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[Continued on next page]

(54) Title: BIFIDOBACTERIUM LONGUM

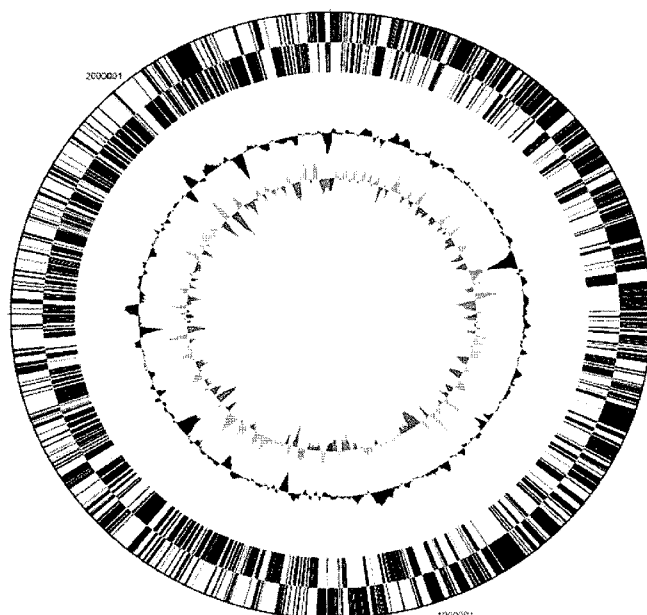


Fig. 1

(57) Abstract: The multiple embodiments described herein comprise the genome of a probiotic *Bifidobacterium longum* bifidobacteria strain and genes encoded by the genome. Various novel *Bifidobacterium longum* are described.



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“*Bifidobacterium longum*”

FIELD OF THE INVENTION

The invention relates to the genome of a probiotic bifidobacteria strain and genes
5 encoded by the genome. Bifidobacteria are one of several predominant culturable bacteria present in human colonic microflora.

BACKGROUND OF THE INVENTION

Bifidobacteria are considered to be probiotics as they are living organisms which exert
10 healthy effects beyond basic nutrition when ingested in sufficient numbers. A high level of ingested bifidobacteria must reach their site of action in order to exert a probiotic effect. A minimum level of approximately 10^6 - 10^7 viable bifidobacteria per gram intestinal contents has been suggested (Bouhnik, Y., Lait 1993). There are reports in the literature which show that *in vivo* studies completed in adults and in infants indicate that some strains of bifidobacteria are
15 capable of surviving passage through the gastrointestinal tract. Significant differences have been observed between the abilities of different bifidobacteria strains to tolerate acid and bile salts, indicating that survival is an important criterion for the selection of potential probiotic strains.

Ingestion of bifidobacteria can improve gastrointestinal transit and may prevent or assist in the treatment of illnesses which may be caused by deficient or compromised microflora such
20 as gastrointestinal tract (GIT) infections, constipation, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD) – Crohn’s disease and ulcerative colitis, food allergies, antibiotic-induced diarrhoea, cardiovascular disease, and certain cancers (e.g. colorectal cancer).

Because of their perceived health-promoting activities, bifidobacteria have in recent years enjoyed an increased amount of scientific scrutiny, which included the full genomic sequencing
25 of a number of strains (reviewed by Liu *et al.*, 2005). These genomic sequences will provide the genetic platforms that allow the study of the molecular mechanisms by which these microorganisms interact with their human host and elicit their probiotic function.

SUMMARY OF THE INVENTION

30 The invention provides an isolated and purified *Bifidobacterium longum* strain, excluding *Bifidobacterium longum* strain 35624 (NCIMB 41003), wherein the strain:

- a) expresses an exopolysaccharide; and

- b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto.

- 5 A *Bifidobacterium longum* strain according to the invention may include any 2 or more such as BI00778, BI00793; BI00778, BI00794; BI00778, BI00795 or any three or more such as BI00793, BI00794, BI00798; BI00794, BI00795, BI00796; BI00796, BI00797, BI00798 or any four or more such as BI00778, BI00779, BI00780, BI00794; BI00778, BI00779, BI00785, BI00786; BI00790, BI00791, BI00794, BI00798 or any five or more such as
- 10 BI00783, BI00786, BI00790, BI00794, BI00798; BI00780, BI00782, BI00785, BI00786, BI00790; BI00778, BI00779, BI00787, BI00789, BI00798 or any six or more such as BI00778, BI00779, BI00780, BI00781, BI00782, BI00794; BI00782, BI00784, BI00785, BI00788, BI00792, BI00797; BI00781, BI00782, BI00783, BI00791, BI00796, BI00797 or any seven or more such as
- 15 BI00779, BI00783, BI00784, BI00787, BI00791, BI00792, BI00797; BI00780, BI00789, BI00790, BI00793, BI00794, BI00797, BI00798; BI00783, BI00784, BI00786, BI00788, BI00789, BI00793, BI00796 or any eight or more such as BI00779, BI00782, BI00783, BI00784, BI00785, BI00794, BI00797, BI00798; BI00780, BI00787, BI00788, BI00789, BI00790, BI00793, BI00794, BI00795;
- 20 BI00783, BI00784, BI00785, BI00786, BI00787, BI00793, BI00795, BI00798 or any nine or more such as BI00778, BI00780, BI00782, BI00784, BI00785, BI00787, BI00793, BI00795, BI00796; BI00779, BI00781, BI00782, BI00784, BI00786, BI00787, BI00793, BI00795, BI00797; BI00782, BI00783, BI00785, BI00786, BI00787, BI00789, BI00792, BI00796, BI00797 or any ten or more such as
- 25 BI00778, BI00781, BI00784, BI00785, BI00786, BI00789, BI00790, BI00792, BI00793, BI00798; BI00779, BI00781, BI00784, BI00786, BI00787, BI00788, BI00791, BI00794, BI00795, BI00796; BI00782, BI00784, BI00785, BI00786, BI00790, BI00792, BI00794, BI00796, BI00797, BI00798 or any eleven or more such as BI00778, BI00781, BI00785, BI00787, BI00788, BI00790, BI00791, BI00792, BI00794, BI00795, BI
- 30 00798; BI00779, BI00782, BI00785, BI00786, BI00789, BI00790, BI00793, BI00794, BI00795, BI00796, BI00797; BI00781, BI00783, BI00785, BI00787, BI00788, BI00789, BI00790, BI00793, BI00794, BI00795, BI00796 or any twelve or more such as

BI00778, BI00781, BI00782, BI00783, BI00784, BI00785, BI00790, BI00791, BI00792, BI00795, BI00796, BI00797;

BI00779, BI00785, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00794, BI00796, BI00797, BI00798;

5 BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00795, BI00796, BI00797, BI00798 or any thirteen or more such as

BI00778, BI00779, BI00780, BI00782, BI00784, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00798;

BI00778, BI00781, BI00782, BI00783, BI00786, BI00787, BI00789, BI00790, BI00791, BI00792, BI00795, BI00796, BI00798;

10

BI00780, BI00781, BI00782, BI00783, BI00785, BI00786, BI00788, BI00790, BI00791, BI00792, BI00793, BI00797, BI00798 or any fourteen or more such as

BI00778, BI00779, BI00780, BI00782, BI00783, BI00784, BI00785, BI00787, BI00789, BI00791, BI00793, BI00794, BI00795, BI00797;

15 BI00778, BI00780, BI00781, BI00782, BI00784, BI00785, BI00786, BI00788, BI00789, BI00792, BI00793, BI00794, BI00796, BI00797;

BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00787, BI00790, BI00791, BI00794, BI00796, BI00797, BI00798 or any fifteen or more such as

BI00778, BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00792, BI00798;

20

BI00778, BI00780, BI00781, BI00782, BI00785, BI00787, BI00788, BI00789, BI00790, BI00791, BI00793, BI00794, BI00795, BI00796, BI00798;

BI00780, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00789, BI00790, BI00791, BI00793, BI00795, BI00796, BI00797, BI00798 or any sixteen or more such as

25 BI00778, BI00779, BI00780, BI00781, BI00782, BI00784, BI00785, BI00787, BI00789, BI00790, BI00791, BI00792, BI00793, BI00795, BI00797, BI00798;

BI00778, BI00779, BI00781, BI00783, BI00784, BI00785, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00794, BI00795, BI00797, BI00798;

BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00787, BI00788, BI00789, BI00790, BI00792, BI00793, BI00795, BI00796, BI00797, BI00798 or any seventeen or more such as

30

BI00778, BI00779, BI00780, BI00781, BI00782, BI00784, BI00785, BI00787, BI00788, BI00789, BI00790, BI00793, BI00794, BI00795, BI00796, BI00797, BI00798;

BI00778, BI00780, BI00781, BI00782, BI00783, BI00785, BI00786, BI00787, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797;

BI00779, BI00780, BI00782, BI00783, BI00784, BI00785, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00797, BI00798 or any eighteen or more such as BI00778, BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00787, BI00788, BI00789, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00798;

5 BI00778, BI00779, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00792, BI00794, BI00795, BI00796, BI00797, BI00798;

BI00779, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797 or any nineteen or more such as

10 BI00778, BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00794, BI00795, BI00796, BI00797;

BI00778, BI00779, BI00780, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797;

BI00779, BI00780, BI00781, BI00782, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI

15 00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797, BI00798 or any twenty or more such as

BI00778, BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00797, BI00798;

BI00778, BI00779, BI00780, BI00781, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI

20 00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797, BI00798;

BI00778, BI00779, BI00780, BI00782, BI00783, BI00784, BI00785, BI00786, BI00787, BI00788, BI00789, BI00790, BI00791, BI00792, BI00793, BI00794, BI00795, BI00796, BI00797, BI00798 or all twentyone of the nucleic acid sequences selected from the group comprising SEQ ID No. 93 to SEQ ID No. 113 or sequences homologous thereto.

25

The strain may comprise at least three nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least four nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid

30 sequences with at least 85% sequence homology thereto. The strain may comprise at least five nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least six nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain

may comprise at least seven nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least eight nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least nine nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least ten nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least twelve nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least three nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least thirteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least fourteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least fifteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least sixteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least seventeen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least eighteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least nineteen nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least twenty nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise all twenty one nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto.

The strain may not comprise the nucleic acid sequence of SEQ ID No. 112.

The strain may comprise at least one nucleic acid sequence selected from the group
5 comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85%
sequence homology thereto.

The strain may comprise at least two nucleic acid sequences selected from the group
comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85%
10 sequence homology thereto. The strain may comprise at least three nucleic acid sequences
selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid
sequences with at least 85% sequence homology thereto. The strain may comprise at least four
nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132
or nucleic acid sequences with at least 85% sequence homology thereto. The strain may
15 comprise at least five nucleic acid sequences selected from the group comprising SEQ ID No.
114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto.
The strain may comprise at least six nucleic acid sequences selected from the group comprising
SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence
homology thereto. The strain may comprise at least seven nucleic acid sequences selected from
20 the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at
least 85% sequence homology thereto. The strain may comprise at least eight nucleic acid
sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic
acid sequences with at least 85% sequence homology thereto. The strain may comprise at least
nine nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No.
25 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may
comprise at least ten nucleic acid sequences selected from the group comprising SEQ ID No. 114
to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto.
The strain may comprise at least eleven nucleic acid sequences selected from the group
comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85%
30 sequence homology thereto. The strain may comprise at least twelve nucleic acid sequences
selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid
sequences with at least 85% sequence homology thereto. The strain may comprise at least
thirteen nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID
No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain

may comprise at least fourteen nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least fifteen nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least sixteen nucleic acid sequence selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least seventeen nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise at least eighteen nucleic acid sequence selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise all nineteen nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto

The strain may comprise a single nucleic acid sequence selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least sequence homology thereto. The strain may comprise a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence with at least sequence homology thereto.

The strain may comprise two nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto. The strain may comprise the nucleic acid sequences of SEQ ID No. 131 and SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto.

The invention also provides an isolated and purified *Bifidobacterium longum* strain wherein the strain:

- a) expresses an exopolysaccharide; and
- b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto; and
- c) comprises a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence with at least 85% sequence homology thereto; and/or

- d) comprises a nucleic acid sequence of SEQ ID No. 131 or a nucleic acid sequence with at least 85% sequence homology thereto.

