.d.	n.d.

Intercell AG January 10, 2008
ICP057-PCT

Claims

1. A composition comprising at least two proteins selected from the group consisting of
   i) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 1 (gbs0233p) or functionally active variant thereof;
   ii) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 2 (gbs1087p) or functionally active variant thereof;
   iii) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 3 (gbs1309p) or functionally active variant thereof;
   iv) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 4 (gbs1477p) or functionally active variant thereof;
   v) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 5 (gbs1478p) or functionally active variant thereof; and
   vi) a protective protein comprising or consisting of the protective peptide of SEQ ID NO: 6 (gbs2018p) or functionally active variant thereof.

2. The composition of claim 1, wherein the composition comprises at least three proteins selected from the group consisting of subgroup i) to vi).

3. The composition of claim 1 or 2, wherein the composition comprises at least four proteins selected from the group consisting of subgroup i) to vi).

4. The composition of any of claims 1 to 3, wherein the at least two, three or four proteins are selected from different subgroups i) to vi).

5. The composition of any of claims 1 to 4, wherein at least two of the proteins are selected from one of the subgroups i) to vi).

6. The composition of any of claims 1 to 5 comprising
   - at least one protein of subgroup iv);
   - at least one protein of subgroup vi);
   - at least one protein of subgroup iv) and at least one protein of subgroup vi);

- at least one protein of subgroup iv), at least one protein of subgroup vi) and at least one protein of subgroup ii); or
- at least one protein of subgroup iv), at least one protein of subgroup vi), at least one protein of subgroup ii) and at least one protein of subgroup v).

7. The composition of any of claims 1 to 6, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 4 (gbs1477p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 4 (gbs1477p) or a naturally occurring variant thereof.

8. The composition of any of claims 1 to 7, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 6 (gbs2018p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 6 (gbs2018p) or a naturally occurring functionally active variant thereof.

9. The composition of any of claims 1 to 8, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 2 (gbs1087p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 2 (gbs1087p) or a naturally occurring functionally active variant thereof.

10. The composition of any of claims 1 to 9, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 5 (gbs1478p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 5 (gbs1478p) or a naturally occurring functionally active variant thereof.

11. The composition of any of claims 1 to 10, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 1 (gbs0233p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 1 (gbs0233p) or a naturally occurring functionally active variant thereof.

12. The composition of any of claims 1 to 11, wherein one of the at least two proteins comprises or consists of the protective peptide of SEQ ID NO: 3 (gbs1309p) or functionally active variant thereof, preferably protective peptide of SEQ ID NO: 3 (gbs1309p) or a naturally occurring functionally active variant thereof.

13. The composition of any of claims 1 to 12, wherein the at least two proteins encompass:
    - the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p);
    - the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p); or
    - the protective peptide of SEQ ID NO: 4 (gbs1477p) and the protective peptide of SEQ ID NO: 6 (gbs2018p) and the protective peptide of SEQ ID NO: 2 (gbs1087p) and the protective peptide of SEQ ID NO: 5 (gbs1478p).

14. The composition of any of claims 1 to 13, wherein two or more proteins of the at least two proteins are combined into at least one fusion protein.

15. The composition of any of claims 1 to 14, wherein the functionally active variant
    a) is a functionally active fragment of the protective peptide, the functionally active fragment comprising at least 50% of the sequence of the protective peptide, preferably at least 70%, more preferably at least 80%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%;
    b) is derived from the protective peptide by at least one amino acid substitution, addition and/or deletion, wherein the functionally active variant has a sequence identity to the protective peptide or to the functionally active fragment as defined in a) of at least 40%, preferably at least 60%, more preferably at least 75%, still more preferably at least 90%, even more preferably at least 95% and most preferably at least 97%, 98% or 99%; and/or
    c) consists of the protective peptide or a functionally active variant thereof and additionally at least one amino acid heterologous to the protective peptide,

    preferably wherein the functionally active variant is derived from or identical to any of the naturally occurring variants of any of the sequences of SEQ ID NO: 55 to 60, 67 to 72, 79 to 84, 91 to 132, 175 to 179, 185 to 203, 223 to 234, and 235 to 425.

16. A protective peptide consisting of the amino acid sequence selected from the group consisting of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 55 to 57, 59, 60, 68, 69, 71, 72, 79 to 84, 91 to 132, 175 to 179, 185 to 203, 223 to 234, and 235 to 425.

17. One or more nucleic acid(s) encoding the at least two proteins comprised in of the composition according to any of claims 1 to 15 and/or any of the protective peptides according to claim 16.

18. The one or more nucleic acid(s) of claim 17, comprising or consisting of at least one nucleic acid sequence selected from the group consisting of SEQ ID NO: 7, SEQ ID NO: 8, SEQ ID NO: 9, SEQ ID NO: 10, SEQ ID NO: 11, SEQ ID NO: 12, SEQ ID NO: 61 to 66, SEQ ID NO: 73 to 78, SEQ ID NO: 85 to 90, SEQ ID NO: 133 to 174, SEQ ID NO: 180 to 184 and SEQ ID NO: 204 to 222.

19. The one or more nucleic acid(s) of claim 17 to 18, wherein the nucleic acid(s) is/are located in a vector or a cell other than *S. agalactiae*.

20. A method of producing the composition of any of claims 1 to 15 or the protective peptide of claim 16, comprising
   (a) introducing the one or more nucleic acids into a host cell;
   (b) expressing the protein(s) and/or peptide(s) encoded by the nucleic acid by culturing the host cell under conditions conducive to the expression of the protein(s) and/or peptide(s); and
   (c) collecting and/or isolating the expressed protein(s) and/or peptide(s) of step (b).

21. A pharmaceutical composition, especially a vaccine, comprising
   (i) the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16; and
   (ii) optionally a pharmaceutically acceptable carrier or excipient.

22. A pharmaceutical composition comprising

(i) the one or more nucleic acid(s) according to any of claims 17 to 19 or one or more nucleic acid(s) complementary thereto, and

(ii) optionally a pharmaceutically acceptable carrier or excipient.

23. A method for producing antibodies, characterized by the following steps:

(a) administering an effective amount of the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16 to an animal; and

(b) isolating the antibodies produced by the animal in response to the administration of step (a) from the animal.

24. A method for producing antibodies, characterized by the following steps:

(a) contacting a B cell with an effective amount of the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16;

(b) fusing the B cell of step (a) with a myeloma cell to obtain a hybridoma cell; and

(c) isolating the antibodies produced by the cultivated hybridoma cell.

25. The method of claim 23 or 24, wherein the isolated antibodies are additionally purified.

26. A mixture of antibodies against the at least two proteins of the composition of any of claims 1 to 15 and/or against the at least one protective peptide according to claim 16.

27. Use of the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16 and/or one or more the nucleic acid(s) according to any of claims 17 to 19 for the manufacture of a medicament for the immunization or treatment of a subject, preferably against *S. agalactiae*, more preferably against pneumonia, septicemia, meningitis, fever, vomiting, poor feeding, irritability, urinary tract infection and/or vaginal infection caused by *S. agalactiae*.

28. A method of diagnosing a *S. agalactiae* infection comprising the steps of:

(a) contacting a sample obtained from a subject with the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16; and

(b) detecting the presence of an antibody against the protective peptide, the functionally active variant and/or the composition in the sample,

wherein the presence of the antibody is indicative for the *S. agalactiae* infection.

29. A method of diagnosing a *S. agalactiae* infection comprising the steps of:

(a) contacting a sample obtained from a subject with the mixture of antibodies according to claim 26; and

(b) detecting the presence of the at least two proteins of the composition of any of claims 1 to 15 and/or of the at least one protective peptide according to claim 16 in the sample,

wherein the presence of the at least two proteins is indicative for the *S. agalactiae* infection.

30. A method for diagnosing an infection with *S. agalactiae* comprising the steps of:

(a) contacting a sample obtained from a subject with a primer and/or a probe specific for the one or more nucleic acid(s) of any of claims 17 to 19; and

(b) detecting the presence of one or more nucleic acid(s) of any of claims 17 to 19 in the sample,

wherein the presence of the one or more nucleic acid(s) is indicative for the *S. agalactiae* infection.

31. A method for identifying a ligand capable of binding the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16 comprising:

(a) providing a test system comprising the peptide and/or composition,

(b) contacting the test system with a test compound, and

(c) detecting a signal generated in response to the binding of the test compound to the peptide and/or composition.

32. Use of the composition according to any of claims 1 to 15 and/or at least one protective peptide according to claim 16 for the isolation and/or purification and/or identification of an interaction partner of the composition and/or the peptide.

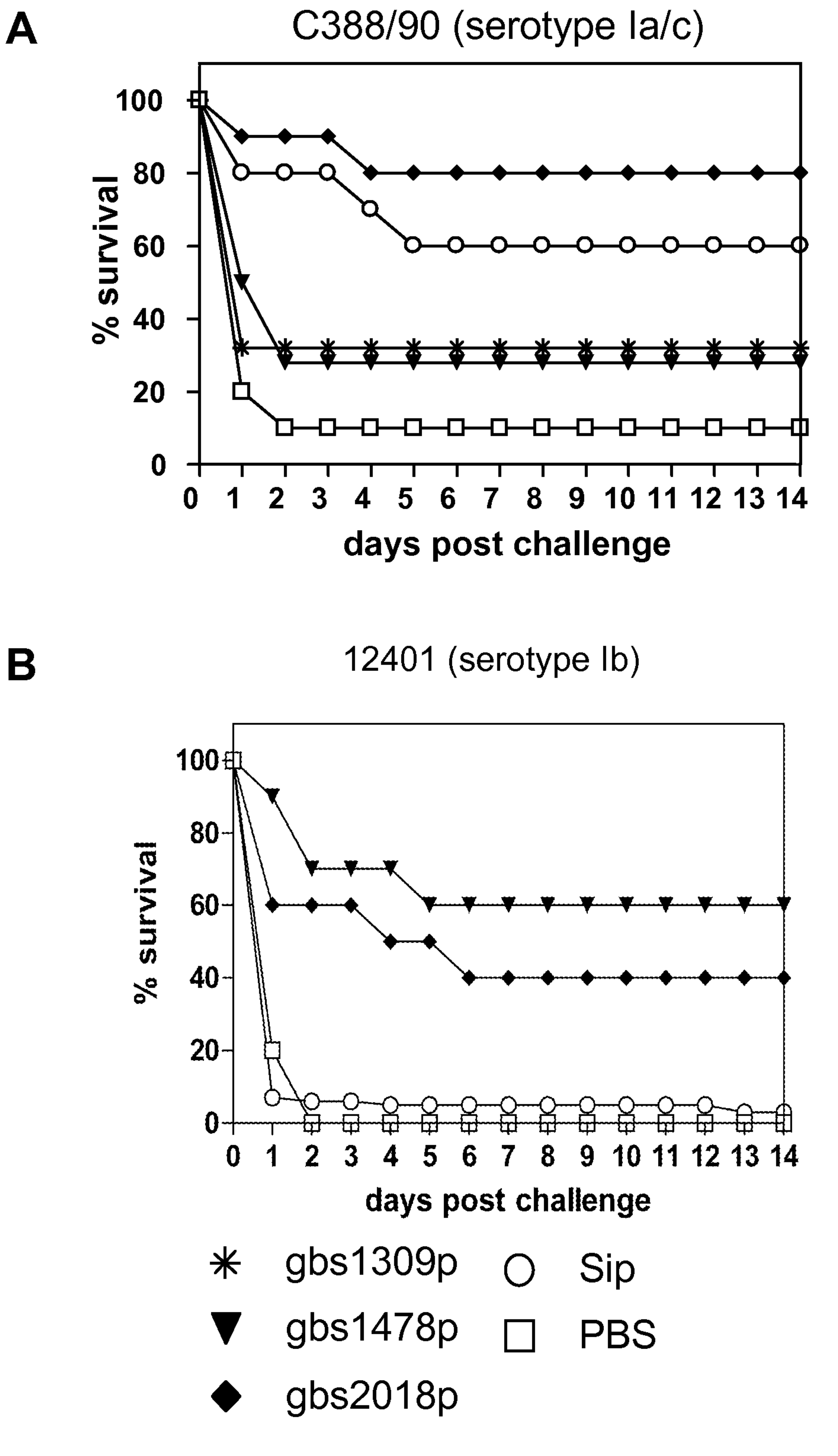

A
C388/90 (serotype Ia/c)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
B
12401 (serotype Ib)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
gbs1309p
gbs1478p
gbs2018p
Sip
PBS