In one embodiment, 1×10^7 CFU/ml of the strain may induce an [IL10] : [IL12] ratio of at least 10 in a peripheral blood mononuclear cell (PMBC) co-incubation assay. The strain may be in the form of a bacterial broth. The strain may be in the form of a freeze-dried powder.

The invention further provides an isolated and purified *Bifidobacterium longum* strain wherein the strain:

- 10 a) expresses an exopolysaccharide; and
b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto; and
c) comprises a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence
15 with at least 85% sequence homology thereto; and/or a nucleic acid sequence of SEQ ID No. 131 or a nucleic acid sequence with at least 85% sequence homology thereto; and
d) induces an [IL10] : [IL12] ratio of at least 10 in a peripheral blood mononuclear cell (PMBC) co-incubation assay at a concentration of 1×10^7 CFU/ml bacteria.

20 The invention also provides an isolated strain of *Bifidobacterium longum* BL1207 (PTA-9608).

The invention further provides an isolated strain of *Bifidobacterium longum* AH121A (NCIMB 41675).

25 The invention further still provides an isolated strain of *Bifidobacterium longum* AH1714 (NCIMB 41676).

The isolated strain may be in the form of viable cells. The isolated strain may be in the form of non-viable cells.

30

The invention also provides a formulation comprising an isolated strain of *Bifidobacterium longum* as described herein. The formulation may comprise an ingestible carrier. The ingestible carrier may be a pharmaceutically acceptable carrier such as a capsule, tablet or powder. The ingestible carrier may be a food product such as acidified milk, yoghurt,

frozen yoghurt, milk powder, milk concentrate, cheese spreads, dressings or beverages. The formulation may comprise a strain that is present at more than 10^6 cfu per gram of ingestible carrier.

- 5 The invention further provides a composition comprising an isolated strain of *Bifidobacterium longum* as described herein and a pharmaceutically acceptable carrier.

The invention also provides for the use of a *Bifidobacterium longum* strain as described herein as a probiotic strain.

10

The invention also provides a method for identifying an exopolysaccharide expressing *Bifidobacterium longum* strain comprising the steps of:

- a) obtaining a sample comprising bacteria;
- b) extracting nucleic acid from the sample;
- 15 c) amplifying the extracted nucleic acid in the presence of at least two primers derived from a nucleic acid sequence selected from the group comprising: SEQ ID No. 2, SEQ ID No. 3, SEQ ID No. 10 to SEQ ID No. 12, SEQ ID No. 93 to SEQ ID No. 132 or a nucleic acid sequence with at least 85% sequence homology thereto;
- 20 d) identifying a bacterial strain that expresses an exopolysaccharide.

The primer may comprise at least 10 consecutive bases from a nucleic acid sequence selected from the group comprising: SEQ ID No. 2, SEQ ID No. 3, SEQ ID No. 10 to SEQ ID No. 12 and SEQ ID No. 93 to SEQ ID No. 132.

- 25 The primer may comprise a nucleic acid sequence selected from the group comprising: SEQ ID No. 10 to SEQ ID No. 12, SEQ ID No. 13 to SEQ ID No. 92 or a nucleic acid sequence with at least 85% sequence homology thereto.

The step of identifying a bacterial strain that expresses an exopolysaccharide may comprise growing the bacterial strain on a Congo red agar plate.

- 30 The sample is a mammalian sample. The sample may be a human derived sample. The sample may be a fecal sample.

The invention also provides for a *Bifidobacterium longum* strain identified by described herein. The *Bifidobacterium longum* strain may be in the form of viable cells. The *Bifidobacterium longum* strain may be in the form of non-viable cells.

The invention further provides for a formulation comprising a *Bifidobacterium longum* strain as described herein. The formulation may comprise an ingestible carrier. The ingestible carrier may be a pharmaceutically acceptable carrier such as a capsule, tablet or powder. The ingestible carrier may be a food product such as acidified milk, yoghurt, frozen yoghurt, milk powder, milk concentrate, cheese spreads, dressings or beverages. The strain may be present at more than 10^6 cfu per gram of ingestible carrier in the formulation.

The invention also provides a composition comprising a *Bifidobacterium longum* strain as described herein and a pharmaceutically acceptable carrier.

In one embodiment of the invention there is a method for identifying exopolysaccharide secreting bacterial strains comprising the steps of:

- obtaining a sample comprising bacteria;
- extracting DNA from the sample;
- amplifying the extracted DNA in the presence of at least one DNA primer derived from the DNA sequence of SEQ ID No. 2 and/or SEQ ID No. 3; and
- identifying a bacterial strain that expresses an exopolysaccharide.

The extracted DNA may be amplified by real time PCR. The DNA may be amplified in the presence of at least one primer of the nucleic acid sequence of SEQ ID No. 10, SEQ ID No. 11 or SEQ ID No. 12.

The sample may be a human derived sample such as a fecal sample.

In another embodiment, the invention also provides for a bacterial strain identified by the method described herein.

In another embodiment, the invention further provides for the use of a bacterial strain identified by the method described herein as a probiotic bacteria.

In yet another embodiment, the invention also provides a formulation comprising a bacterial strain identified by the method described herein.

In another embodiment, the invention further provides a composition comprising a bacterial strain identified by the method described herein and a pharmaceutically acceptable carrier.

5

In another embodiment, the invention also provides an isolated bifidobacterial longum strain BL1207 (PTA-9608).

In yet another embodiment, the invention further provides a formulation comprising an isolated bifidobacterial longum strain BL1207 (PTA-9608).

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In another embodiment, the invention also provides a composition comprising an isolated bifidobacterial longum strain BL1207 (PTA-9608) and a pharmaceutically acceptable carrier.

15

In another embodiment, the invention further provides a DNA array/chip comprising at least one polynucleotide derived from the nucleic acid sequence of SEQ ID NO. 1, SEQ ID No. 2, or SEQ ID No. 3.

In one embodiment, the invention also provides a computer readable medium comprising a nucleic acid sequence of SEQ ID NO. 1, SEQ ID No. 2, or SEQ ID No. 3 or parts thereof.

20

A Bifidobacterium longum strain in accordance with an embodiment of the invention may express or produce EPS at a yield of between about 10mg/L to about 1000mg/L of bacterial culture.

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There are a number of strains of Bifidobacteria which are already deposited under the Budapest Treaty. These include the strain deposited at the NCIMB under the number 41003, the genome of which is presented herein. As this is a known strain, this strain is specifically disclaimed for the claims to the strains per se. In so far as the following strains may fall within the scope of the patent claims at the relevant date(s), the following claims are also disclaimed: ATCC BAA-999, CNCM I-1227, CNCM I-1228, CNCM I-2168, CNCM I-2170, CNCM I-2618, CNCM I-3446, CNCM I-3853, CNCM I-3854, CNCM I-3855, NCIMB 41290, NCIMB 41291, NCIMB 41382, NCIMB 41387, NTCC 2705.

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Brief Description of the drawings

The invention will be more clearly understood from the following description thereof given by way of example only with reference to the accompanying drawings in which;-

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Fig. 1 is a Genome atlas of *Bifidobacterium longum* biotype infantis UCC 35624. The numbers on the genome (1, 1000001, 200001) refer to base pair position. 1 refers to the adenine nucleotide of the ATG start codon of the gene encoding the predicted replication protein. The outer circle (two strands, black and white) refers to the gene density within the chromosome. 10 The second circle (middle circle – black) refers to the GC content and the innermost circle refers to the GC skew;

Fig. 2 is a bar chart showing the induction profile of IL-1beta in PBMCs by *Bifidobacterium longum* infantis strain UCC35624 (B624), *Bifidobacterium longum* strain 1207 (BL1207), *Bifidobacterium longum* strain 15707 (BL15707), *Bifidobacterium lactis* (BL-07) and *Bifidobacterium breve* strain 8807 [UCC2003] (breve);

Fig. 3 is a bar chart showing the induction profile of IL-12p70 in PBMCs by *Bifidobacterium longum* infantis strain UCC35624 (B624), *Bifidobacterium longum* strain 1207 (BL1207), *Bifidobacterium longum* strain 15707 (BL15707), *Bifidobacterium lactis* (BL-07) and *Bifidobacterium breve* strain 8807 [UCC2003] (breve);

Fig. 4 is a bar chart showing the induction profile of IL-10 in PBMCs by *Bifidobacterium longum* infantis strain UCC35624 (B624), *Bifidobacterium longum* strain 1207 (BL1207), *Bifidobacterium longum* strain 15707 (BL15707), *Bifidobacterium lactis* (BL-07) and *Bifidobacterium breve* strain 8807 [UCC2003] (breve);

Fig. 5 is a bar chart showing the induction profile of TNF-alpha in PBMCs by *Bifidobacterium longum* infantis strain UCC35624 (B624), *Bifidobacterium longum* strain 1207 (BL1207), *Bifidobacterium longum* strain 15707 (BL15707), *Bifidobacterium lactis* (BL-07) and *Bifidobacterium breve* strain 8807 [UCC2003] (breve).

Fig. 6 is a photograph of *B. longum* 35624 grown on a Congo Red Agar plate;

Fig. 7 is a photograph of *B. longum* AH121A grown on a Congo Red Agar plate;

Fig. 8 is a photograph of *B. longum* AH1714 grown on a Congo Red Agar plate;

Fig. 9 is a photograph of *B. longum* AH0119 grown on a Congo Red Agar plate;

Fig. 10 is a photograph of *B. breve* UCC2003 grown on a Congo Red Agar plate;

Fig. 11 is a photograph of *L. Rhamnosus* AH308 grown on a Congo Red Agar plate;

Fig. 12 is a photograph of *L. salivarius* UCC1 grown on a Congo Red Agar plate; and

Fig. 13 is a bar chart illustrating the IL-10:IL-12p70 ratio for PBMCs stimulated with *Bifidobacterium longum infantis* strain 35624 (*Bifidobacterium* 35624), *Bifidobacterium longum* strain 1714 (*Bifidobacterium* 1714), *Bifidobacterium longum* strain 1207 (*Bifidobacterium* 1207), *Bifidobacterium longum* strain 121A (*Bifidobacterium* 121A), *Bifidobacterium longum* strain 0119 (*Bifidobacterium* 0119), *Bifidobacterium longum* strain 15707 (*Bifidobacterium* 15707), *Bifidobacterium breve* strain 8807 (*Bifidobacterium* UCC2003), *Lactobacillus rhamnosus* and *Lactobacillus salivarius* strain UCC1.

DETAILED DESCRIPTION OF THE INVENTION

Disclosed herein is an isolated polynucleotide of SEQ ID No. 1. The polynucleotide of SEQ ID No. 1 encodes a strain of *Bifidobacterium*. The *Bifidobacterium* encoded by the isolated polynucleotide sequence has a number of unique genes. The unique genes encoded by the polynucleotide have a unique order in the sequence of SEQ ID No. 1. As used herein, the term “unique genes”, mean genes that are not found in the currently available sequences of *Bifidobacterium*. As used herein, the term “unique order”, means that the position / sequence of the genes in the polynucleotide is not found in the currently available sequences of *Bifidobacterium*. The unique genes present in the isolated polynucleotide may be interspersed with nucleic acid residues that code for other (known) genes or stretches of non-coding sequence but the overall order/sequence of the unique genes in the isolated polynucleotide is in itself unique compared to the order of genes found in the currently available sequences of *Bifidobacterium*.

The polynucleotide was isolated from a strain of the bacterial species *Bifidobacterium longum* biotype *infantis* with the strain designation UCC 35624. A deposit of *Bifidobacterium*

longum biotype *infantis* strain UCC 35624 was made at the National Collections of Industrial and Marine Bacteria Limited (NCIMB) Ferguson Building, Craibstone Estate, Bucksburn, Aberdeen, AB21 9YA, Scotland, UK on January 13, 1999 and accorded the accession number NCIMB 41003.

5 A deposit of *Bifidobacteria infantis* strain BL1207 was made at the American Type Culture Collection (ATTC) 10801 University Boulevard, Manassas, Virginia 20110-2209, USA on November 14, 2008 and accorded the accession number PTA-9608.

A deposit of *Bifidobacterium longum* strain AH121A was made at the National Collections of Industrial and Marine Bacteria Limited (NCIMB) Ferguson Building, Craibstone
10 Estate, Bucksburn, Aberdeen, AB21 9YA, Scotland, UK on November 5, 2009 and accorded the accession number NCIMB 41675.

A deposit of *Bifidobacterium longum* strain AH1714 was made at the National Collections of Industrial and Marine Bacteria Limited (NCIMB) Ferguson Building, Craibstone Estate, Bucksburn, Aberdeen, AB21 9YA, Scotland, UK on November 5, 2009 and accorded the
15 accession number NCIMB 41676.

Given the size of the isolated polynucleotide it would not be uncommon for a point mutation or some other form of mutation to be present in the sequence. As such we encompass variants of SEQ ID No. 1 in the disclosure. As used herein, the term “variants”, means strains of *Bifidobacteria* that have a sequence identity of at least 99.5% or more with SEQ ID No. 1.

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SEQ ID No. 1 contains a large number of open reading frames which represent the predicted genes. We have identified 1,836 protein coding regions or genes within this polynucleotide. As such, our disclosure encompasses fragments of the polynucleotide of SEQ ID No. 1. The fragments may correspond to portions of the polynucleotide sequence that encode
25 one or more proteins. Alternatively, the fragments may correspond to portions of the polynucleotide sequence that specify part of a gene or genes for example the fragment may correspond to a portion of the polynucleotide sequence that spans a part of two or more genes.

The sequence of SEQ ID No. 1 is a DNA polynucleotide sequence, our disclosure encompasses sequences that are complementary to the DNA sequence for example
30 complementary DNA (cDNA) or RNA sequences including messenger RNA (mRNA) and transfer RNA (tRNA) or protein sequences such as amino acid sequences encoded by the polynucleotide sequence.

The polynucleotide of SEQ ID No.1 and complementary sequences thereof may take many forms for example an isolated polynucleotide sequence; an isolated protein sequence; a

biologically pure culture of a Bifidobacterial strain comprising the nucleic acid of SEQ ID NO. 1; a plasmid comprising the polynucleotide of SEQ ID No. 1; and the like. All of these forms of the sequence of SEQ ID No. 1 are encompassed in this disclosure.

As used herein, the term “expresses an exopolysaccharide”, may be interpreted to mean that a bacterial strain contains a DNA sequence encoding an exopolysaccharide for example a DNA sequence that encodes at least one gene from SEQ ID No. 2 and/or at least one gene from SEQ ID No. 3 or a functional fragment or variant thereof.

As used herein, the term “sequence homology” encompasses sequence homology at a nucleic acid and/or an amino acid (protein) level. Sequence homology is indicated as the overall percentage of identity across the nucleic acid and/or amino acid sequence. The sequence homology may be determined using standard techniques known to those skilled in the art. For example sequence homology may be determined using the on-line homology algorithm “BLAST” program, publicly available at <http://www.ncbi.nlm.nih.gov/BLAST/>. A sequence may have at least 85% or at least 86% or at least 87% or at least 88% or at least 89% or at least 90% or at least 91% or at least 92% or at least 93% or at least 94% or at least 95% or at least 96% or at least 97% or at least 98% or at least 99% sequence homology with the nucleic acid sequences described herein or the amino acid (protein) encoded thereby.

The present invention is based on the whole genome sequence of *Bifidobacterium longum* biotype infantis UCC 35624. The genome sequence is listed in SEQ ID No. 1 of the attached sequence listing and comprises 2,264,374 base pairs. Analysis of the genome sequence identified 1,836 genes having the open reading frames as set out in Table 1 below.

Table 1 – Open reading frames of the genome of UCC 35624.

GeneID	Start	End	Strand	Description
BI00001	1667321	1667608	-	CRISPR-associated protein Cas2
BI00002	1667697	1668593	-	CRISPR-associated protein Cas1
BI00002a	1668725	1669423	-	CRISPR-associated protein Cas4
BI00003	1669465	1670313	-	CRISPR-associated protein, TM1801 family
BI00005	1670320	1672275	-	CRISPR-associated protein, CT1133 family
BI00006	1672281	1672982	-	CRISPR-associated protein, CT1134 family
BI00007	1672992	1675427	-	hypothetical CRISPR-associated helicase Cas3
BI00008	1676109	1676426	-	COG3464: Transposase and inactivated derivatives
BI00009	1677053	1680283	-	isoleucyl-tRNA synthetase
BI00010	1680955	1682163	+	aminotransferase, class I, putative
BI00011	1682280	1683785	-	galactoside symporter
BI00012	1684111	1687299	+	beta-galactosidase, putative
BI00013	1687365	1688372	-	sugar-binding transcriptional regulator, LacI family, putative
BI00014	1688522	1689889	-	Putative antibiotic resistance protein (membrane

				protein)
BI00015	1690007	1690906	-	hypothetical pfkB family carbohydrate kinase
BI00016	1690909	1692111	-	alcohol dehydrogenase, iron-containing
BI00017	1692111	1692794	-	hypothetical haloacid dehalogenase-like hydrolase
BI00018	1692921	1693901	-	inosine-uridine preferring nucleoside hydrolase
BI00019	1693960	1694913	-	hypothetical pfkB family carbohydrate kinase
BI00020	1694909	1695553	-	hypothetical N-(5'phosphoribosyl)anthranilate isomerase
BI00021	1695603	1696415	-	ABC transporter, ATP-binding protein
BI00022	1696415	1697242	-	conserved hypothetical protein
BI00023	1697246	1698055	-	hypothetical Cobalt transport protein
BI00024	1698062	1698712	-	conserved hypothetical protein
BI00025	1698969	1700846	+	transcriptional regulator, LacI family/carbohydrate kinase, PfkB family protein
BI00026	1700977	1702989	-	ABC transporter, ATP-binding/permease protein
BI00027	1702989	1704944	-	ABC transporter, ATP-binding protein
BI00028	1704944	1705402	-	transcriptional regulator, MarR family, putative
BI00029	1705699	1706610	-	COG1472: Beta-glucosidase-related glycosidases
BI00030	1706029	1706937	+	COG1309: Transcriptional regulator
BI00031	1707015	1708373	-	unnamed protein product
BI00032	1708509	1710902	-	xylosidase/arabinosidase [imported]
BI00033	1710937	1711287	-	hypothetical protein
BI00034	1711383	1712762	-	glutamate--cysteine ligase, putative
BI00035	1712905	1718037	+	conserved domain protein
BI00036	1718044	1718883	+	hypothetical protein
BI00037	1719052	1724187	-	BadF/BadG/BcrA/BcrD ATPase family family
BI00038	1724418	1725143	-	anaerobic ribonucleoside-triphosphate reductase activating protein
BI00039	1725294	1727699	-	anaerobic ribonucleoside-triphosphate reductase
BI00040	1728167	1729534	+	exodeoxyribonuclease VII, large subunit
BI00041	1729587	1729886	+	exodeoxyribonuclease VII, small subunit
BI00042	1730013	1730534	+	NADP(H) oxidoreductase CC0205 [imported]
BI00043	1730676	1732529	-	long-chain-fatty-acid--CoA ligase, putative
BI00044	1732662	1732787	-	COG1970: Large-conductance mechanosensitive channel
BI00045	1732765	1733166	-	hypothetical Large-conductance mechanosensitive channel, MscL
BI00046	1733337	1733762	-	UNKNOWN PROTEIN, putative
BI00047	1733887	1734102	-	COG0454: Histone acetyltransferase HPA2 and related acetyltransferases
BI00048	1734587	1735696	+	hypothetical transmembrane protein with unknown function
BI00049	1735718	1736683	-	exopolyphosphatase, putative
BI00050	1736864	1737967	-	aminotransferase, class I
BI00051	1738178	1739230	+	oxidoreductase, Gfo/Ildh/MocA family, putative
BI00052	1739267	1739779	-	patch repair protein [imported]
BI00053	1739931	1740377	+	acetyltransferase, GNAT family
BI00054	1740356	1740841	-	conserved hypothetical protein
BI00055	1741026	1745207	-	helicase, Snf2 family
BI00056	1745285	1746367	+	conserved hypothetical protein
BI00057	1746358	1746504	-	hypothetical protein
BI00058	1746604	1747620	+	tetrahydrodipicolinate N-succinyltransferase (dapD)

BI00059	1747840	1749129	-	citrate synthase I
BI00060	1749406	1750242	-	methionine aminopeptidase, type I
BI00061	1750378	1751355	-	membrane protein, putative
BI00062	1751532	1753703	+	belongs to peptidase family M13
BI00063	1753792	1754526	-	single-stranded DNA-binding protein (ssb) subfamily
BI00064	1754805	1756616	-	prolyl-tRNA synthetase
BI00065	1757008	1757361	+	hypothetical protein
BI00066	1757392	1758561	-	pflA
BI00067	1758551	1760338	-	Protein of unknown function family
BI00068	1760391	1761806	-	TPR domain protein
BI00069	1761858	1762505	-	oligoribonuclease
BI00070	1762676	1764259	-	inosine-5'-monophosphate dehydrogenase
BI00071	1764282	1765562	-	undecaprenyl-phosphate alpha-N-acetylglucosaminyltransferase
BI00072	1765562	1766233	-	Sua5/YciO/YrdC/YwlC family protein
BI00073	1766408	1767082	+	maltose O-acetyltransferase
BI00074	1767220	1767921	-	branched-chain amino acid ABC transporter, ATP-binding protein
BI00075	1767924	1768781	-	branched chain amino acid ABC transporter, ATP-binding protein
BI00076	1768781	1769854	-	branched-chain amino acid ABC transporter, permease protein
BI00077	1769874	1770797	-	branched-chain amino acid ABC transporter, permease protein
BI00078	1771042	1772226	-	branched-chain amino acid ABC transporter, amino acid-binding protein, putative
BI00079	1772502	1773407	-	N-methylase PapM
BI00080	1773473	1774492	-	peptide chain release factor 1
BI00003g	1774715	1774924	-	ribosomal protein L31
BI00081	1775256	1776482	-	transcription regulator ROK family VC2007 [imported], putative
BI00082	1776702	1778219	+	xylulokinase
BI00083	1778416	1778760	+	lipoprotein, putative
BI00084	1778773	1779114	+	hypothetical protein
BI00085	1779393	1779737	-	possible sugar permease
BI00086	1779656	1780930	-	transposase, Mutator family
BI00087	1781199	1782545	-	xylose isomerase
BI00088	1782842	1783072	+	drug resistance transporter, EmrB/QacA subfamily
BI00089	1783095	1783409	+	drug resistance transporter, EmrB/QacA subfamily
BI00090	1783425	1784222	-	conserved hypothetical protein
BI00091	1785149	1785661	-	polypeptide deformylase
BI00092	1785576	1786421	-	oxidoreductase, aldo/keto reductase family superfamily
BI00093	1786497	1786673	-	COG0477: Permeases of the major facilitator superfamily
BI00094	1786761	1787264	-	hypothetical COG0477: Permeases of the major facilitator superfamily
BI00095	1787291	1787791	-	possible MarR-type transcriptional regulator
BI00011g	1787998	1788333	-	hypothetical protein Blon021361
BI00096	1788358	1789572	-	sugar ABC transporter, permease protein
BI00097	1789575	1791125	-	sugar ABC transporter, ATP-binding protein