Figure 1

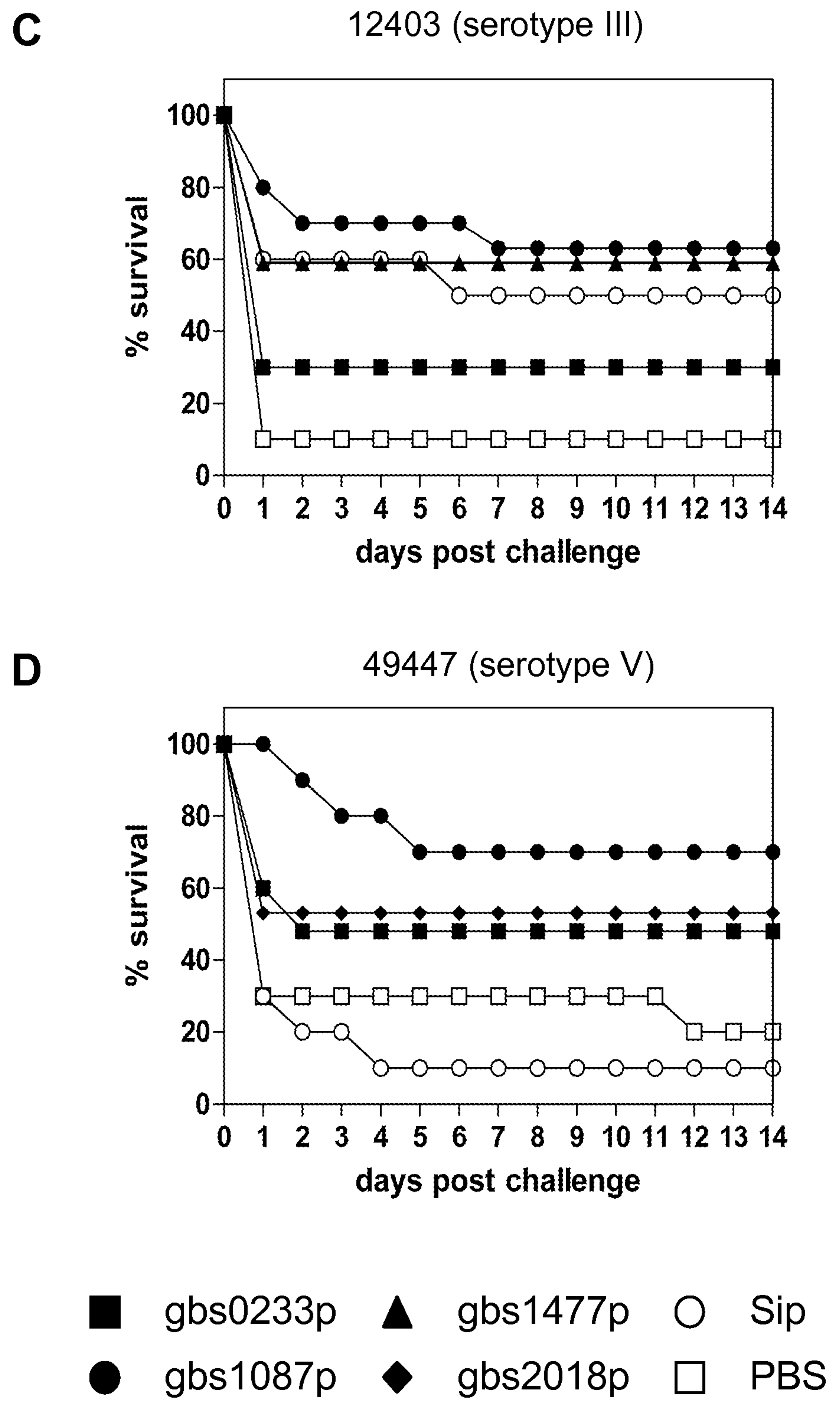
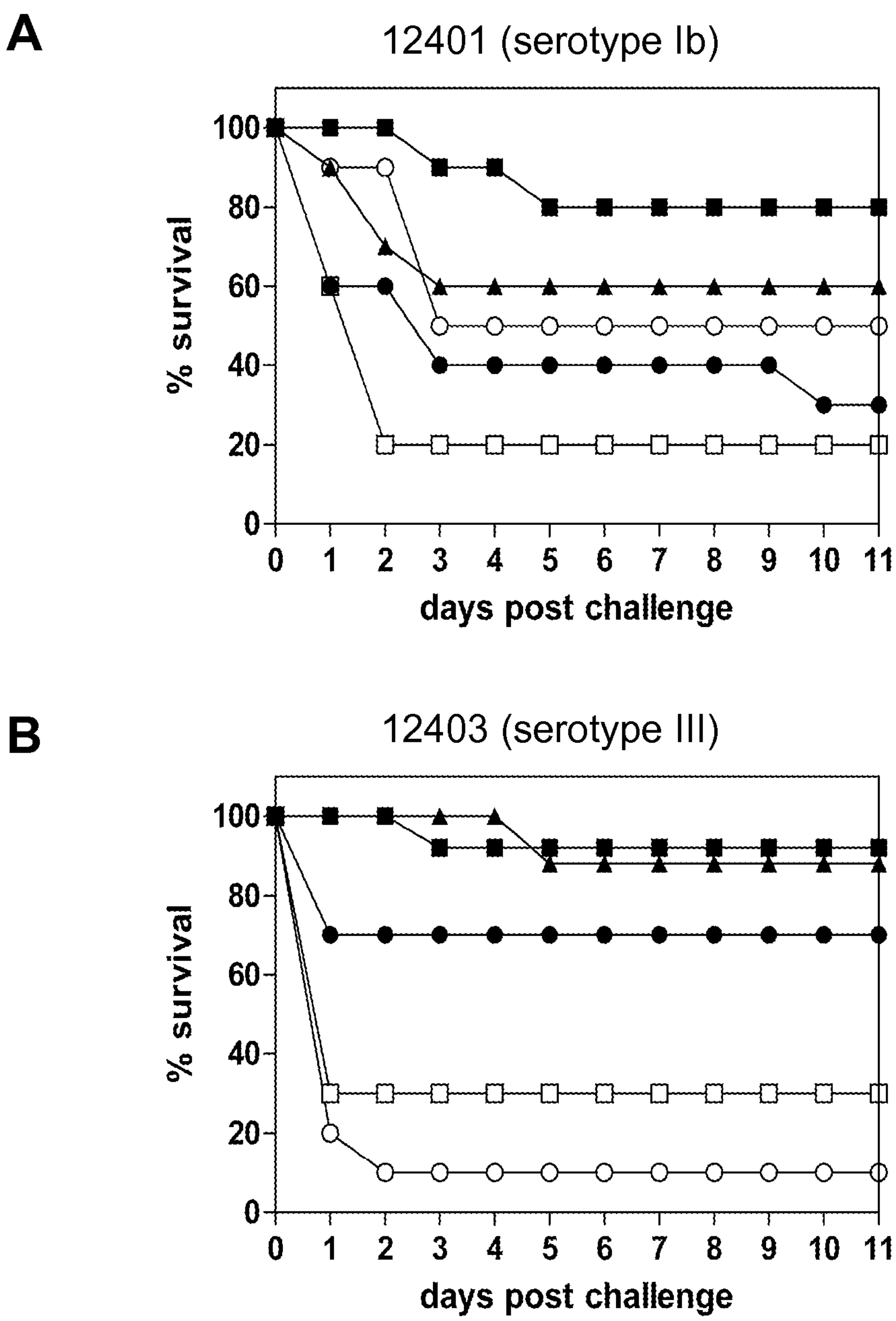

C
12403 (serotype III)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
D
49447 (serotype V)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
gbs0233p
gbs1477p
Sip
gbs1087p
gbs2018p
PBS

Figure 1



● gbs1477p + gbs2018p

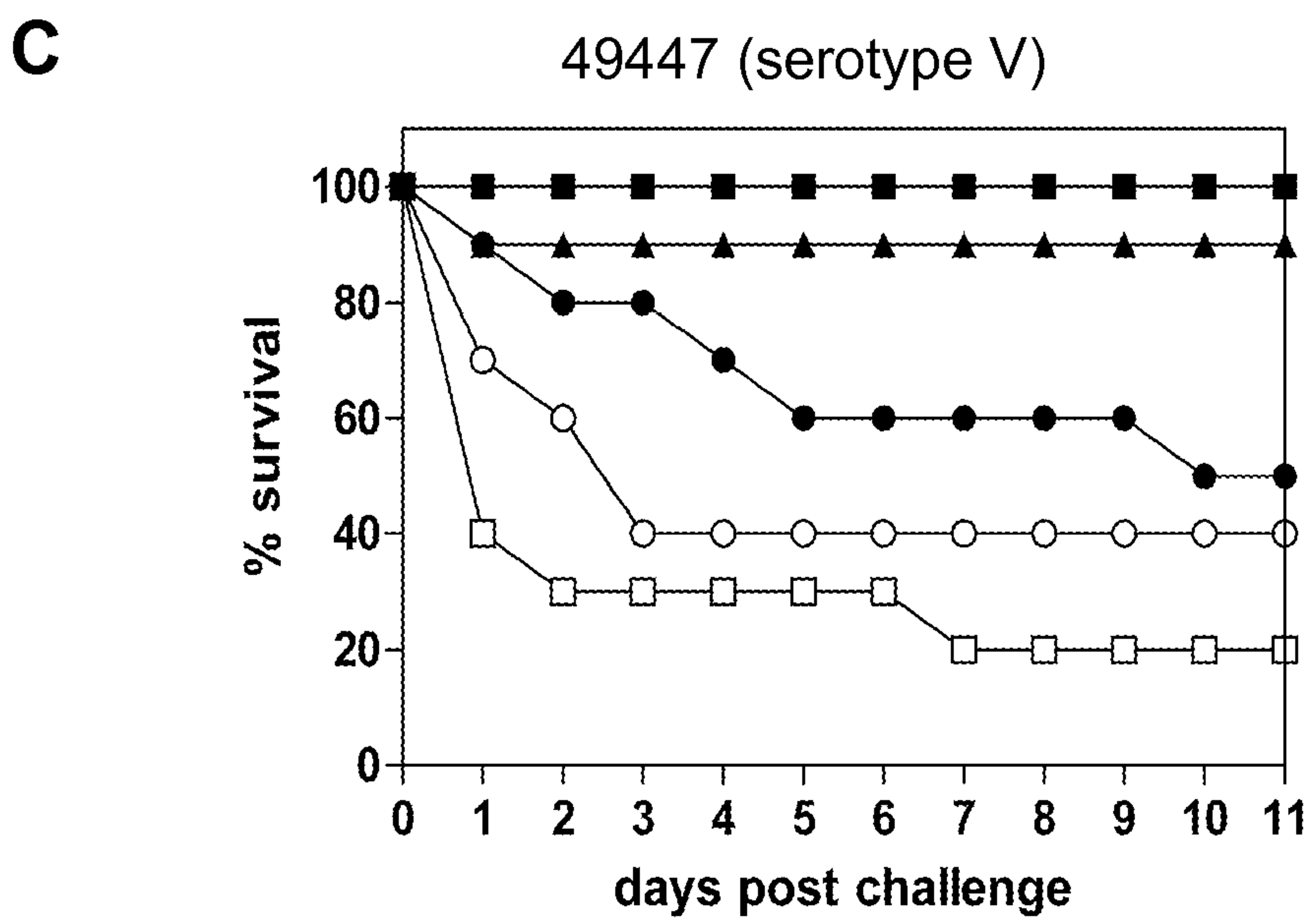
▲ gbs1087p + gbs1477p + gbs2018p

■ gbs1087p + gbs1477p + gbs1478p + gbs2018p

○ Sip

□ PBS

Figure 2


C
49447 (serotype V)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11
days post challenge