BI00098	1791229	1792383	-	sugar ABC transporter, periplasmic sugar-binding protein
BI00099	1792462	1792608	-	hypothetical protein
BI00100	1792854	1793801	+	probable repressor protein in (NagC/XylR) family
BI00101	1793842	1794705	+	sugar ABC transporter, ATP-binding protein, putative
BI00102	1794736	1795683	-	glucokinase, putative
BI00103	1796537	1798192	+	ATP binding protein of ABC transporter
BI00104	1798507	1799409	+	acyl-CoA thioesterase II
BI00105	1799511	1800035	-	hypothetical membrane protein with unknown function
BI00106	1800213	1801622	-	dihydroneopterin aldolase
BI00107	1801736	1802608	-	dihydropteroate synthase
BI00108	1802699	1803295	-	GTP cyclohydrolase I
BI00109	1803391	1805478	-	cell division protein FtsH
BI00110	1805478	1806038	-	hypoxanthine phosphoribosyltransferase
BI00111	1806028	1807191	-	COG0037:Predicted ATPase of the PP-loop superfamily implicated
BI00112	1807285	1808772	-	D-alanyl-D-alanine carboxypeptidase/D-alanyl-D-alanine-endopeptidase
BI00113	1808798	1810468	-	hypothetical transmembrane protein with unknown function
BI00114	1810468	1811421	-	ATP-binding protein of ABC transporter system
BI00115	1811519	1812739	-	glycosyl transferase domain protein, putative
BI00116	1812742	1814496	-	hypothetical integral membrane protein in upf0118
BI00117	1814587	1815252	+	probable glycosyltransferase
BI00118	1815481	1816629	-	alcohol dehydrogenase, iron-containing
BI00119	1817069	1818370	+	cyclopropane-fatty-acyl-phospholipid synthase
BI00120	1818383	1819687	+	hypothetical COG0477: Permeases of the major facilitator superfamily
BI00121	1820205	1821215	-	UDP-glucose 4-epimerase
BI00122	1821585	1822400	+	methyltransferase, putative
BI00123	1822698	1823195	-	hypothetical protein
BI00124	1823244	1823708	-	Orf2
BI00125	1823795	1824079	+	hypothetical Helix-turn-helix
BI00126	1824492	1824788	-	hypothetical protein
BI00127	1825086	1826453	-	gp22
BI00128	1827148	1827699	-	hypothetical protein
BI00170t	1827699	1828901	-	hypothetical Phage integrase family
BI00129	1829429	1830229	+	azlC protein, putative
BI00130	1830229	1830558	+	branched-chain amino acid permease
BI00131	1830743	1831258	-	phosphotyrosine protein phosphatase, putative
BI00132	1831385	1832044	-	dihydrofolate reductase
BI00133	1832157	1832936	-	thymidylate synthase
BI00134	1833154	1833564	+	conserved hypothetical protein
BI00135	1833629	1834663	-	demannu, putative
BI00136	1834835	1835572	-	P60 extracellular protein, invasion associated protein lap
BI00137	1835733	1836476	-	NLP/P60 family domain protein
BI00138	1836692	1837645	-	N-acetylmuramoyl-L-alanine amidase domain protein
BI00139	1838255	1839178	+	phosphoserine aminotransferase, putative
BI00140	1839305	1839562	+	conserved hypothetical protein

BI00141	1839693	1840874	-	sensor histidine kinase, putative
BI00142	1841128	1841745	+	phosphate transport system regulatory protein PhoU, putative
BI00143	1842110	1842847	-	phosphoglycerate mutase
BI00144	1842910	1843872	-	1,4-dihydroxy-2-naphthoate octaprenyltransferase
BI00145	1843937	1845412	-	lysyl-tRNA synthetase
BI00146	1846534	1847304	+	AraJ-like protein probably involved in transport of arabinose polymers
BI00147	1847394	1849754	+	TPR Domain domain protein
BI00148	1849833	1850462	+	conserved hypothetical protein
BI00149	1850618	1852216	-	hypothetical membrane protein possibly involved in transport
BI00150	1852325	1853029	-	conserved hypothetical protein
BI00151	1853062	1854903	-	conserved hypothetical protein
BI00152	1854930	1856174	+	possible histidine kinase sensor of two component system
BI00153	1856174	1856866	+	transcription regulator, LuxR family NMB1250 [imported]
BI00154	1856920	1857939	-	UDP-glucose 4-epimerase
BI00155	1858012	1859556	-	galactose-1-phosphate uridylyltransferase
BI00156	1859606	1860682	-	putative desulfatase possibly for mucin
BI00157	1860713	1862965	-	conserved hypothetical protein
BI00158	1863426	1864382	-	sugar ABC transporter, permease protein
BI00159	1864382	1865278	-	sugar ABC transporter, permease protein, putative
BI00160	1865546	1866859	-	solute binding protein of ABC transporter for sugars
BI00161	1867217	1867369	-	hypothetical protein
BI00162	1867867	1868856	-	seryl-tRNA synthetase
BI00163	1869384	1870562	+	Diacylglycerol kinase catalytic domain (presumed) protein
BI00164	1870573	1871409	-	transcription antiterminator, BglG family, putative
BI00165	1871430	1873829	-	PTS system component, putative
BI00166	1874293	1875843	+	major facilitator family transporter CC0814 [imported], putative
BI00167	1875934	1877607	+	phosphoglucomutase, alpha-D-glucose phosphate-specific
BI00222t	1878343	1879437	-	conserved hypothetical protein
BI00168	1879668	1880087	+	conserved hypothetical protein
BI00169	1880224	1881837	+	oxidoreductase, pyridine nucleotide-disulfide, class I
BI00170	1882002	1882151	-	hypothetical protein
BI00171	1882305	1883360	+	RNase H
BI00172	1883494	1884189	+	ribose 5-phosphate isomerase
BI00173	1884629	1885258	-	conserved hypothetical protein
BI00174	1885386	1886921	+	DNA repair protein RadA
BI00175	1886942	1888063	-	riboflavin biosynthesis protein RibF
BI00176	1888164	1889324	-	tRNA pseudouridine synthase B
BI00177	1889329	1889799	-	ribosome-binding factor A
BI00178	1889953	1892799	-	translation initiation factor IF-2
BI00179	1893150	1894214	-	N utilization substance protein A
BI00180	1894422	1895147	+	lipoprotein, putative
BI00181	1895194	1896234	-	transcriptional regulator, LacI family, putative
BI00182	1896528	1896629	-	hypothetical protein
BI00183	1896770	1897798	-	hypothetical

BI00184	1897936	1898568	-	alpha-L-arabinosidase
BI00185	1899147	1899917	-	Transglutaminase-like superfamily domain protein
BI00186	1900154	1902331	-	Domain of unknown function (DUF404) family
BI00187	1902473	1902586	-	hypothetical protein
BI00188	1902727	1903515	+	tRNA pseudouridine synthase A
BI00189	1903603	1904142	-	ribosomal protein L17
BI00190	1904245	1905237	-	RNA polymerases L / 13 to 16 kDa subunit
BI00191	1905321	1905716	-	ribosomal protein S11
BI00192	1905807	1906181	-	ribosomal protein S13p/S18e
BI00193	1906333	1906443	-	ribosomal protein L36
BI00194	1906470	1906685	-	translation initiation factor IF-1
BI00195	1906865	1907422	-	adenylate kinase
BI00196	1907595	1908722	-	preprotein translocase, SecY subunit
BI00197	1909207	1909656	-	ribosomal protein L15
BI00198	1909662	1909844	-	ribosomal protein L30
BI00199	1909853	1910581	-	ribosomal protein S5
BI00200	1910581	1910991	-	ribosomal protein L18
BI00201	1910954	1911490	-	ribosomal protein L6
BI00202	1911511	1911906	-	ribosomal protein S8
BI00203	1911999	1912181	-	ribosomal protein S14p/S29e
BI00204	1912186	1912755	-	ribosomal protein L5 VC2584 [imported]
BI00205	1912755	1913087	-	ribosomal protein L24
BI00206	1913092	1913457	-	ribosomal protein L14
BI00207	1913555	1913812	-	ribosomal protein S17
BI00208	1913818	1914066	-	ribosomal protein L29
BI00209	1914069	1914485	-	ribosomal protein L16
BI00210	1914495	1915295	-	ribosomal protein S3
BI00211	1915301	1915657	-	ribosomal protein L22
BI00212	1915677	1915952	-	ribosomal protein S19
BI00213	1915971	1916798	-	ribosomal protein L2
BI00214	1916838	1917131	-	ribosomal protein L23
BI00215	1917140	1917793	-	ribosomal protein L4/L1 family
BI00216	1917803	1918441	-	ribosomal protein L3
BI00217	1918461	1918766	-	ribosomal protein S10
BI00218	1919023	1920027	+	membrane protein, putative
BI00219	1920366	1923092	-	Unknown
BI00220	1923607	1924797	+	probable repressor in the Rok (NagC/XylR) family
BI00221	1924797	1927334	+	glycogen operon protein GlgX
BI00222	1927431	1927919	-	ribosomal protein S9
BI00223	1927945	1928391	-	ribosomal protein L13
BI00224	1928792	1930954	-	4-alpha-glucanotransferase
BI00225	1931125	1931931	-	hypothetical Leucine rich repeat variant
BI00226	1931876	1932514	-	conserved hypothetical protein TIGR00257
BI00227	1932579	1933592	-	possible 2-hydroxyacid dehydrogenase
BI00228	1933669	1935009	-	capA protein, putative
BI00229	1935547	1936608	-	COG0697:Permeases of the drug/metabolite transporter (DMT) superfamily
BI00230	1936648	1937991	+	DNA-damage-inducible protein P
BI00231	1938024	1939256	-	aminotransferase, putative
BI00232	1939374	1939691	-	fdxC
BI00233	1939755	1941278	-	possible cationic amino acid transporter

BI00234	1941433	1942398	-	UDP-N-acetylenolpyruvoylglucosamine reductase
BI00235	1942930	1943094	-	ribosomal protein L33
BI00236	1943529	1944245	+	possible cystathionine gamma lyase
BI00237	1944924	1945214	-	chaperonin, 10 kDa
BI00238	1945390	1946604	-	conserved hypothetical protein
BI00239	1946895	1947557	-	rimJ
BI00240	1947644	1948360	+	5-formyltetrahydrofolate cyclo-ligase-related protein
BI00241	1948527	1948709	+	conserved hypothetical protein
BI00242	1948950	1949516	+	conserved hypothetical protein
BI00243	1949617	1949814	-	hypothetical protein Blon021580
BI00244	1949820	1953440	-	conserved hypothetical protein
BI00245	1953452	1954999	-	conserved hypothetical protein
BI00246	1955200	1955577	-	ribosomal protein L7/L12
BI00247	1955689	1956207	-	ribosomal protein L10
BI00248	1956479	1957222	-	conserved hypothetical protein
BI00249	1957561	1958952	+	Unknown
BI00250	1959385	1962123	-	polyribonucleotide nucleotidyltransferase
BI00251	1962444	1962710	-	ribosomal protein S15
BI00252	1962882	1963562	-	conserved hypothetical protein
BI00253	1963721	1963951	-	hypothetical protein
BI00254	1964091	1966964	-	possible extracellular exo-xylanase
BI00255	1967190	1969712	-	endo-1,4-beta-xylanase D
BI00256	1970329	1971432	+	IS30 family, transposase [imported]
BI00257	1971591	1972274	-	conserved hypothetical protein
BI00334t	1972174	1972389	+	conserved hypothetical protein
BI00258	1972411	1973094	-	hypothetical protein Blon021028
BI00259	1973553	1974914	-	possible cell surface protein
BI00260	1974994	1977351	-	von Willebrand factor type A domain protein
BI00261	1978150	1978326	-	hypothetical protein Blon021305
BI00262	1978353	1978820	-	phosphopantethiene protein transferase
BI00263	1979459	1988974	-	MaoC like domain protein
BI00264	1989016	1990635	-	propionyl-CoA carboxylase, beta chain
BI00265	1990631	1992514	-	accA3
BI00266	1993105	1993701	+	bioY protein
BI00267	1993739	1994710	-	biotin--acetyl-CoA-carboxylase ligase
BI00268	1994853	1996895	+	membrane protein, putative
BI00269	1996904	1997731	+	conserved hypothetical protein
BI00270	1997829	1998524	-	transcriptional regulator, putative
BI00350t	1998629	1999459	-	hypothetical transcriptional regulator, lclR family
BI00271	2011598	2011726	-	hypothetical protein
BI00272	2011797	2012486	-	ribosomal protein L1
BI00273	2012505	2012933	-	ribosomal protein L11
BI00274	2013199	2014089	-	transcription termination/antitermination factor NusG
BI00275	2014122	2014346	-	preprotein translocase SecE subunit
BI00276	2014593	2015795	-	aspartate aminotransferase [imported]
BI00277	2015889	2016986	-	glutamate 5-kinase
BI00278	2017023	2018711	-	GTP-binding protein
BI00279	2018783	2019028	-	ribosomal protein L27
BI00280	2019054	2019359	-	ribosomal protein L21
BI00281	2019502	2022534	-	hypothetical ribonuclease, Rne/Rng family
BI00282	2022850	2024121	-	succinyl-diaminopimelate desuccinylase

BI00283	2024159	2025100	+	transporter, putative
BI00284	2025282	2026727	-	permease, putative domain protein
BI00285	2026727	2027818	-	ABC transporter, ATP-binding protein
BI00286	2027996	2029441	-	Maf-like protein
BI00287	2029581	2030690	-	homoserine kinase
BI00288	2030800	2032113	-	homoserine dehydrogenase
BI00289	2032276	2033865	-	diaminopimelate decarboxylase
BI00290	2033871	2035541	-	arginyl-tRNA synthetase
BI00291	2035944	2036606	+	possible TetR-type transcriptional regulator
BI00292	2036606	2037880	+	permease, putative
BI00293	2037742	2038899	+	transcription regulator LysR family VC1588 [imported], putative
BI00294	2038996	2040246	+	probable aminotransferase
BI00295	2040298	2041521	-	UDP-N-acetylglucosamine 1-carboxyvinyltransferase
BI00296	2041869	2043212	+	NADH oxidase
BI00297	2043424	2044548	-	dihydroorotate dehydrogenase family protein, putative
BI00298	2044591	2046468	-	CAAX amino terminal protease family protein family
BI00299	2046594	2047283	-	3-isopropylmalate dehydratase small subunit
BI00300	2047369	2048769	-	3-isopropylmalate dehydratase, large subunit
BI00301	2049087	2049860	+	transcriptional regulator, IclR family
BI00302	2050021	2051391	-	Ser/Thr protein phosphatase family
BI00303	2051896	2054130	+	polyphosphate kinase
BI00304	2054291	2055487	+	mutT1
BI00305	2055480	2056298	+	hypothetical protein Blon021115
BI00306	2056564	2057871	-	conserved hypothetical protein
BI00307	2057963	2058121	-	hypothetical protein
BI00308	2058175	2058813	+	uracil phosphoribosyltransferase
BI00309	2058864	2059340	+	conserved hypothetical protein TIGR00246
BI00310	2059542	2060648	-	possible phosphodiesterase
BI00311	2060677	2061747	-	glutamyl-tRNA synthetase domain protein
BI00312	2061933	2064599	-	ATP-dependent Clp protease, ATP-binding subunit ClpB
BI00313	2064821	2066371	-	histidine ammonia-lyase
BI00314	2066617	2067489	+	transcriptional regulator, IclR family, putative
BI00315	2067489	2067662	+	conserved hypothetical protein
BI00316	2067741	2068559	-	possible 2-hydroxyhepta-2,4-diene-1,7-dioate isomerase in the fumarylacetoacetate hydrolase family
BI00317	2068665	2069873	-	hypothetical membrane protein with unknown function
BI00318	2070097	2071272	-	UDP-galactopyranose mutase
BI00319	2071426	2072670	+	dTDP-glucose 4,6-dehydratase
BI00320	2072827	2074311	+	conserved hypothetical protein
BI00321	2074367	2075068	+	conserved hypothetical protein
BI00423t	2075382	2075687	+	putative transposase
BI00322	2075763	2076530	-	IS1533, OrfB
BI00323	2076530	2077987	-	transposase (25) BH3998 [imported], putative
BI00324	2078280	2078996	-	glycosyltransferase, putative
BI00325	2079313	2079666	-	sialic acid-specific 9-O-acetyltransferase
BI00326	2080049	2081173	+	hypothetical Acyltransferase family

BI00327	2081181	2082893	-	hypothetical membrane protein with unknown function
BI00328	2082902	2085811	-	hypothetical Glycosyl transferase family 8
BI00329	2085935	2087170	-	hypothetical glycosyl transferase, group 2 family protein
BI00330	2087259	2088509	-	polysaccharide ABC transporter, ATP-binding protein
BI00331	2088515	2089351	-	polysaccharide ABC transporter, permease protein, putative
BI00332	2089580	2091367	+	hypothetical Glycosyl transferase family 8
BI00333	2091457	2092698	-	UDP-glucose 6-dehydrogenase
BI00334	2092974	2093636	+	hypothetical NAD dependent epimerase/dehydratase family
BI00335	2093654	2094844	-	membrane protein, putative
BI00336	2094847	2097099	-	conserved hypothetical protein
BI00337	2097441	2098844	+	hypothetical membrane protein with unknown function
BI00338	2098844	2099962	+	possible ATP binding protein of ABC transporter
BI00339	2100089	2100790	+	HDIG domain protein
BI00340	2100871	2101728	-	conserved hypothetical protein
BI00341	2101825	2104335	-	Kup system potassium uptake protein [imported]
BI00342	2104481	2105188	-	hydrolase, TatD family
BI00343	2105717	2106784	+	Fic protein family family
BI00344	2106816	2108621	-	ABC transporter, ATP-binding/permease protein
BI00345	2108635	2110542	-	ABC transporter, ATP-binding/permease protein
BI00346	2110935	2111099	-	hypothetical protein
BI00347	2111297	2112703	-	possible alpha-galactosidase
BI00348	2113077	2114231	+	transcriptional regulator, LacI family, putative
BI00349	2114409	2115356	-	probable AraC/XylS-type transcriptional regulator
BI00350	2115401	2117626	-	conserved hypothetical protein
BI00351	2117851	2119374	+	aminopeptidase C
BI00352	2119555	2120628	+	conserved hypothetical protein
BI00353	2121673	2123403	-	methionyl-tRNA synthetase
BI00354	2123873	2124496	+	conserved hypothetical protein
BI00466t	2124496	2124864	+	conserved hypothetical protein
BI00355	2124897	2125922	-	conserved hypothetical protein TIGR00096
BI00356	2126487	2127902	-	possible symporter
BI00357	2127864	2129027	+	conserved hypothetical protein
BI00358	2129186	2131012	-	ABC transporter, ATP-binding/permease protein
BI00359	2131231	2133099	-	ABC transporter, ATP-binding/permease protein
BI00360	2133289	2133684	-	transcriptional regulator, MarR family, putative
BI00475t	2134267	2134506	+	DNA-damage-inducible protein of Escherichia coli
BI00361	2135008	2138841	-	LPXTG-motif cell wall anchor domain protein
BI00362	2139056	2139151	-	hypothetical protein
BI00363	2139209	2143594	-	secreted protein
BI00364	2143901	2145394	-	ATP-dependent DNA helicase recG
BI00365	2145737	2147257	-	amino acid permease
BI00366	2147448	2151185	-	permease, putative
BI00367	2151199	2151897	-	ABC transporter, ATP-binding protein
BI00368	2152041	2152607	+	probable TetR-like transcriptional regulator
BI00369	2152832	2154310	+	aromatic amino acid transport protein AroP
BI00370	2154575	2155774	+	putative invertase/transposase

BI00371	2155961	2160952	-	hypothetical Glycosyl hydrolases family 43
BI00372	2161359	2164649	-	hypothetical
BI00373	2164997	2168173	-	possible arabinosidase
BI00374	2168529	2169131	-	conserved hypothetical protein
BI00375	2169340	2170179	-	sugar ABC transporter, permease protein, putative
BI00376	2170182	2171033	-	sugar ABC transporter, permease protein, putative
BI00377	2171416	2172429	+	transcription regulator, LacI family [imported], putative
BI00378	2172690	2174015	-	possible solute binding protein of ABC transporter
BI00379	2174424	2175134	-	phosphoglycerate mutase family protein
BI00380	2175226	2175600	+	hypothetical COG0531: Amino acid transporters
BI00381	2175612	2176550	+	hypothetical nitroreductase family protein
BI00382	2176846	2179572	+	phage infectio, putative
BI00383	2179572	2181908	+	phage infection protein, putative
BI00384	2188511	2189263	+	regulatory protein, SIR2 family
BI00385	2189415	2190791	-	threonine dehydratase
BI00386	2190928	2192745	-	glucan 1,6-alpha-glucosidase
BI00387	2192872	2194731	-	hypothetical Raffinose synthase or seed imbibition protein Sip1
BI00388	2194766	2196433	-	alpha-amylase family protein
BI00389	2196537	2197358	-	hypothetical abc transporter permease protein yurm. {bacillus
BI00390	2197364	2198383	-	hypothetical Binding-protein-dependent transport systems inner membrane component
BI00391	2198408	2199730	-	hypothetical Bacterial extracellular solute-binding protein
BI00392	2199980	2201095	-	hypothetical protein Efae022644
BI00393	2201159	2202484	-	hypothetical Bacterial extracellular solute-binding protein
BI00394	2202692	2203717	+	transcription regulator, LacI family [imported], putative
BI00395	2203838	2204854	+	transcription regulator, LacI family [imported], putative
BI00396	2204919	2205782	-	sugar ABC transporter, permease protein
BI00397	2205804	2206730	-	sugar ABC transporter, permease protein
BI00398	2206755	2208041	-	sugar ABC transporter, sugar-binding protein, putative
BI00399	2208215	2209420	+	transcription regulator ROK family VC2007 [imported], putative
BI00400	2209591	2211894	-	alpha-galactosidase
BI00401	2212017	2212445	-	hypothetical Cytidine and deoxycytidylate deaminase zinc-binding region
BI00402	2212589	2214658	+	Na ⁺ /H ⁺ antiporter
BI00403	2214858	2215613	-	serine esterase, putative
BI00404	2215613	2215714	-	hypothetical protein
BI00405	2215735	2216592	-	conserved hypothetical protein
BI00406	2216949	2217527	+	deoxycytidine triphosphate deaminase
BI00407	2217593	2219320	+	cell wall surface anchor family protein, putative
BI00408	2219543	2222527	-	calcium E1-E2-type ATPase
BI00409	2222713	2223447	-	protein probably involved in xylan degradation, possible xylan esterase
BI00410	2223622	2225049	-	hypothetical major facilitator superfamily protein
BI00411	2225005	2225994	+	RNA methyltransferase, TrmH family, group 3

BI00412	2226107	2227516	-	conserved hypothetical protein
BI00413	2227740	2228864	-	ATP binding protein of ABC transporter for sugars
BI00414	2229226	2230419	-	glycosyl transferase domain protein
BI00415	2230486	2231475	-	Ribonucleotide reductase, beta subunit
BI00416	2231704	2233896	-	ribonucleoside-diphosphate reductase, alpha subunit
BI00417	2234015	2234470	-	nrdI protein
BI00418	2234470	2234733	-	COG0695: Glutaredoxin and related proteins
BI00419	2235324	2235767	-	hypothetical Helix-turn-helix
BI00420	2235958	2236635	-	conserved hypothetical protein
BI00421	2236828	2237592	+	ion transporter
BI00422	2237788	2238891	+	conserved hypothetical protein
BI00423	2239035	2239349	-	beta-glucosidase-related glycosidase
BI00424	2239828	2241951	+	widely conserved protein with eukaryotic protein kinase domain
BI00425	2242132	2243106	+	conserved hypothetical protein
BI00426	2243627	2245111	+	conserved hypothetical protein
BI00427	2245147	2246067	+	dimethyladenosine transferase
BI00428	2246067	2247014	+	kinase, GHMP family, group 2
BI00429	2246860	2247690	+	hypothetical protein BL0655
BI00430	2247781	2249193	-	pcnA
BI00431	2249280	2250569	+	NUDIX domain protein
BI00432	2250569	2252836	+	cell wall surface anchor family protein, putative
BI00433	2252836	2254560	+	conserved hypothetical membrane protein in MviN family
BI00434	2254646	2256706	+	conserved hypothetical protein
BI00435	2256829	2257845	+	thioredoxin reductase
BI00436	2258158	2259516	-	chromosome partitioning protein ParB
BI00437	2259519	2260487	-	Soj family protein
BI00438	2260741	2261403	-	methyltransferase GidB
BI00439	2261558	2262088	-	R3H domain protein
BI00440	2262215	2263219	-	inner membrane protein, 60 kDa VC0004 [imported]
BI00143g	2263219	2263533	-	conserved hypothetical protein TIGR00278
BI00576t	2263533	2264063	-	ribonuclease P protein component
BI00441	2263925	2264056	-	ribosomal protein L34
BI00442	1	1500	+	chromosomal replication initiator protein DnaA
BI00443	2239	3360	+	DNA polymerase III, beta subunit
BI00444	3442	4626	+	recF protein
BI00445	4626	5093	+	conserved hypothetical protein
BI00446	5229	7364	+	DNA gyrase, B subunit
BI00447	7534	10083	+	DNA gyrase, A subunit
BI00448	10156	10719	+	conserved hypothetical protein
BI00449	11406	12116	+	hypothetical protein
BI00450	12179	13699	+	hypothetical Pectinesterase
BI00451	14103	15446	-	NADP-specific glutamate dehydrogenase
BI00452	15768	16199	-	AsnC-type transcriptional regulator
BI00453	16405	17736	+	aspartate aminotransferase
BI00454	17757	18746	-	hypothetical protein Blon021073
BI00455	19007	19600	+	hypothetical protein BL0627
BI00456	19770	20462	+	hypothetical protein Blon021075
BI00457	20579	20821	+	Putative acraB operon repressor transcription