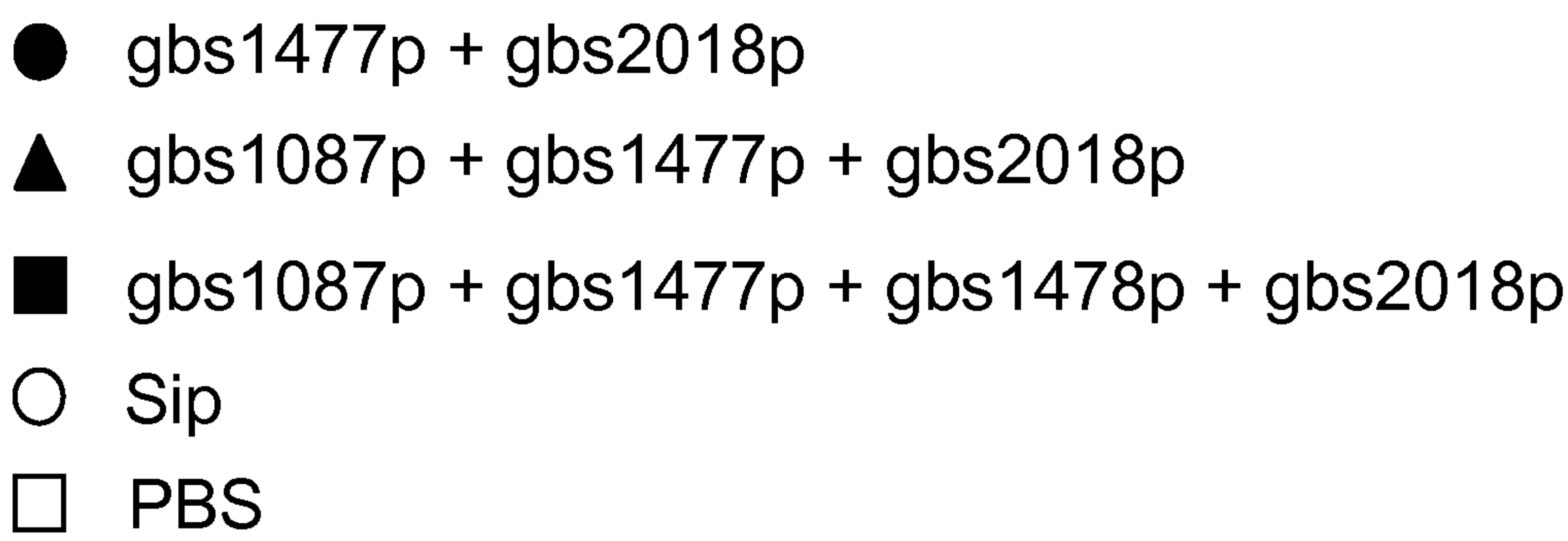
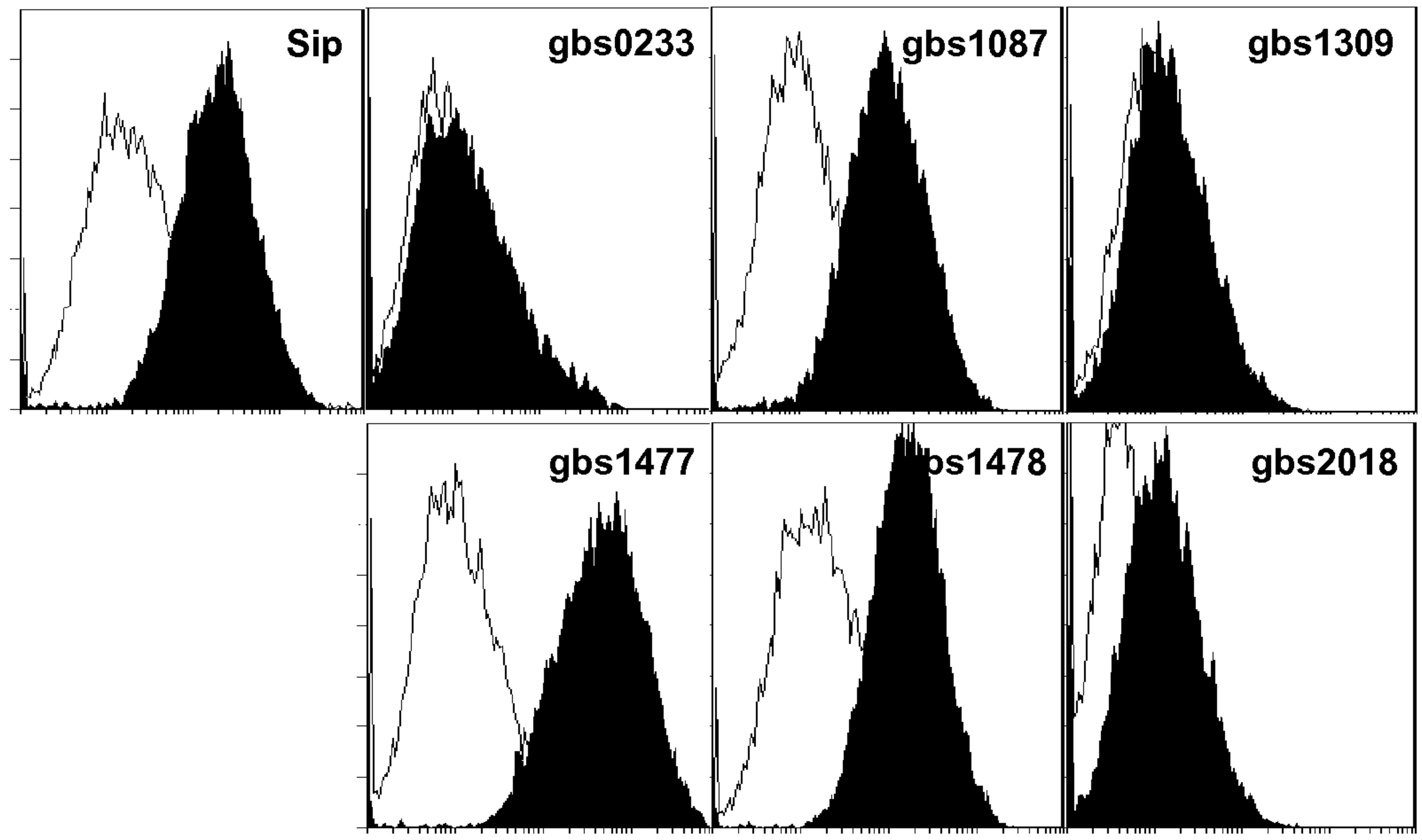

gbs1477p + gbs2018p
gbs1087p + gbs1477p + gbs2018p
gbs1087p + gbs1477p + gbs1478p + gbs2018p
Sip
PBS

Figure 2

12403 (serotype III)



Fluorescence intensity

Figure 3

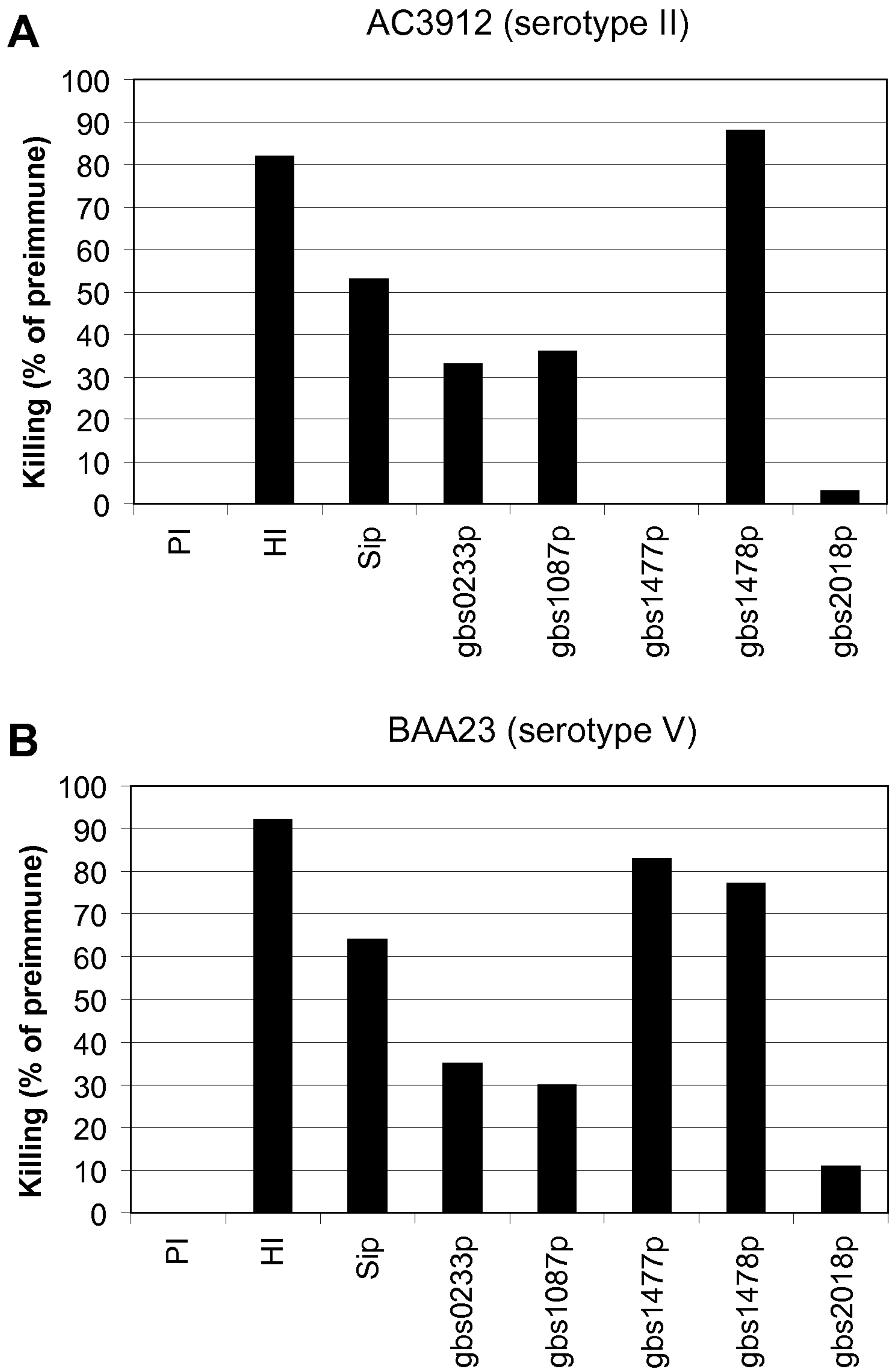

A
AC3912 (serotype II)
Killing (% of preimmune)
100
90
80
70
60
50
40
30
20
10
0
PI
HI
Sip
gbs0233p
gbs1087p
gbs1477p
gbs1478p
gbs2018p
B
BAA23 (serotype V)
Killing (% of preimmune)
100
90
80
70
60
50
40
30
20
10
0
PI
HI
Sip
gbs0233p
gbs1087p
gbs1477p
gbs1478p
gbs2018p