				regulator protein
BI00599t	21403	21735	-	IS1557, transposase, putative
BI00146g	21834	22397	-	conserved hypothetical protein
BI00458	22130	23497	-	hypothetical COG1167: Transcriptional regulators containing a DNA-binding HTH domain and an aminotransferase domain (MocR family) and their eukaryotic orthologs
BI00459	24132	25454	+	aminotransferase, class III superfamily
BI00460	25495	26397	+	Zinc metalloprotease
BI00461	26414	26509	-	hypothetical protein
BI00462	26487	26849	+	COG3265: Gluconate kinase
BI00463	27114	28424	-	conserved hypothetical protein
BI00464	28662	29138	-	Dps family protein, putative
BI00465	29238	30608	-	CBS domain protein, putative
BI00466	30841	31521	-	Prokaryotic-type carbonic anhydrases
BI00467	31727	32287	+	alkyl hydrogen peroxide reductase
BI00468	32458	34371	+	thioredoxin reductase
BI00469	34494	35963	-	oxalate:formate antiporter
BI00470	35948	36094	+	hypothetical protein
BI00471	36333	37328	+	LacI-type transcriptional regulator
BI00472	37558	40308	-	phosphoenolpyruvate carboxylase
BI00473	40594	42471	+	membrane protein, putative
BI00474	42737	44344	+	possible sodium/proline symporter
BI00475	44680	45663	-	narrowly conserved hypothetical protein
BI00476	45917	47533	+	conserved hypothetical protein
BI00477	47717	48805	-	tryptophanyl-tRNA synthetase
BI00478	49056	49325	+	hypothetical protein
BI00479	49437	49967	-	conserved hypothetical protein
BI00480	49986	52505	+	glycogen phosphorylase
BI00481	52725	52940	-	hypothetical protein BL0595
BI00482	53195	53887	+	Rhomboid family protein
BI00483	54562	55029	-	conserved hypothetical protein
BI00484	55119	55907	+	conserved hypothetical protein
BI00485	55907	57142	+	hypothetical transmembrane protein with unknown function
BI00486	57196	57837	+	pabA
BI00487	58067	60136	-	serine/threonine protein kinase
BI00488	60136	60942	-	serine/threonine protein kinase
BI00489	61083	62546	-	pbpA
BI00490	62546	64204	-	Unknown, putative
BI00491	64204	65895	-	possible phosphoprotein phosphatase
BI00492	65903	66430	-	FHA-domain-containing proteins
BI00493	66463	67161	-	FHA domain protein
BI00494	67349	69790	-	dipeptidyl peptidase IV, putative
BI00495	69951	70997	+	lysophospholipase L2, putative
BI00496	71080	72228	+	von Willebrand factor type A domain protein
BI00497	72231	72947	+	conserved hypothetical protein
BI00498	72947	73348	+	hypothetical protein Blon021556
BI00654t	73348	73497	+	hypothetical protein Blon021556
BI00499	73873	74724	+	tellurite resistance protein
BI00500	75108	75608	+	heat shock protein, Hsp20 family
BI00501	75938	76891	+	Probable transmembrane protein
BI00502	77065	77520	-	conserved hypothetical protein

BI00503	77753	79132	+	COG0627: Predicted esterase
BI00504	79132	81702	+	COG2898:Uncharacterized BCR
BI00505	82241	83212	+	peptide methionine sulfoxide reductase
BI00506	83218	83304	+	hypothetical protein BL0567
BI00668t	83341	83496	+	COG0463: Glycosyltransferases involved in cell wall biogenesis
BI00507	83506	86709	-	helicase-related protein
BI00509	86785	87195	-	mutator MutT protein, putative
BI00510	87337	88587	+	hypothetical Domain of unknown function
BI00511	88678	89139	+	acetyltransferase, GNAT family family
BI00512	89226	90080	-	hypothetical
BI00513	90187	90420	-	hypothetical protein
BI00514	90480	90842	+	conserved hypothetical protein
BI00515	91329	92639	-	queuine tRNA-ribosyltransferase
BI00516	93056	95065	+	heat shock protein HtrA
BI00517	95480	97636	+	cation-transporting ATPase, E1-E2 family
BI00684t	97816	98862	+	transcriptional regulator, LacI family
BI00518	98874	99131	-	hypothetical mttA/Hcf106 family
BI00519	99136	100215	-	Sec-independent protein translocase TatC
BI00687t	100215	100730	-	hypothetical twin-arginine translocation protein, TatA/E family
BI00520	101182	103581	+	hypothetical Tat (twin-arginine translocation) pathway signal sequence
BI00521	103674	106151	+	hypothetical
BI00522	106547	107707	-	conserved hypothetical protein
BI00523	107911	109359	+	ferredoxin/ferredoxin--NADP reductase, putative
BI00524	109452	110450	+	heat shock protein HtpX
BI00525	110667	111731	-	fructose-bisphosphate aldolase, class II
BI00526	111947	113230	+	adenylosuccinate synthetase
BI00527	113524	114837	+	chloride channel
BI00528	115027	116094	+	CrcB-like protein family
BI00700t	116097	116489	+	protein with similarity to CrcB
BI00529	116581	116691	+	hypothetical protein
BI00530	116767	117849	+	sugar-binding transcriptional regulator, LacI family, putative
BI00531	118274	119842	+	Kup system potassium uptake protein [imported]
BI00532	120262	121806	+	alpha-L-arabinofuranosidase
BI00533	121981	123012	+	transcription regulator, LacI family [imported], putative
BI00534	123104	124012	-	glycosyl hydrolase, family 31
BI00535	124149	124370	-	IS861, transposase OrfB
BI00711t	124604	125803	+	probable integrase/recombinase
BI00712t	125878	126765	+	probable integrase/recombinase
BI00536	126765	127817	+	integrase/recombinase XerC, probable [imported], putative
BI00537	127910	128956	-	IS3 family transposase
BI00538	129291	130814	+	sucrose phosphorylase
BI00539	131035	132669	+	hypothetical transmembrane protein with unknown function
BI00540	132736	133776	+	sugar-binding transcriptional regulator, LacI family, putative
BI00541	134407	135771	+	major facilitator family transporter
BI00542	135971	137020	+	ketol-acid reductoisomerase

BI00543	137452	138501	+	ketol-acid reductoisomerase
BI00544	138689	140500	-	alpha-amylase family protein
BI00545	140663	141694	-	transcription regulator, LacI family [imported], putative
BI00546	142008	144242	-	4-alpha-glucanotransferase
BI00547	144506	144784	-	hypothetical protein Blon021648
BI00548	144856	145482	+	conserved hypothetical protein
BI00549	145500	146507	-	transcription regulator, LacI family [imported], putative
BI00550	146777	147490	+	sugar ABC transporter, permease protein
BI00551	147605	150139	+	glycosyl hydrolase, family 31
BI00552	151125	153002	+	dnaK protein
BI00553	153005	153658	+	co-chaperone GrpE
BI00554	153753	154769	+	DnaJ protein [imported]
BI00555	154787	155371	+	hspR
BI00556	155647	156996	+	xanthine permease, putative
BI00557	157036	158154	+	possible acyl protein synthase/acyl-CoA reductase-like protein
BI00558	158144	159640	+	possible acyl-CoA reductase
BI00559	159715	160497	+	3-oxoacyl-acyl carrier protein reductase
BI00560	160553	161281	+	beta-phosphoglucomutase, putative
BI00561	161435	162157	+	DedA protein
BI00749t	162383	163330	+	conserved hypothetical protein
BI00562	163340	164404	+	trbB
BI00751t	164410	165060	+	conserved hypothetical protein
BI00752t	165060	165659	+	hypothetical membrane protein with unknown function
BI00563	165947	166231	+	hypothetical protein BL0505
BI00754t	166240	166614	+	conserved hypothetical protein
BI00564	166715	167041	+	conserved hypothetical protein
BI00565	167093	168220	+	BmrU protein, putative
BI00566	168424	169020	-	possible TetR-type transcriptional regulator
BI00567	169297	172125	+	DNA polymerase III, tau/gamma subunit
BI00568	172154	172753	+	recombination protein RecR
BI00569	172756	173886	-	sortase family protein
BI00570	174774	176054	+	conserved hypothetical protein
BI00571	176649	177179	+	hypothetical Amino acid kinase family
BI00572	177262	177801	+	aspartokinase, alpha and beta subunits
BI00573	177889	178980	-	aspartate-semialdehyde dehydrogenase
BI00574	179055	179765	+	conserved hypothetical protein
BI00575	179774	181351	-	Ser/Thr protein phosphatase family
BI00576	182040	183953	+	2-isopropylmalate synthase
BI00577	184031	186493	-	penicillin-binding protein, putative
BI00578	186772	187959	+	possible pre-pilin peptidase
BI00579	188086	191169	+	DNA topoisomerase I
BI00580	191549	192067	+	thymidylate kinase
BI00581	192067	193215	+	DNA polymerase III, delta subunit
BI00582	193337	193888	+	conserved hypothetical protein TIGR00481
BI00583	194034	195632	+	Unknown
BI00584	195767	197281	+	formate-tetrahydrofolate ligase
BI00585	197684	198028	-	conserved hypothetical protein
BI00586	198149	198763	+	narrowly conserved hypothetical membrane protein

BI00587	198817	200226	-	hypothetical membrane protein with unknown function
BI00588	200521	201177	+	phosphoglycerate mutase family protein
BI00589	201278	202228	+	conserved hypothetical protein
BI00590	202352	203224	+	transglycolase, epimerase
BI00591	203348	204496	-	extensin precursor (cell wall hydroxyproline-rich glycoprotein)
BI00790t	204684	204866	+	hypothetical protein BL0470
BI00592	205053	206570	+	glutamyl-tRNA synthetase
BI00593	207503	207988	+	hypothetical protein Blon021299
BI00594	207946	208221	-	hypothetical protein BL0466
BI00595	208388	214285	+	cell wall surface anchor family protein, authentic frameshift
BI00596	214390	215208	-	hypothetical
BI00597	216652	218460	+	conserved hypothetical integral membrane protein
BI00598	218637	219317	+	membrane antigen, putative
BI00599	219470	220744	+	Integral membrane protein
BI00600	220769	222070	+	possible permease protein of ABC transporter system
BI00601	222107	223327	+	possible permease protein of ABC transporter system
BI00602	223346	224140	+	ABC transporter, ATP-binding protein
BI00603	224259	224819	+	lipoprotein, putative
BI00604	224831	225427	-	transcriptional regulator, TetR family, putative
BI00605	225545	227704	-	phage infection protein, putative
BI00606	227704	230250	-	phage infection protein, putative
BI00607	230686	231969	+	membrane protein, putative
BI00608	232037	233602	+	6-phosphogluconate dehydrogenase, decarboxylating
BI00609	233756	234595	-	6-phosphogluconolactonase
BI00610	234825	235847	-	oxppcycle protein OpcA
BI00611	235847	237499	-	glucose-6-phosphate 1-dehydrogenase
BI00612	237652	239337	+	Unknown
BI00613	239417	240448	-	Glycosyltransferase involved in cell wall biogenesis
BI00614	240475	241311	-	transcriptional regulator, TetR family
BI00615	241407	242675	+	signal recognition particle-docking protein FtsY
BI00616	243046	244338	+	ammonium transporter
BI00617	244343	244678	+	Nitrogen regulatory protein P-II
BI00618	244832	246613	+	protein-pII, uridylyltransferase
BI00619	246653	248095	-	DNA-damage-inducible protein F, putative
BI00620	248301	249827	+	replicative DNA helicase
BI00621	249830	251299	+	UDP-N-acetylmuramyl tripeptide synthase
BI00622	251405	252154	+	cobyric acid synthase
BI00623	252306	252590	+	conserved hypothetical protein
BI00624	252590	254407	+	ABC1 family family
BI00625	254428	255447	-	transcriptional regulator, LacI family
BI00626	255933	257255	+	solute binding protein of ABC transporter system
BI00627	257546	258469	+	sugar ABC transporter, permease protein, putative
BI00628	258493	259308	+	ABC transporter, permease protein, MalFG family
BI00629	259473	261446	+	conserved hypothetical protein
BI00630	262147	267966	+	hypothetical

BI00631	268074	271778	+	cell wall surface anchor family protein, putative
BI00632	271911	272741	+	conserved hypothetical protein TIGR00044
BI00633	272825	273835	-	prsA
BI00634	273960	274439	-	hypothetical COG3210: Large exoproteins involved in heme utilization or adhesion
BI00635	274604	274891	+	ribosomal protein S6
BI00636	274951	275604	+	hypothetical single-strand binding protein
BI00637	275668	275913	+	ribosomal protein S18
BI00638	275936	276379	+	ribosomal protein L9
BI00639	276769	277026	+	ptsH
BI00640	277029	278705	+	phosphoenolpyruvate-protein phosphotransferase
BI00641	278942	279673	+	glycerol uptake facilitator protein
BI00642	279763	282468	-	copper-translocating P-type ATPase
BI00643	282580	282858	+	COG1937 family protein
BI00644	283012	284325	+	Uncharacterized BCR, YigN family, COG1322 family
BI00645	284325	284951	+	conserved hypothetical protein
BI00646	285048	285893	+	COG0566:rRNA methylases
BI00647	285787	286359	+	glutamyl-tRNA(Gln) amidotransferase, C subunit
BI00648	286366	287904	+	glutamyl-tRNA(Gln) amidotransferase, A subunit
BI00649	287933	289429	+	glutamyl-tRNA(Gln) amidotransferase, B subunit
BI00650	289728	290789	+	possible acetyltransferase
BI00651	290803	291114	+	conserved hypothetical protein
BI00652	291501	293141	+	conserved hypothetical protein
BI00653	293363	294973	+	BarJ
BI00654	295245	297248	+	transcription termination factor Rho
BI00655	297358	297501	+	hypothetical protein
BI00656	297559	297945	+	chorismate mutase
BI00657	298070	300151	+	cell wall surface anchor family protein, putative
BI00658	300383	303220	-	valyl-tRNA synthetase, putative
BI00659	303262	304686	-	ABC transporter, periplasmic substrate-binding protein, putative
BI00660	304850	305533	-	endonuclease III
BI00661	305595	306374	-	transcriptional regulator
BI00662	306556	307212	-	membrane protein, putative
BI00663	307369	307950	-	integral membrane protein in the upf0059
BI00664	308187	308678	-	inorganic pyrophosphatase
BI00665	308908	311145	-	alpha-amylase family protein
BI00666	311386	313377	+	conserved hypothetical protein
BI00667	313988	315019	+	homoserine O-succinyltransferase
BI00668	315484	316293	+	ATP synthase F0, A subunit
BI00669	316400	316624	+	ATP synthase F0, C subunit
BI00670	316684	317199	+	ATP synthase F0, B subunit
BI00671	317237	318070	+	ATP synthase F1, delta subunit
BI00672	318149	319777	+	ATP synthase F1, alpha subunit
BI00673	319784	320704	+	ATP synthase F1, gamma subunit
BI00674	320716	322185	+	ATP synthase F1, beta subunit
BI00675	322188	322478	+	ATP synthase F1, epsilon subunit, putative
BI00676	322539	323336	+	Predicted nuclease of the RecB family
BI00677	323388	324374	-	possible secreted peptidyl-prolyl cis-trans isomerase protein
BI00678	324455	325531	+	conserved hypothetical protein
BI00679	325534	326538	+	conserved hypothetical protein

BI00680	326790	327761	+	thioredoxin [imported], putative
BI00681	327850	328473	-	Adenylate cyclase
BI00682	329012	329398	+	endoribonuclease L-PSP, putative
BI00683	329536	330498	+	Acyltransferase domain protein
BI00684	330595	331593	+	glycerol-3-phosphate dehydrogenase, NAD-dependent
BI00685	331783	332967	+	D-ala D-ala ligase
BI00686	333223	334386	+	ABC transporter, periplasmic substrate-binding protein
BI00687	334206	335348	+	spermidine/putrescine ABC transporter, permease protein, putative
BI00688	335348	336199	+	spermidine/putrescine ABC transporter, permease protein, putative
BI00689	336207	337481	+	spermidine/putrescine ABC transporter, ATP-binding protein
BI00690	337788	338828	+	CAAX amino terminal protease family protein family
BI00691	338873	339667	-	Mechanosensitive ion channel family
BI00692	339751	341181	-	aspartate ammonia-lyase
BI00693	341302	342030	-	transcriptional regulator, TetR family domain protein
BI00694	342124	343527	-	conserved hypothetical protein
BI00695	343852	344400	-	methylated-DNA--protein-cysteine methyltransferase
BI00696	345228	346055	+	hypothetical protein with helix turn helix motif
BI00697	345928	347202	-	MFS transporter family protein, putative
BI00698	347393	348406	-	ribokinase [imported]
BI00939t	348735	349001	+	ribosomal protein L28
BI00699	349116	351944	+	ATP-dependent DNA helicase RecG
BI00700	352204	352782	+	methyltransferase, putative
BI00701	352812	353624	-	tRNA (guanine-N1)-methyltransferase
BI00702	353623	355341	+	Unknown
BI00703	355422	356399	+	conserved hypothetical protein
BI00704	356482	357354	+	4-diphosphocytidyl-2C-methyl-D-erythritol synthase, putative
BI00705	357367	358041	+	pyrrolidone-carboxylate peptidase, putative
BI00706	358303	359766	+	IgA-specific serine endopeptidase, putative
BI00707	359884	361224	+	aminopeptidase C
BI00708	361519	362649	+	phospho-2-dehydro-3-deoxyheptonate aldolase
BI00709	362781	364010	+	phospho-2-dehydro-3-deoxyheptonate aldolase
BI00710	364141	364845	+	MTA/SAH nucleosidase
BI00711	365444	366427	+	hypothetical ATPase, histidine kinase-, DNA gyrase B-, and HSP90-like domain protein
BI00712	366563	367330	+	DNA-binding response regulator RegX3
BI00713	367583	368713	+	phosphate ABC transporter, phosphate-binding protein
BI00714	368927	369877	+	pstC2
BI00715	369997	370875	+	phosphate ABC transporter, permease protein
BI00716	370931	371707	+	phoT
BI00717	372005	372580	+	lemA protein
BI00718	372647	374902	+	conserved hypothetical protein
BI00719	374971	375831	+	oxidoreductase, aldo/keto reductase family
BI00720	375932	376981	+	inosine-uridine preferring nucleoside hydrolase
BI00721	377109	377729	-	16S rRNA processing protein RimM

BI00722	377755	377985	-	KH domain protein
BI00723	378009	378467	-	ribosomal protein S16
BI00724	378703	379809	-	Endonuclease/Exonuclease/phosphatase family family
BI00725	379889	381634	-	signal recognition particle protein
BI00726	381843	382748	+	cation efflux family protein superfamily
BI00727	382773	384488	-	cysteinyl-tRNA synthetase
BI00728	384518	385363	+	possible amidotransferase
BI00729	385627	387687	+	ABC transporter, ATP-binding protein
BI00730	387746	388162	-	plasmid stability protein StbB
BI00731	388175	388450	-	hypothetical protein
BI00732	388609	389160	-	acetolactate synthase, small subunit
BI00733	389180	391144	-	acetolactate synthase, large subunit, biosynthetic type
BI00734	391308	392033	-	ribonuclease III
BI00735	392189	392380	-	ribosomal protein L32
BI00736	392472	393098	-	Uncharacterized ACR, COG1399
BI00737	393191	394078	-	conserved hypothetical protein
BI00738	394089	394586	-	pantetheine-phosphate adenylyltransferase
BI00739	394860	395150	+	conserved hypothetical protein
BI00740	395198	396205	-	K ⁺ channel, beta subunit
BI00741	396379	396804	+	transcription regulator, MerR family NMB1303 [imported], putative
BI00742	396910	397533	-	hypothetical transmembrane protein with unknown function
BI00743	397764	399083	+	nicotinate phosphoribosyltransferase, putative
BI00744	399381	400142	+	ribonuclease PH
BI00745	400189	400944	+	HamI family
BI00746	401106	402659	+	hypothetical FemAB family
BI00747	402736	404043	+	FemAB family protein, putative
BI00748	404096	405373	+	beta-lactam resistance factor, putative
BI00749	405462	406460	-	membrane protein, putative
BI00750	407182	408879	+	glucose-6-phosphate isomerase
BI00751	409515	409877	+	ribosomal protein L19
BI00752	410047	410901	+	lepB
BI00753	411024	411860	+	ribonuclease HII
BI00754	411990	413102	+	transcription regulator, LacI family [imported]
BI00755	413261	414904	+	probable sugar kinase
BI00756	414992	415681	+	sugar isomerase
BI00757	416114	417430	+	L-arabinose isomerase
BI00758	417620	418240	-	trp-G type glutamine amidotransferase/dipeptidase
BI00759	418178	420178	+	membrane protein, putative
BI00760	420330	421694	+	permease, putative
BI00761	421694	422914	+	transmembrane protein Vexp1, putative
BI00762	422930	423562	+	Vexp2
BI00763	423886	425706	-	long-chain-fatty-acid--CoA ligase, putative
BI00764	425820	426098	+	fragment of arabinose permease
BI00765	426765	429890	+	hypothetical ABC transporter
BI00766	430170	430436	-	major facilitator family transporter CC0814 [imported], putative
BI00767	431272	432618	+	solute binding protein of ABC transporter system
BI00768	432750	433799	+	sugar ABC transporter, permease protein, putative

BI00769	433820	434809	+	Unknown
BI00770	435125	437128	+	beta-D-galactosidase, putative
BI00771	437175	438227	+	transcription regulator, LacI family [imported], putative
BI00772	438426	441116	+	arabinogalactan endo-1,4-beta-galactosidase, putative
BI00773	441755	442621	+	oxidoreductase, aldo/keto reductase family
BI00774	442628	443368	+	conserved hypothetical protein
BI00775	443378	444745	-	conserved hypothetical protein
BI00776	445003	446367	+	transport protein, NRAMP family
BI00777	446472	448073	-	drug resistance transporter, EmrB/QacA subfamily
BI00778	448424	450007	+	glycosyl transferase CpsE
BI00779	450302	452029	+	COG0840: Methyl-accepting chemotaxis protein
BI00780	452064	453566	+	possible Etk-like tyrosine kinase involved in Eps biosynthesis
BI00781	453760	454725	+	hypothetical glycosyl transferase, group 1 family protein
BI00782	454725	456065	+	putative glycosyltransferase protein
BI00783	456065	457126	+	NAD dependent epimerase/dehydratase family protein
BI00784	457201	458448	+	UDP-glucose 6-dehydrogenase
BI00785	458489	459550	+	hypothetical glycosyl transferase, group 1 family protein
BI00786	459581	460408	+	hypothetical Eps1 II
BI00787	460446	460952	+	hypothetical Bacterial transferase hexapeptide (three repeats)
BI00788	460985	461998	+	hypothetical Capsular polysaccharide synthesis protein
BI00789	462020	463360	+	hypothetical protein
BI00790	463363	464292	+	Eps9K
BI00791	464362	465753	+	hypothetical Polysaccharide biosynthesis protein
BI00792	465789	466280	+	hypothetical Bacterial transferase hexapeptide (three repeats)
BI00793	466366	467514	-	NAD-dependent epimerase/dehydratase family protein, putative
BI00794	467785	468363	-	transposase, degenerate
BI00795	468615	468770	-	hypothetical COG2963: Transposase and inactivated derivatives
BI00796	469189	470208	+	dTDP-glucose 4,6-dehydratase
BI00797	470347	471303	+	dTDP-4-dehydrorhamnose 3,5-epimerase
BI00798	471349	472245	+	glucose-1-phosphate thymidyltransferase
BI00799	472858	473046	-	hypothetical protein
BI00800	473371	473802	-	conserved hypothetical protein
BI00801	474083	474640	-	hypothetical Low molecular weight phosphotyrosine protein phosphatase
BI00802	474825	475331	-	hypothetical protein
BI00803	475655	475867	-	hypothetical Helix-turn-helix
BI00804	475860	476042	-	hypothetical protein
BI00805	475971	476312	+	hypothetical protein
BI00806	476415	477422	-	conserved hypothetical protein
BI00807	477471	478751	+	narrowly conserved hypothetical protein
BI00808	477495	477866	-	thioredoxin
BI00809	478880	479734	+	3-oxoadipate enol-lactonase, putative