Figure 4

```
                 1                                                50
   NEM316   (1)  MKKINKCLTVFSTLLLILTSLFSVAPAFADDV--TTDTVTLHKIVMPQAA
   CJB111   (1)  MKKINKCLTMFSTLLLILTSLFSVAPAFADDA--TTDTVTLHKIVMPQAA
    BAA23   (1)  MKKINKCLTMFSTLLLILTSLFSVAPAFADDA--TTDTVTLHKIVMPQAA
      515   (1)  MKKINKYFAVFSALLLTVTSLFSVAPVFAEEAK-TTDTVTLHKIVMPRTA
  0176H4A   (1)  MKKINKFFVAFSALLLILTSLLSVAPAFAEKEK-TTETVTLHKILQTDTN
    12401   (1)  MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDN
     H36B   (1)  MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDN
    IC105   (1)  MKRINKYFAMFSALLLILTSLLSVAPVFAAEMGNITKTVTLHKIVQTSDN
  2603V/R   (1)  MKRINKYFAMFSALLLTLTSLLSVAPAFADEA--TTNTVTLHKILQTESN
   18RS21   (1)  MKRINKYFAMFSALLLTLTSLLSVAPAFADEA--TTNTVTLHKILQTESN
    IC458   (1)  MKKINKYFAVFSALLLTVTSLLSVAPAFADEA--TTNTVTLHKILQTESN
Consensus   (1)  MKKINKYFAMFSALLLILTSLLSVAPAFADEA  TT TVTLHKIVQT AN
                 51                                              100
   NEM316  (49)  FDN-FTEGTKGKNDSDYVGKQINDLKSYFGSTDAKEIKGAFFVFKNETGT
   CJB111  (49)  FDN-FTEGTKGKNDSDYVGKQINDLKSYFGSTDAKEIKGAFFVFKNETGT
    BAA23  (49)  FDN-FTEGTKGKNDSDYVGKQINDLKSYFGSTDAKEIKGAFFVFKNETGT
      515  (50)  FDG-FTAGTKGKDNTDYVGKQIEDLKTYFGSGEAKEIAGAYFAFKNEAGT
  0176H4A  (50)  LKNSAFPGTKGLDGTEYDGKAIDKLDSYFGND-SKDIGGAYFILANSKGE
    12401  (51)  LAKPNFPGINGLNGTKYMGQKLTDISGYFGQG-SKEIAGAFFAVMNESQT
     H36B  (51)  LAKPNFPGINGLNGTKYMGQKLTDISGYFGQG-SKEIAGAFFAVMNESQT
    IC105  (51)  LAKPNFPGINGLNGTKYMGQKLTDISGYFGQG-SKEIAGAFFAVMNESQT
  2603V/R  (49)  LNKSNFPGTTGLNGKDYKGGAISDLAGYFGEG-SKEIEGAFFALALKEDK
   18RS21  (49)  LNKSNFPGTTGLNGKDYKGGAISDLAGYFGEG-SKEIEGAFFALALKEDK
    IC458  (49)  LNKSNFPGTTGLNGDDYKGESISDLAEYFGSG-SKEIDGAFFALALEEEK
Consensus  (51)  L K NFPGT GLNGTDYVG  ISDLA YFG G SKEI GAFFAL NES T
                 101                                             150
   NEM316  (98)  KFITENGKEVDTLEAKDA------------EGGAVLSGLTK--DTGFAFN
   CJB111  (98)  KFITENGKEVDTLEAKDA------------EGGAVLSGLTK--DNGFVFN
    BAA23  (98)  KFITENGKEVDTLEAKDA------------EGGAVLSGLTK--DNGFVFN
      515  (99)  KYITENGEEVDTLDTTDA------------KGCAVLKGLTT--DNGFKFN
  0176H4A  (99)  YIKANDKNKLKPEFSGNT-------PKTTLNISEAVGGLTEE-NAGIKFE
    12401 (100)  KYITESGTEVESIDAA-----------------GVLKGLTT--ENGITFN
     H36B (100)  KYITESGTEVESIDA---------------AG--VLKGLTT--ENGITFN
    IC105 (100)  KYITESGTEVESIDAA-----------------GVLKGLTT--ENGITFN
  2603V/R  (98)  SGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGLVFN
   18RS21  (98)  SGKVQYVKAKEGNKLTPALINKDGTPEITVNIDEAVSGLTPEGDTGLVFN
    IC458  (98)  DGVVQYVKAKANDKLTPDLITK-GTPATTTKVEEAVGGLTT--GTGIVFN
Consensus (101)  KYITE GKEVETLDA  A               AVL GLT   DNGI FN
                 151                                             200
   NEM316 (134)  TAKLKGTYQIVELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDA
   CJB111 (134)  TAKLKGIYQIVELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDA
    BAA23 (134)  TAKLKGIYQIVELKEKSNYDNNGSILADSKAVPVKITLPLVNNQGVVKDA
      515 (135)  TSKLTGTYQIVELKEKSTYNNDGSILADSKAVPVKITLPLVNDNGVVKDA
  0176H4A (141)  TTGLRGDFQIIELKDKSTYNNGGAILADSKAVPVKITLPLINKDGVVKDA
    12401 (131)  TANLKGTYQIVELLDKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDA
     H36B (131)  TANLKGTYQIVELLDKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDA
    IC105 (131)  TANLKGTYQIVELLDKSNYKNGDKVLADSKAVPVKITLPLYNEEGIVVDA
  2603V/R (148)  TKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADA
   18RS21 (148)  TKGLKGEFKIVEVKSKSTYNNNGSLLAASKAVPVNITLPLVNEDGVVADA
    IC458 (145)  TAGLKGNFKIIELKDKSTYNNNGSLLAASKAVPVKITLPLVSKDGVVKDA
Consensus (151)  TA LKG YQIVELKDKSNY NNGSILADSKAVPVKITLPLVNEDGVVKDA
```

Figure 5A

```
                     201                                                250
   NEM316    (184)   HIYPKNTETKPQVDKNFADK---------------DLDYTDNRKDKGVVS
   CJB111    (184)   HIYPKNTETKPQVDKNFADK---------------DLDYTDNRKDKGVVS
    BAA23    (184)   HIYPKNTETKPQVDKNFADK---------------DLDYTDNRKDKGVVS
      515    (185)   HVYPKNTETKPQVDKNFADK---------------ELDYANNKKDKGTVS
  0176H4A    (191)   HVYPKNTETKPQIDKNFADK---------------NLDYINNQKDKGTIS
    12401    (181)   EVYPKNTEEAPQIDKNFAKANKLLNDSD-NSAIAGGADYDKYQAEKAKAT
     H36B    (181)   EVYPKNTEEAPQIDKNFAKANKLLNDSD-NSAIAGGADYDKYQAEKAKAT
    IC105    (181)   EVYPKNTEEAPQIDKNFAKANKLLNDSD-NSAIAGGADYDKYQAEKAKAT
  2603V/R    (198)   HVYPKNTEEKPEIDKNFAKTNDLTALTDVNRLLTAGANYGNYARDKATAT
   18RS21    (198)   HVYPKNTEEKPEIDKNFAKTNDLTALTDVNRLLTAGANYGNYARDKATAT
    IC458    (195)   HVYPKNTETKPEVDKNFAKTNDLTALKD-ATLLKAGADYKNYSATKATVT
Consensus    (201)   HVYPKNTETKPQIDKNFAK N L    D    I AGADY  Y KDKA VT
                     251                                                300
   NEM316    (219)   ATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLD---GK
   CJB111    (219)   ATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLD---GE
    BAA23    (219)   ATVGDKKEYIVGTKILKGSDYKKLVWTDSMTKGLTFNNNVKVTLD---GE
      515    (220)   ASVGDVKKYHVGTKILKGSDYKKLIWTDSMTKGLTFNNDIAVTLD---GA
  0176H4A    (226)   ATVGDVKKYTVGTKILKGSDYKKLVWTDSMTKGLTFNNDVTVTLD---GA
    12401    (230)   AEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASS--GS
     H36B    (230)   AEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASS--GS
    IC105    (230)   AEIGQEIPYEVKTKIQKGSKYKNLAWVDTMSNGLTMGNTVNLEASS--GS
  2603V/R    (248)   AEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVSLKASGTTET
   18RS21    (248)   AEIGKVVPYEVKTKIHKGSKYENLVWTDIMSNGLTMGSTVSLKASGTTET
    IC458    (244)   AEIGKVIPYEVKTKVLKGSKYEKLVWTDTMSNGLTMGDDVNLAVSGTTTT
Consensus    (251)   AEIG  IPYEVKTKILKGSKYKKLVWTDSMSNGLTMGN V L LS   GS
                     301                                                350
   NEM316    (266)   DFPVLNYKLVTDDQGFRLALNATGLAAVAAAAKDKDVEIKITYSATVNGS
   CJB111    (266)   DFPVLNYKLVTDDQGFRLALNATGLAAVAAAAKDKDVEIKITYSATVNGS
    BAA23    (266)   DFPVLNYKLVTDDQGFRLALNATGLAAVAAAAKDKDVEIKITYSATVNGS
      515    (267)   TLDATNYKLVADDQGFRLVLTDKGLEAVAKAAKTKDVEIKITYSATLNGS
  0176H4A    (273)   NFEQSNYTLVADDQGFRLVLNATGLSKVAEAAKTKDVEIKINYSATVNGS
    12401    (278)   FVEGTDYNVERDDRGFTLKFTDTGLTKLQKEAETQAVEFTLTYSATVNGA
     H36B    (278)   FVEGTDYNVERDDRGFTLKFTDTGLTKLQKEAETQAVEFTLTYSATVNGA
    IC105    (278)   FVEGTDYNVERDDRGFTLKFTDTGLTKLQKEAETHAVEFTLTYSATVNGA
  2603V/R    (298)   FAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQ
   18RS21    (298)   FAKDTDYELSIDARGFTLKFTADGLGKLEKAAKTADIEFTLTYSATVNGQ
    IC458    (294)   FIKDIDYTLSIDDRGFTLKFKATGLDKLEEAAKASDVEFTLTYKATVNGQ
Consensus    (301)   F   TDY L  DDRGFTLKFTATGL KL KAAKT DVEFTLTYSATVNGS
                     351                                                400
   NEM316    (316)   TTVEVPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG-----
   CJB111    (316)   TTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG-----
    BAA23    (316)   TTVEIPETNDVKLDYGNNPTEESEPQEGTPANQEIKVIKDWAVDG-----
      515    (317)   AVVEVLETNDVKLDYGNNPTIENEPKEGIPVDKKITVNKTWAVDGN----
  0176H4A    (323)   TVVEKSENNDVKLDYGNNPTTENEPQTGNPVNKEITVRKTWAVDGN----
    12401    (328)   AIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNGEITVSKTWDKGSDLENA
     H36B    (328)   AIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNGEITVSKTWDKGSDLENA
    IC105    (328)   AIDDKPESNDIKLQYGNKPGKKVKEIPVTPSNGEITVSKTWDKGSDLENA
  2603V/R    (348)   AIIDNPESNDIKLSYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGV
   18RS21    (348)   AIIDNPESNDIKLSYGNKPGKDLTELPVTPSKGEVTVAKTWSDGIAPDGV
    IC458    (344)   AIIDNPEVNDIKLDYGNKPGTDLSEQPVTPEDGEVKVTKTWAAGANKADA
Consensus    (351)   AIVD PESNDIKLDYGNKPG EL E PVTPSNGEITV KTWA GG
```

Figure 5B

```
                     401                                              450
   NEM316    (361)   ----TITDVNVAVKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLD
   CJB111    (361)   ---TITDANVA-VKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLD
    BAA23    (361)   ---TITDANVA-VKAIFTLQEKQTDGTWVNVASHEATKPSRFEHTFTGLD
      515    (363)   ---EVNKADET-VDAVFTLQVKDGD-KWVNVDSAKATAATSFKHTFENLD
  0176H4A    (369)   ----EVNKGDEKVDAVFTLQVKDSD-KWVNVDSATATAATDFKYTFKNLD
    12401    (378)   NVVYTLKDGGT-AVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLT
     H36B    (378)   NVVYTLKDGGT-AVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLT
    IC105    (378)   NVVYTLKDGGT-AVASVSLTKTTPNGEINLGNGIKFTVTGAFAGKFSGLT
  2603V/R    (398)   NVVYTLKDKDK-TVASVSLTKTSKG-TIDLGNGIKFEVSGNFSGKFTGLE
   18RS21    (398)   NVVYTLKDKDK-TVASVSLTKTSKG-TIDLGNGIKFEVSGNFSGKFTGLE
    IC458    (394)   KVVYTLKNATKQVVASVALTAADTKGTINLGKGMTFEITGAFSGTFKGLQ
Consensus    (401)    VVYTLKD    VVASVSLT     GTI LG GIKFTVTG FAGTFTGLD
                     451                                              500
   NEM316    (407)   NTKTYRVVERVSGYTPEYVSFKNGVVTIKNNKNSNDPTPINPSEPKVVTY
   CJB111    (407)   NAKTYRVVERVSGYTPEYVSFKNGVVTIKNNKNSNDPTPINPSEPKVVTY
    BAA23    (407)   NAKTYRVVERVSGYTPEYVSFKNGVVTIKNNKNSNDPTPINPSEPKVVTY
      515    (408)   NAKTYRVIERVSGYAPEYVSFVNGVVTIKNNKDSNEPTPINPSEPKVVTY
  0176H4A    (414)   NAKTYRVVERVSGYAPAYVSFVGGVVTIKNNKNSNDPTPINPSEPKVVTY
    12401    (427)   DSKTYMISERIAGYG-NTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTH
     H36B    (427)   DSKTYMISERIAGYG-NTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTH
    IC105    (427)   DSKTYMISERIAGYG-NTITTGAGSAAITNTPDSDNPTPLNPTEPKVVTH
  2603V/R    (446)   N-KSYMISERVSGYG-SAINLENGKVTITNTKDSDNPTPLNPTEPKVETH
   18RS21    (446)   N-KSYMISERVSGYG-SAINLENGKVTITNTKDSDNPTPLNPTEPKVETH
    IC458    (444)   N-KAYTVSERVAGYT-NAINVTGNAVAITNTPDSDNPTPLNPTQPKVETH
Consensus    (451)   NAKTY VSERVSGYG   IS  NG VTITNTKDSDNPTPLNPTEPKVVTH
                     501                                              550
   NEM316    (457)   GRKFVKTNQANTERLAGATFLVKKE-GKYLARKAGAATAEAKAAVKTAKL
   CJB111    (457)   GRKFVKTNQANTERLAGATFLVKKE-GKYLARKAGAATAEAKAAVKTAKL
    BAA23    (457)   GRKFVKTNQANTERLAGATFLVKKE-GKYLARKAGAATAEAKAAVKTAKL
      515    (458)   GRKFVKTNKDGKERLAGATFLVKKD-GKYLARKSGVATDAEKAAVDSTKS
  0176H4A    (464)   GRKFVKTNQDGSERLAGATFLVKNSQSQYLARKSGVATNEAHKAVTDAKV
    12401    (476)   GKKFVKTSSTETERLQGAQFVVKDSAGKYLALKSSATISAQTTAYTNAKT
     H36B    (476)   GKKFVKTSSTETERLQGAQFVVKDSAGKYLALKSSATISAQTTAYTNAKT
    IC105    (476)   GKKFVKTSSTETERLQGAQFVVKDSAGKYLALKSSATISAQTTAYTNAKT
  2603V/R    (494)   GKKFVKTNEQG-DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAK--KI
   18RS21    (494)   GKKFVKTNEQG-DRLAGAQFVVKNSAGKYLALKADQSEGQKTLAAK--KI
    IC458    (492)   GKKFVKVGDAD-ARLAGAQFVVKNSAGKFLALKEDAAVSGAQTELATAKT
Consensus    (501)   GKKFVKTN   TERLAGAQFVVK SAGKYLALKA AA S    AV  AKL
                     551                                              600
   NEM316    (506)   ALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWV
   CJB111    (506)   ALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWV
    BAA23    (506)   ALDEAVKAYNDLTKEKQEGQEGKTALATVDQKQKAYNDAFVKANYSYEWV
      515    (507)   ALDAAVKAYNDLTKEKQEGQDGKSALATVSEKQKAYNDAFVKANYSYEWV
  0176H4A    (514)   QLDEAVKAYNKLTKEQQESQDGKAALNLIDEKQTAYNEAFAKANYSYEWV
    12401    (526)   ALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWV
     H36B    (526)   ALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWV
    IC105    (526)   ALDAKIAAYNKLSADDQKGTKGETAKAEIKTAQDAYNAAFIVARTAYEWV
  2603V/R    (541)   ALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADYDAAFIEARTAYEWI
   18RS21    (541)   ALDEAIAAYNKLSATDQKGEKGITAKELIKTKQADYDAAFIEARTAYEWI
    IC458    (541)   DLDNAIKAYNGLTKAQQEGADGTSAKELINTKQSAYDAAFIKARTAYTWV
Consensus    (551)   ALDEAIKAYNKLTKE QEG DG TAKA I TKQ AYNAAFIKARTAYEWV
```

Figure 5C

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                   601                                                650
   NEM316   (556)  ADKKADNVVKLISNAGGQFEITGLDKGTYSLEETQAPAGYATLSGDVNFE
   CJB111   (556)  ADKKADNVVKLISNAGGQFEITGLDKGTYGLEETQAPAGYATLSGDVNFE
    BAA23   (556)  ADKKADNVVKLISNAGGQFEITGLDKGTYGLEETQAPAGYATLSGDVNFE
      515   (557)  EDKNAKNVVKLISNDKGQFEITGLTEGQYSLEETQAPTGYAKLSGDVSFN
  0176H4A   (564)  VDKNAANVVKLISNTAGKFEITGLNAGEYSLEETQAPTGYAKLSSDVSFK
    12401   (576)  TNKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFK
     H36B   (576)  TNKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFK
    IC105   (576)  TNKEDANVVKVTSNADGQFEVSGLATGDYKLEETQAPAGYAKLAGDVDFK
  2603V/R   (591)  TDK--ARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFV
   18RS21   (591)  TDK--ARAITYTSNDQGQFEVTGLADGTYNLEETLAPAGFAKLAGNIKFV
    IC458   (591)  DEK--TKAITFTSNNQGQFEVTGLEVGSYKLEETLAPAGYAKLSGDIEFT
Consensus   (601)   DK  ANVVKLTSNA GQFEVTGL  GTY LEETQAPAGYAKLSGDV F
                   651                                                700
   NEM316   (606)  VTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGTILFTIIG
   CJB111   (606)  VTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGTILFTIIG
    BAA23   (606)  VTATSYSKGATTDIAYDKGSVKKDAQQVQNKKVTIPQTGGIGTILFTIIG
      515   (607)  VNATSYSKGSAQDIEYTQGSKTKDAQQVINKKVTIPQTGGIGTIFFTIIG
  0176H4A   (614)  VNDTSYSEGASNDIAYDKDSGKTDAQKVVNKKVTIPQTGGIGTILFTIIG
    12401   (626)  VGNSSKAD-DSGNIDYTASSNKKDAQRIENKKVTIPQTGGIGTILFTIIG
     H36B   (626)  VGNSSKAD-DSGNIDYTASSNKKDAQRIENKKVTIPQTGGIGTILFTIIG
    IC105   (626)  VGNSSKAD-DSGNIDYTASSNKKDAQRIENKKVTIPQTGGIGTILFTIIG
  2603V/R   (639)  VNQGSYIT--GGNIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIG
   18RS21   (639)  VNQGSYIT--GGNIDYVANSNQKDATRVENKKVTIPQTGGIGTILFTIIG
    IC458   (639)  VGHDSYTS---GDIKYKTDDASNNAQKVFNKKVTIPQTGGIGTILFTIIG
Consensus   (651)  V  TSYS   SGDIDY   S KKDAQRV NKKVTIPQTGGIGTILFTIIG
                   701                720
   NEM316   (656)  LSIMLGAVVVMKKRQSEEA* (SEQ ID NO: 223)
   CJB111   (656)  LSIMLGAVVIMKKRQSEEA* (SEQ ID NO: 224)
    BAA23   (656)  LSIMLGAVVIMKKRQSEEA* (SEQ ID NO: 98)
      515   (657)  LSIMLGAVVIMKRRQSEEV* (SEQ ID NO: 225)
  0176H4A   (664)  LSIMLGAVVIMKRRQSEEA* (SEQ ID NO: 91)
    12401   (675)  LSIMLGAVIIMKRRQSEEA* (SEQ ID NO: 93)
     H36B   (675)  LSIMLGAVIIMKRRQSEEA* (SEQ ID NO: 226)
    IC105   (675)  LSIMLGAVIIMKRRQSEEA* (SEQ ID NO: 103)
  2603V/R   (687)  LSIMLGAVVIMKRRQSKEA* (SEQ ID NO: 227)
   18RS21   (687)  LSIMLGAVVIMKRRQSKEA* (SEQ ID NO: 228)
    IC458   (686)  LSIMLGAVVIMKRRQSEEA* (SEQ ID NO: 127)
Consensus   (701)  LSIMLGAVVIMKRRQSEEA
```

Figure 5D

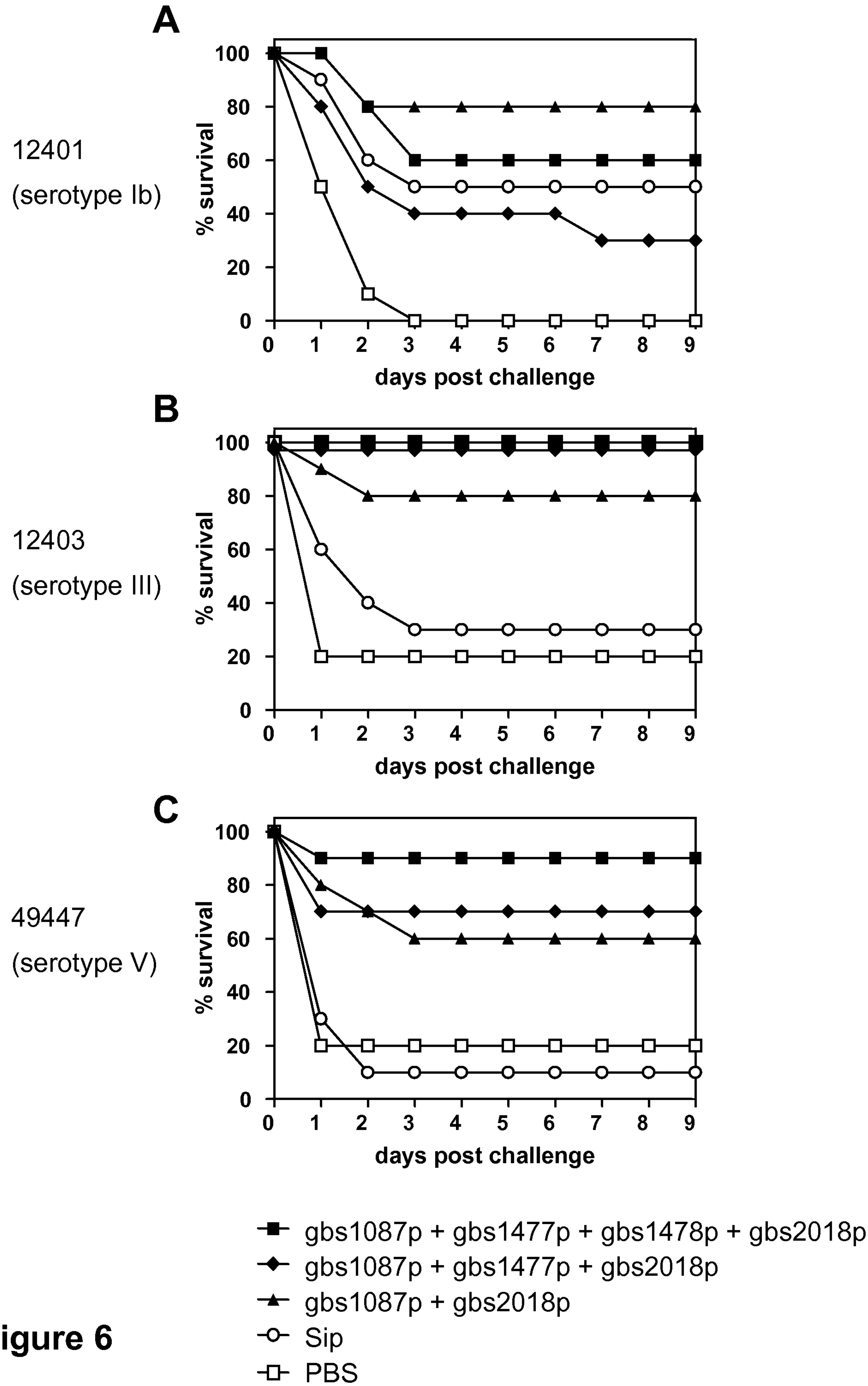
A
12401
(serotype Ib)
B
12403
(serotype III)
C
49447
(serotype V)
% survival
days post challenge
0
20
40
60
80
100
0
1
2
3
4
5
6
7
8
9
gbs1087p + gbs1477p + gbs1478p + gbs2018p
gbs1087p + gbs1477p + gbs2018p
gbs1087p + gbs2018p
Sip
PBS

Figure 6

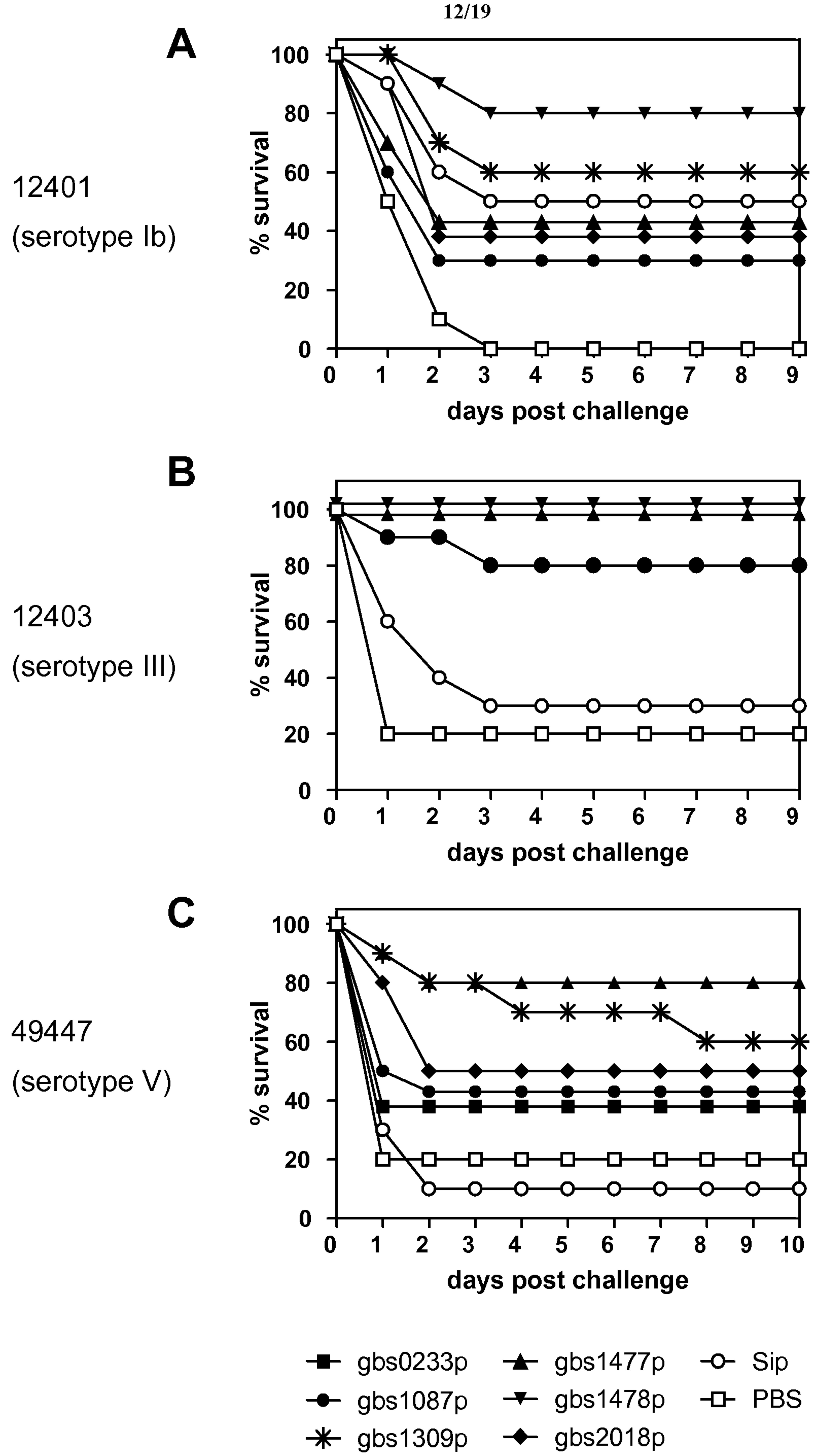
A
12401
(serotype Ib)
% survival
days post challenge
B
12403
(serotype III)
% survival
days post challenge
C
49447
(serotype V)
% survival
days post challenge
gbs0233p
gbs1087p
gbs1309p
gbs1477p
gbs1478p
gbs2018p
Sip
PBS

Figure 7

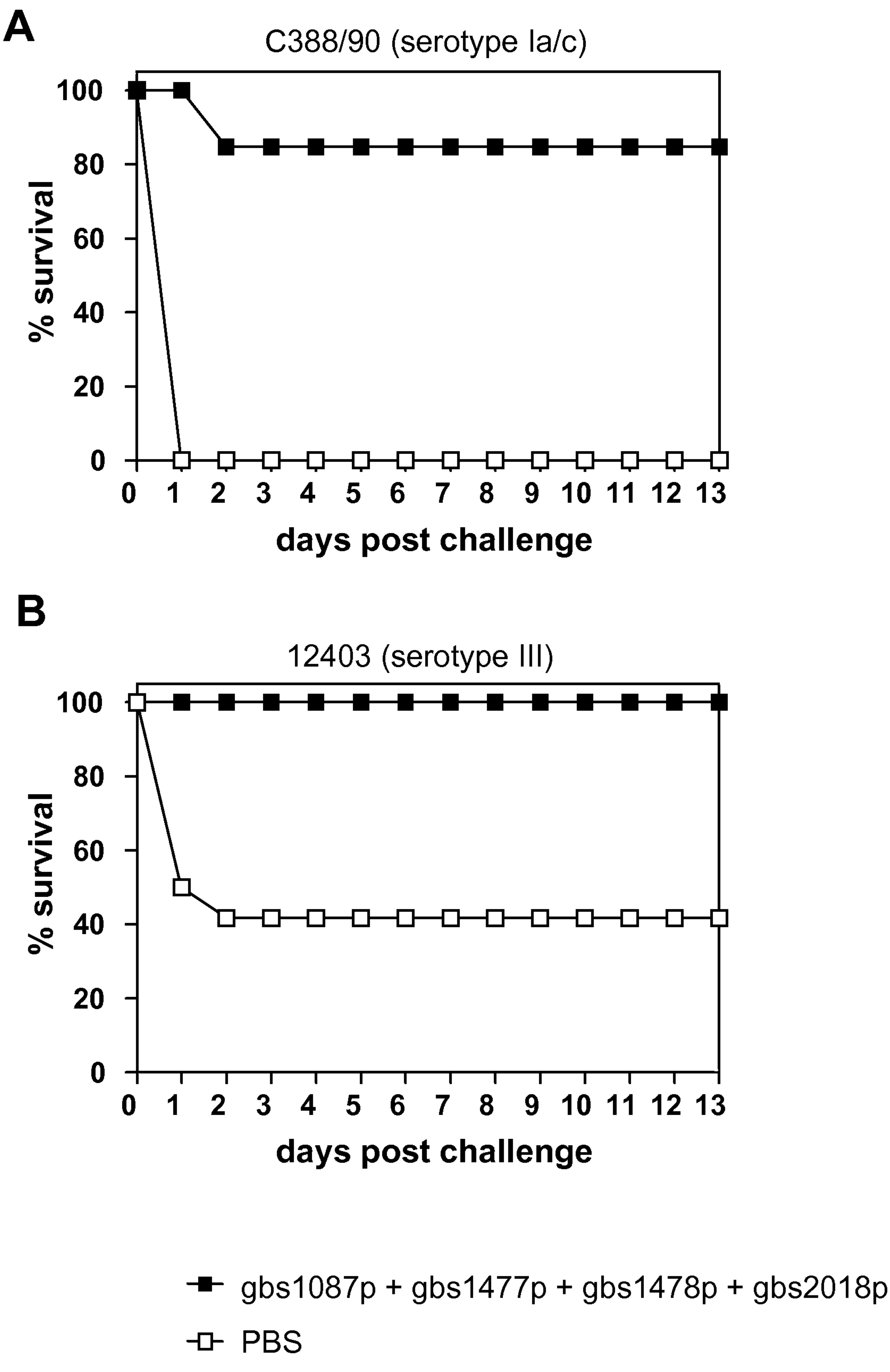
A
C388/90 (serotype Ia/c)
100
80
60
40
20
0
% survival
0 1 2 3 4 5 6 7 8 9 10 11 12 13
days post challenge
B
12403 (serotype III)
100
80
60
40
20
0
% survival
0 1 2 3 4 5 6 7 8 9 10 11 12 13
days post challenge
gbs1087p + gbs1477p + gbs1478p + gbs2018p
PBS

Figure 8

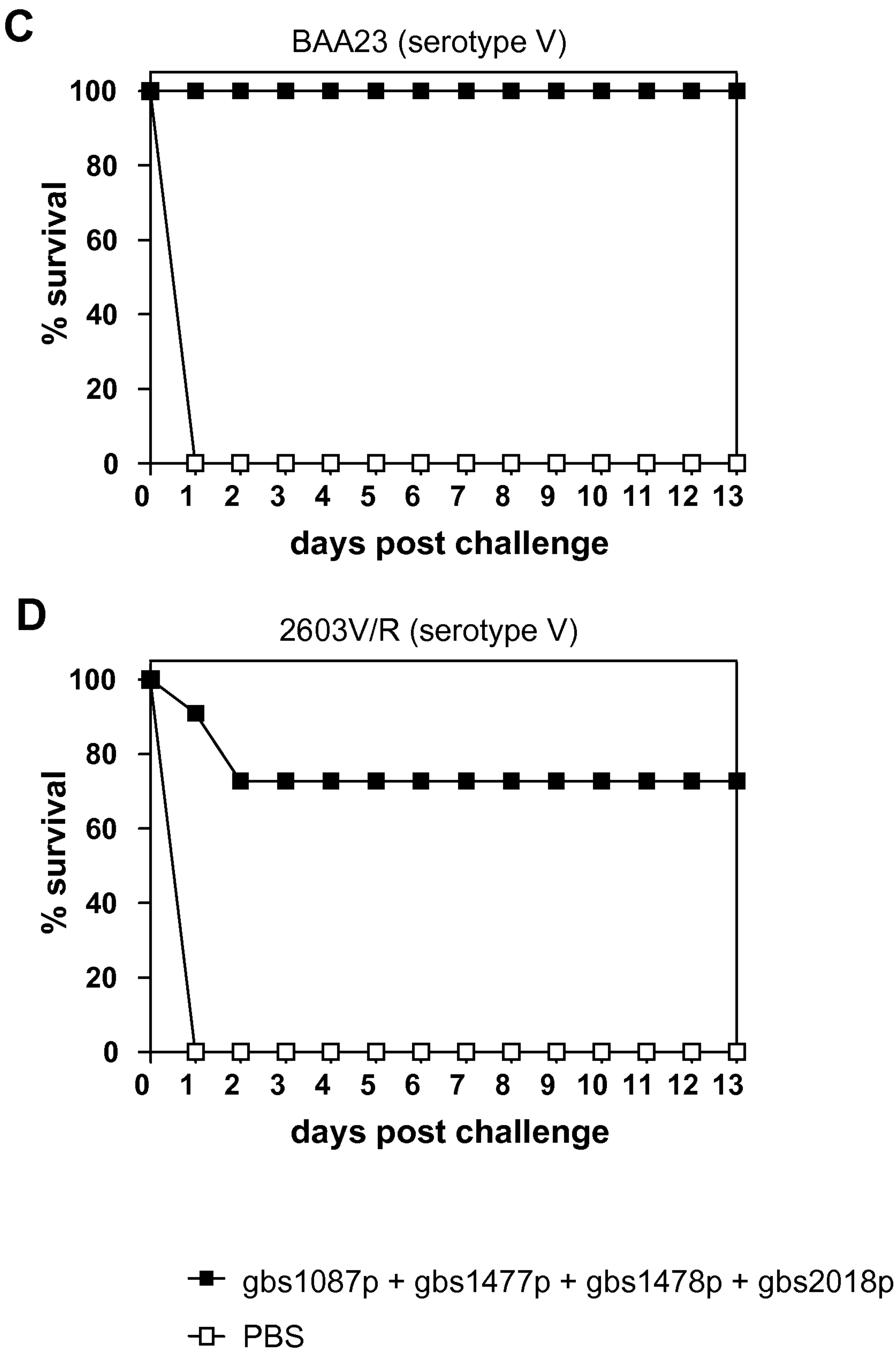
C
BAA23 (serotype V)
100
80
60
40
20
0
% survival
0 1 2 3 4 5 6 7 8 9 10 11 12 13
days post challenge
D
2603V/R (serotype V)
100
80
60
40
20
0
% survival
0 1 2 3 4 5 6 7 8 9 10 11 12 13
days post challenge
gbs1087p + gbs1477p + gbs1478p + gbs2018p
PBS

Figure 8

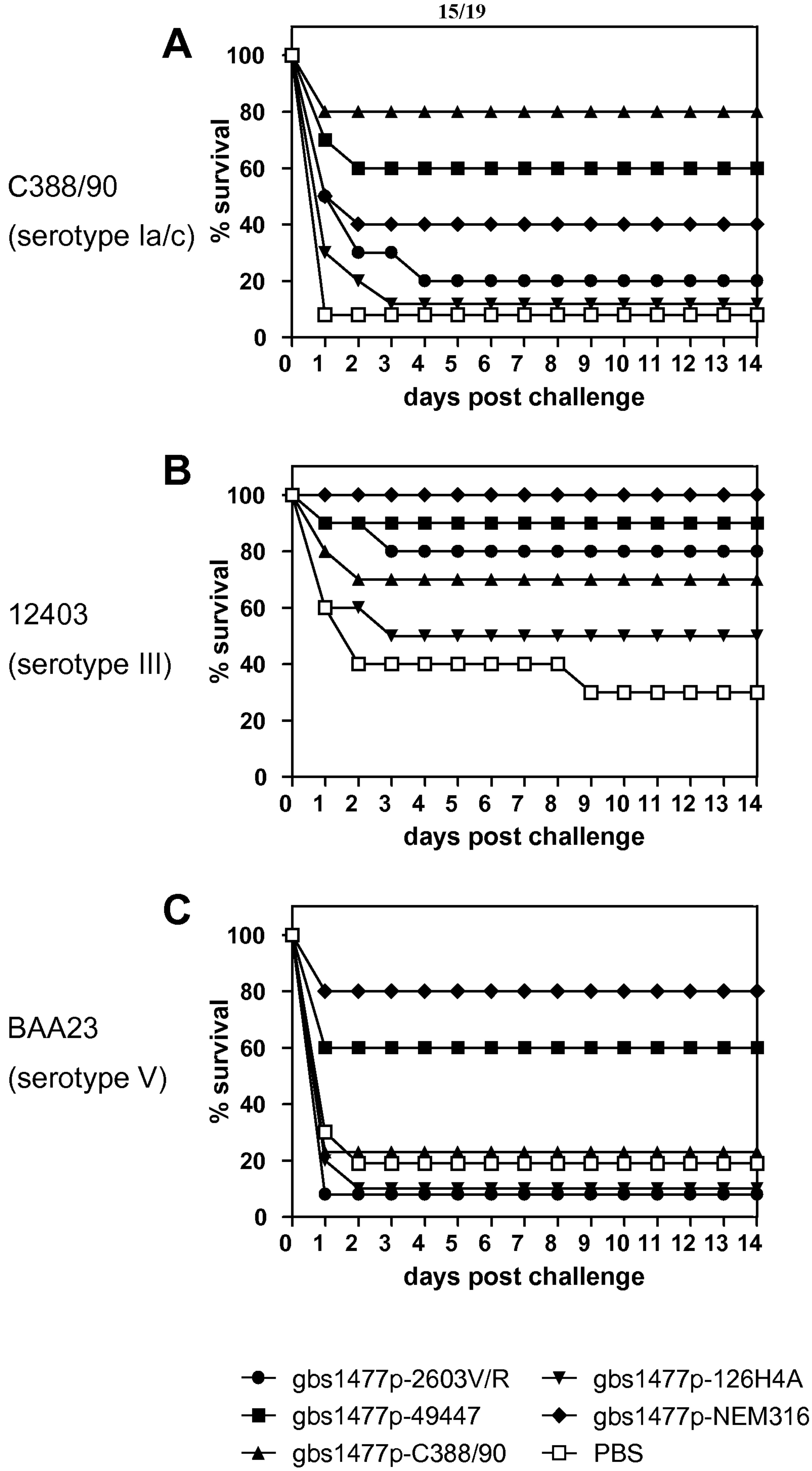
A
C388/90
(serotype Ia/c)
B
12403
(serotype III)
C
BAA23
(serotype V)
% survival
days post challenge
0 20 40 60 80 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
gbs1477p-2603V/R
gbs1477p-49447
gbs1477p-C388/90
gbs1477p-126H4A
gbs1477p-NEM316
PBS

Figure 9

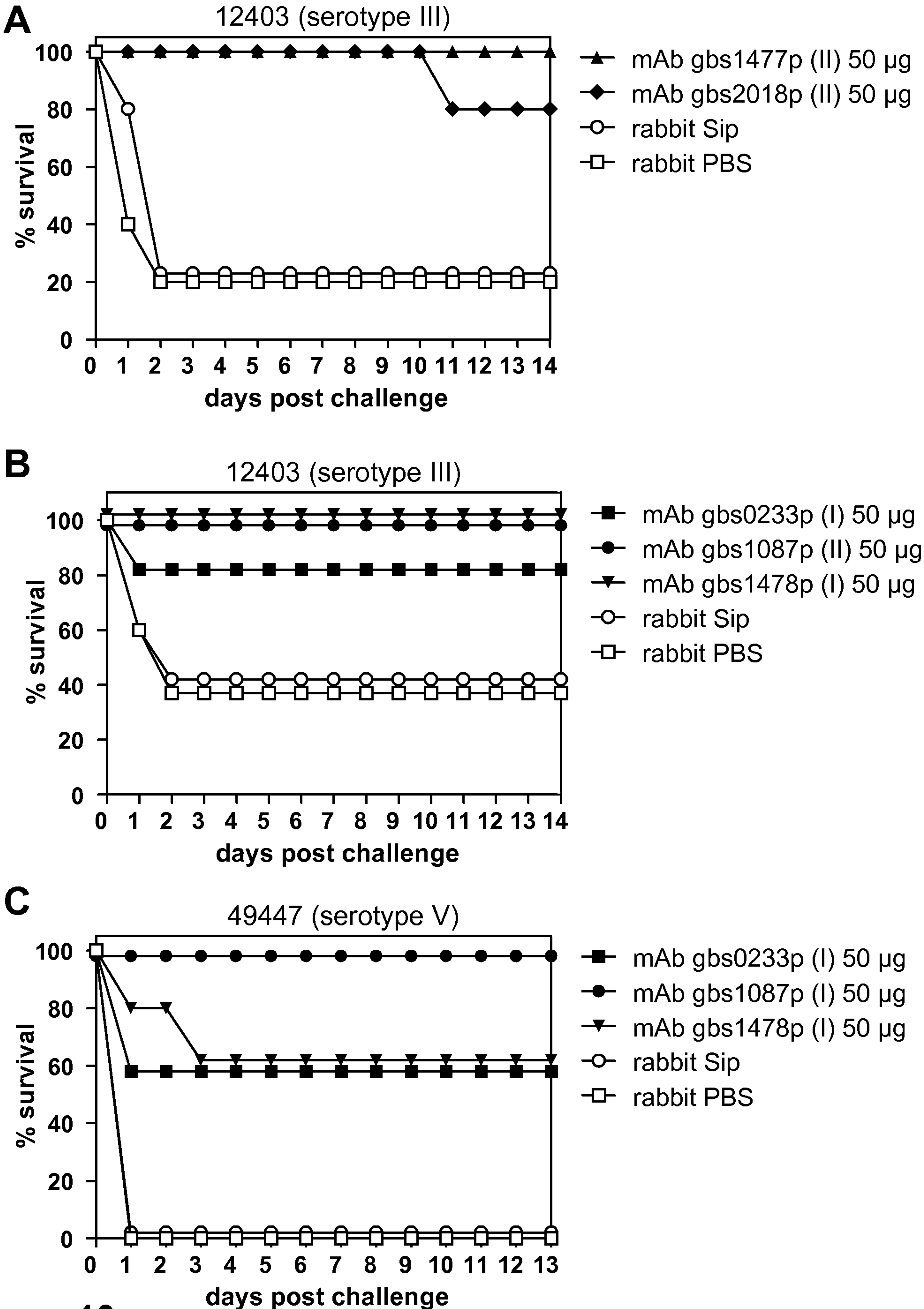
A
12403 (serotype III)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
mAb gbs1477p (II) 50 µg
mAb gbs2018p (II) 50 µg
rabbit Sip
rabbit PBS
B
12403 (serotype III)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
days post challenge
mAb gbs0233p (I) 50 µg
mAb gbs1087p (II) 50 µg
mAb gbs1478p (I) 50 µg
rabbit Sip
rabbit PBS
C
49447 (serotype V)
% survival
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13
days post challenge
mAb gbs0233p (I) 50 µg
mAb gbs1087p (I) 50 µg
mAb gbs1478p (I) 50 µg
rabbit Sip
rabbit PBS

Figure 10

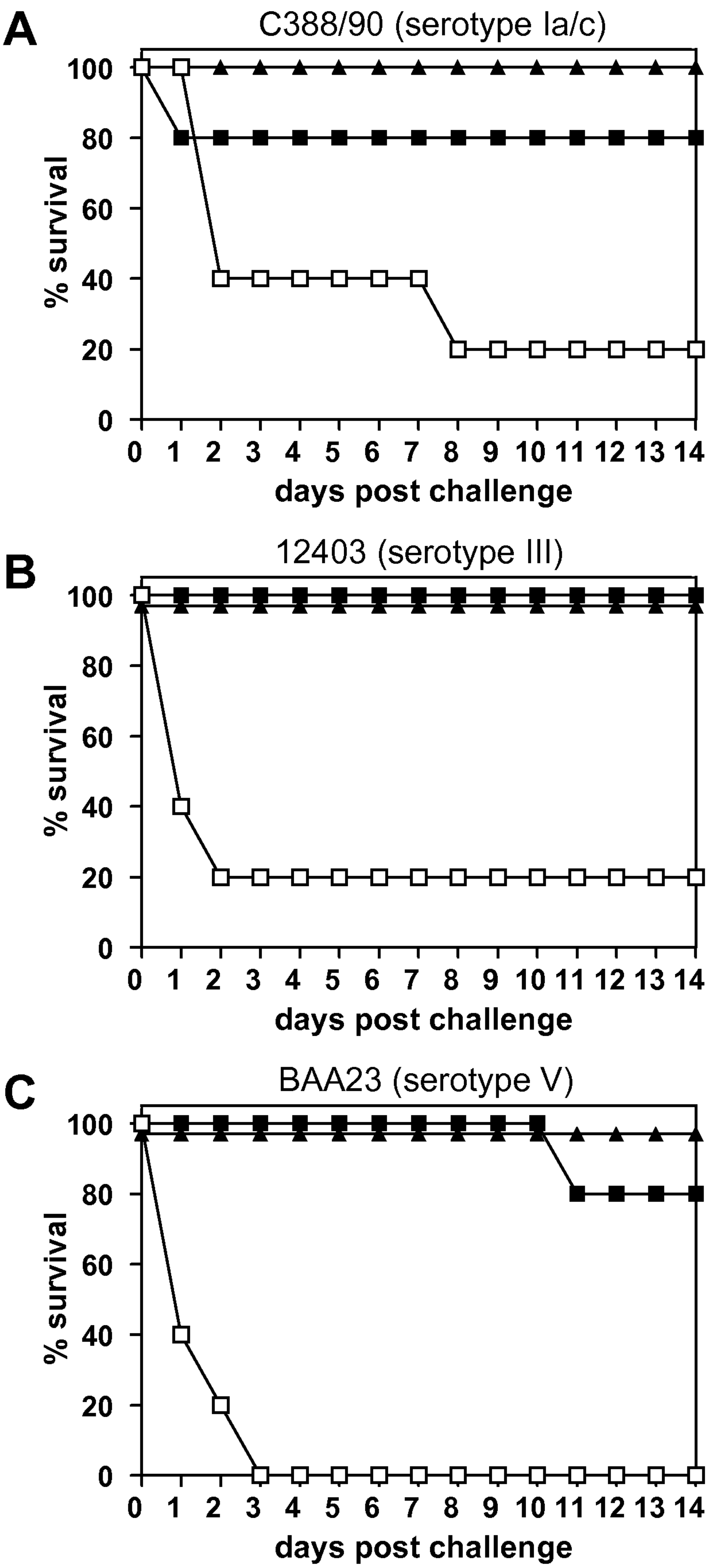
A
C388/90 (serotype Ia/c)
% survival
days post challenge
B
12403 (serotype III)
% survival
days post challenge
C
BAA23 (serotype V)
% survival
days post challenge
mAbs (gbs0233p + gbs1087p + gbs1477p + gbs1478p + gbs2018p)
rabbit sera (gbs0233p + gbs1087p + gbs1477p + gbs1478p + gbs2018
rabbit PBS sera

Figure 11

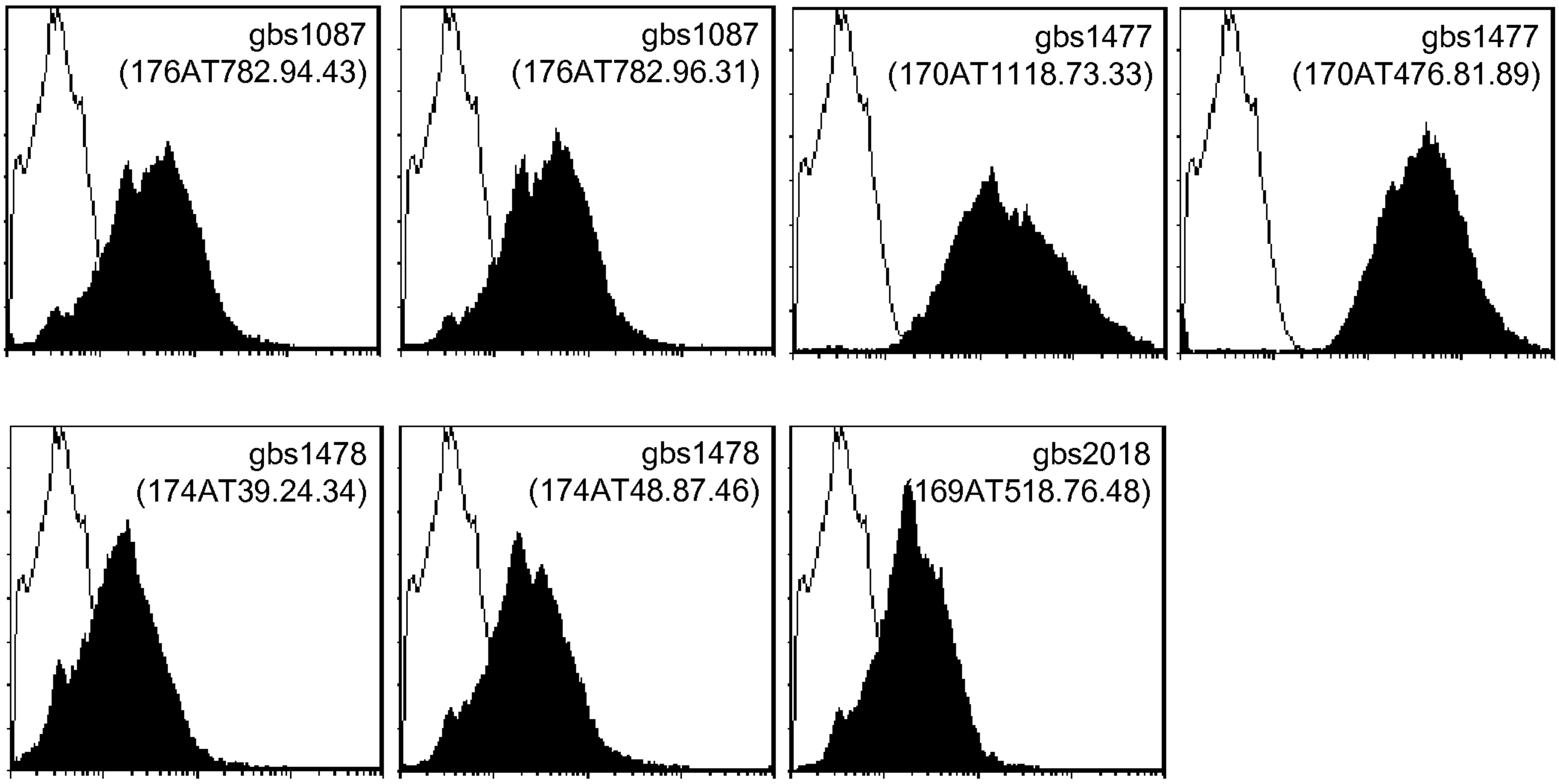
gbs1087
(176AT782.94.43)
gbs1087
(176AT782.96.31)
gbs1477
(170AT1118.73.33)
gbs1477
(170AT476.81.89)
gbs1478
(174AT39.24.34)
gbs1478
(174AT48.87.46)
gbs2018
(169AT518.76.48)

Figure 12

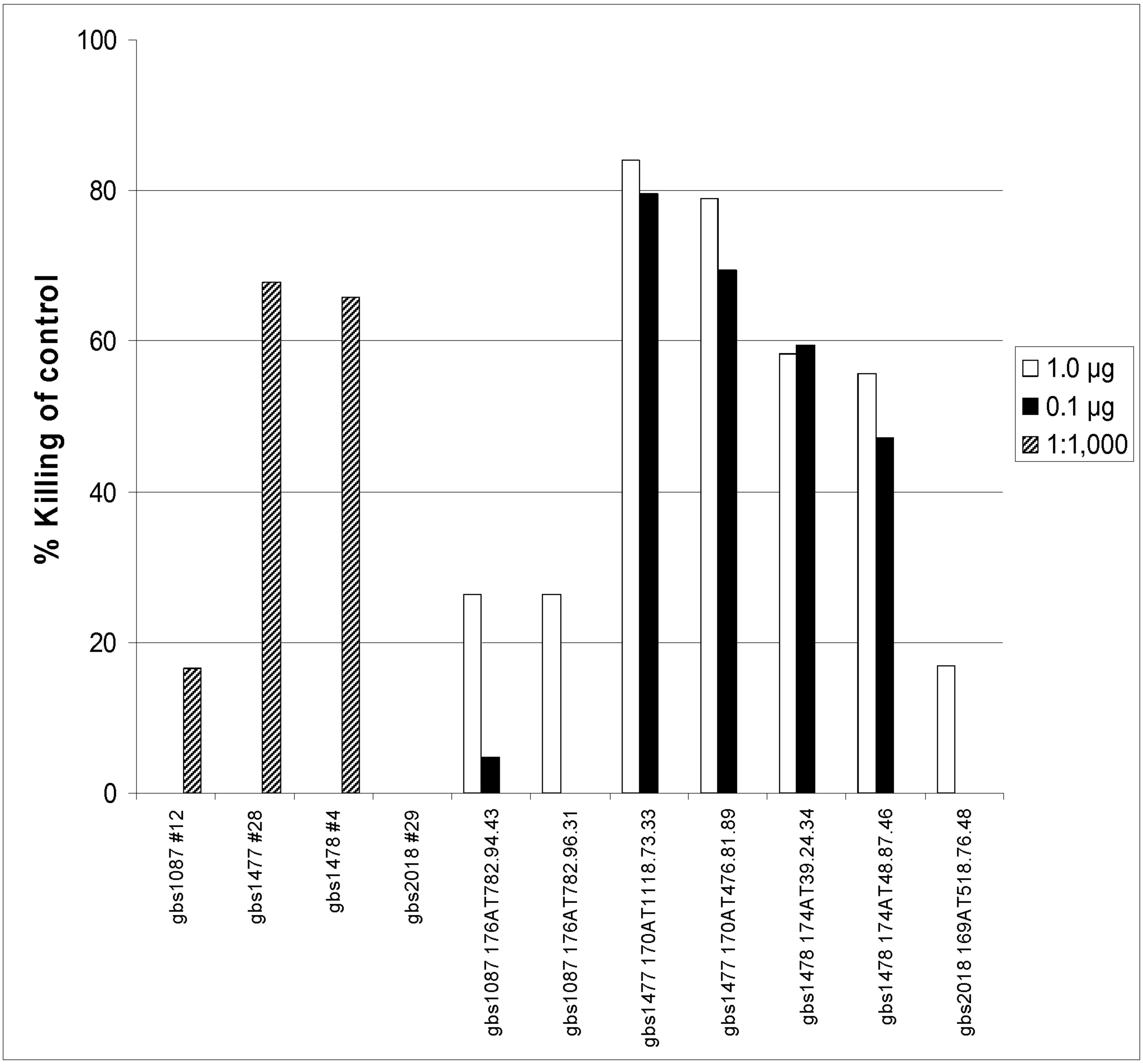
100
80
60
40
20
0
% Killing of control
1.0 µg
0.1 µg
1:1,000
gbs1087 #12
gbs1477 #28
gbs1478 #4
gbs2018 #29
gbs1087 176AT782.94.43
gbs1087 176AT782.96.31
gbs1477 170AT1118.73.33
gbs1477 170AT476.81.89
gbs1478 174AT39.24.34
gbs1478 174AT48.87.46
gbs2018 169AT518.76.48

Figure 13