BI00810	479747	481036	+	MutT/nudix family protein
BI00811	481065	481475	+	glycine cleavage system H protein
BI00812	481547	482875	+	conserved hypothetical protein
BI00813	482973	485453	+	protease II
BI00814	485521	486549	+	3-isopropylmalate dehydrogenase
BI00815	486610	487692	+	lipoate-protein ligase a
BI00817	487934	488650	+	probable transcriptional regulator with cyclic nucleotide-binding domain
BI00818	488757	491069	+	ponA, putative
BI00819	491264	492634	+	NADH-dependent flavin oxidoreductase, putative
BI00820	492807	493955	-	dihydroorotate dehydrogenase, putative
BI00821	494409	495122	+	glycerol-3-phosphate regulon repressor
BI00822	495118	496365	+	galactose-1-phosphate uridylyltransferase
BI00823	496241	497632	+	galactokinase
BI00824	497718	497987	+	ACT domain protein
BI00825	498201	499487	+	similar to unknown proteins
BI00826	499800	500516	-	spoU
BI00827	500612	501463	+	mutY
BI00828	501531	502250	+	conserved hypothetical protein
BI00829	502633	505968	+	DNA-directed RNA polymerase, beta subunit
BI00830	506139	510173	+	DNA-directed RNA polymerase, beta-prime subunit
BI00831	510338	510967	-	FHA domain protein
BI00832	510986	511498	-	hypothetical protein Blon020438
BI00833	511528	512457	-	possible phosphoprotein phosphatase
BI00834	512457	514967	-	membrane protein, putative
BI00835	514967	516187	-	Protein of unknown function family
BI00836	516215	517585	-	moxR2
BI00837	517599	523580	-	cell wall surface anchor family protein, putative
BI00838	523750	525168	-	serine/threonine protein kinase, putative
BI00839	525300	529592	+	hypothetical COG0210: Superfamily I DNA and RNA helicases
BI00840	529427	533620	+	UvrD/REP helicase domain protein
BI00841	533962	535152	+	possible transport protein
BI00842	535527	536243	+	dihydrodipicolinate reductase
BI00843	536388	537311	+	dihydrodipicolinate synthase
BI00844	537585	539246	+	metallo-beta-lactamase superfamily protein
BI00845	539291	541897	+	Peptidase family M1 domain protein
BI00846	542078	542971	+	hypothetical transmembrane protein with unknown function
BI00847	543164	543502	+	conserved hypothetical protein
BI00848	543954	545336	+	phosphoglucosamine mutase
BI00849	545362	546012	+	polypeptide deformylase
BI00850	546072	547472	+	conserved hypothetical protein
BI00851	547492	547620	+	hypothetical protein
BI00852	547858	548979	+	peptide chain release factor 2
BI00853	548991	550121	+	ftsE
BI00854	550135	551055	+	cell division ABC transporter, permease protein FtsX, putative
BI00855	551161	552519	+	autolysin, putative
BI00856	552673	553146	+	SsrA-binding protein
BI00857	553192	554265	+	amino acid ABC transporter, permease protein
BI00858	554479	555420	+	amino acid ABC transporter, permease protein

BI00859	555554	556546	+	amino acid ABC transporter, permease protein
BI00860	556566	557393	+	glutamine ABC transporter, ATP-binding protein
BI00861	557604	559493	+	glucosamine--fructose-6-phosphate aminotransferase, isomerizing
BI00862	559699	560271	+	COG0564: Pseudouridylate synthases, 23S RNA- specific
BI00863	560313	560525	-	hypothetical protein Blon020898
BI00864	560565	561548	-	transcriptional regulator, LacI family, putative
BI00865	561794	562717	+	sugar ABC transporter, permease protein, putative
BI00866	562776	563780	+	Unknown
BI00867	563975	566047	+	beta-D-galactosidase
BI00868	566259	567185	+	transcriptional regulator, LacI family, putative
BI00869	567311	569008	-	alpha-L-arabinofuranosidase
BI00870	569168	570517	+	solute binding protein of ABC transporter system
BI00871	570852	572192	+	probable solute binding protein of ABC transporter system for sugars
BI00872	572449	573729	+	sugar binding protein Sbp
BI00873	573795	574562	-	transcription activator, probable Baf family [imported]
BI00874	574688	576304	+	ABC transporter, periplasmic substrate-binding protein, putative
BI00875	576372	577346	+	membrane protein, putative
BI00876	577346	578245	+	peptide ABC transporter, permease protein, putative
BI00877	578245	579033	+	ABC transporter, nucleotide binding/ATPase protein
BI00878	579029	579811	+	ABC transporter, ATP-binding protein
BI00879	580296	581360	+	cystathionine beta-synthase
BI00880	581455	582636	+	cystathionine beta-lyase
BI00881	582780	584501	-	ErfK/YbiS/YcfS/YnhG family
BI00882	584781	586613	+	ATP-dependent DNA helicase RecQ
BI00883	586729	587220	+	autoinducer-2 production protein LuxS
BI00884	587453	587917	+	acetyltransferase, GNAT family, putative
BI00885	588181	589638	-	hypothetical protein Blon020876
BI00886	589890	591347	-	amino acid permease
BI00887	591542	592891	+	alanine racemase
BI00888	593087	594370	+	deoxyguanosinetriphosphate triphosphohydrolase, putative
BI00889	594546	596642	+	DNA primase, putative
BI00890	596961	597710	+	pyridoxine biosynthesis protein
BI00891	597799	598434	+	SNO glutamine amidotransferase family superfamily
BI00892	598495	600156	+	aminotransferase, class I, putative
BI00893	600514	601443	+	asparaginase family protein
BI00894	601476	601607	+	hypothetical protein Blon020867
BI00895	601574	601897	-	hypothetical protein
BI00896	601995	603179	+	possible transport protein
BI00897	603210	603467	-	hypothetical protein Blon020865
BI00898	603634	603723	+	hypothetical protein
BI00899	603651	605795	-	similar to alpha-L-arabinofuranosidase A
BI00900	605923	606921	+	EF0065, putative
BI00901	607014	608087	-	conserved hypothetical protein
BI00902	608687	609373	+	ABC transporter, ATP-binding protein

BI00903	609373	610545	+	conserved hypothetical protein
BI00904	610560	612116	+	ABC transporter, ATP-binding protein
BI00905	612106	614304	-	1-deoxyxylulose-5-phosphate synthase
BI00906	614478	615467	+	oxidoreductase, zinc-binding, putative
BI00907	615572	616069	+	phosphoribosylaminoimidazole carboxylase, catalytic subunit
BI00908	616095	617231	+	phosphoribosylaminoimidazole carboxylase, ATPase subunit
BI00909	617243	617668	+	furB
BI00910	617709	617954	-	conserved hypothetical protein
BI00911	618183	619103	+	possible solute binding protein of ABC transporter system
BI00912	619367	621439	+	membrane protein, putative
BI00913	621563	623197	+	aldehyde dehydrogenase
BI00914	623577	624842	-	phosphoribosylamine--glycine ligase
BI00915	624872	625702	-	phosphoribosylformylglycinamide cyclo-ligase
BI00916	626029	627537	-	amidophosphoribosyltransferase
BI00917	627944	628726	-	glutamine ABC transporter, ATP-binding protein
BI00918	628726	629610	-	amino acid ABC transporter, permease protein
BI00919	629723	630583	-	amino acid ABC transporter, periplasmic amino acid-binding protein
BI00920	630788	631255	-	conserved hypothetical protein
BI00921	631328	632698	-	Atz/Trz family protein, putative
BI00922	632741	634240	-	S-adenosyl-L-homocysteine hydrolase, NAD binding domain
BI00923	634405	635991	+	structural gene for ultraviolet resistance
BI00924	635991	636206	+	hypothetical protein Blon020836
BI00925	636246	637220	-	K ⁺ channel, beta subunit
BI00926	637331	638293	-	transcriptional regulator, HTH_1 family, putative
BI00927	638512	640023	+	Na ⁺ /H ⁺ antiporter, putative
BI00928	640043	640699	-	membrane protein, putative
BI00929	640699	642066	-	conserved hypothetical protein
BI00930	642042	643337	-	possible carboxylesterase or lipase
BI00931	643478	647209	-	phosphoribosylformylglycinamide synthase
BI00932	647275	648024	-	phosphoribosylaminoimidazole-succinocarboxamide synthase
BI00933	648113	648232	-	hypothetical protein
BI00934	648420	649754	-	phosphoribosylglycinamide formyltransferase 2 VC1228 [imported]
BI00935	649928	651085	+	type 1 capsular polysaccharide biosynthesis protein J (capJ)
BI00936	651238	652260	-	conserved hypothetical protein
BI00937	652822	653880	+	transporter
BI00938	654695	654967	+	ribosomal protein S12
BI00939	654976	655443	+	ribosomal protein S7
BI00940	655478	657598	+	translation elongation factor G
BI00941	657774	658970	+	translation elongation factor Tu
BI00942	659184	659909	+	conserved hypothetical protein
BI00943	660169	660864	+	transcriptional regulator, LysR family, putative
BI00944	661085	662098	+	membrane protein, putative
BI00945	662161	662637	-	COG2246: Predicted membrane protein
BI00946	662721	663083	-	CrcB protein
BI00947	663086	663619	-	protein with similarity to CrcB

BI00948	663706	663987	+	hypothetical protein
BI00949	664023	665063	+	alcohol dehydrogenase, zinc-containing
BI00950	665437	665625	+	hypothetical protein
BI00951	665652	667028	-	conserved hypothetical protein
BI00952	667295	667462	-	possible MarR-type transcriptional regulator
BI00953	667902	670487	+	excinuclease ABC, subunit A
BI00954	670548	671903	+	MATE efflux family protein, putative
BI00955	671914	672603	+	endonuclease III, putative
BI00956	672783	673076	-	hypothetical protein Blon020400
BI00957	673098	673766	+	Unknown
BI00958	673782	674042	-	hexapeptide-repeat containing-acetyltransferase
BI00959	674207	675292	+	possible integral membrane permease protein
BI00960	675273	675902	+	hypothetical Glycosyl hydrolases family 2, TIM barrel domain
BI00961	676090	677316	-	glutamine synthetase, type I
BI00962	677846	678625	-	narrowly conserved hypothetical transmembrane protein
BI00963	678712	680199	-	dihydrolipoamide dehydrogenase
BI00964	680351	680971	-	conserved hypothetical protein
BI00965	681063	682427	+	widely conserved protein in peptidase or deacetylase family
BI00966	682730	683326	+	conserved hypothetical protein
BI00967	683329	684801	+	ABC transporter, ATP-binding protein, putative
BI00968	684801	685625	+	possible permease protein of ABC transporter for cobalt
BI00969	685824	686699	+	spoU rRNA methylase family protein [imported]
BI00970	686891	687820	+	phenylalanyl-tRNA synthetase, alpha subunit
BI00971	687831	690437	+	phenylalanyl-tRNA synthetase, beta subunit
BI00972	690471	691154	+	conserved hypothetical protein
BI00973	691385	692347	+	N-acetyl-gamma-glutamyl-phosphate reductase
BI00974	692434	693519	+	arginine biosynthesis bifunctional protein ArgJ
BI00013g	693503	693979	-	hypothetical protein Magn025872
BI00975	693809	694612	+	acetylglutamate kinase
BI00976	694605	695897	+	acetylornithine aminotransferase
BI00977	695944	696906	+	ornithine carbamoyltransferase
BI00978	696906	697415	+	arginine repressor
BI00979	697501	698736	+	argininosuccinate synthase
BI00980	699184	700653	+	argininosuccinate lyase
BI01326t	701005	701196	+	thiamine biosynthesis protein ThiS
BI00981	701211	702077	+	thiG protein
BI00982	702157	702963	+	moeB
BI00983	703023	703376	+	rhodanese-like domain protein
BI00984	703541	704071	+	HD domain protein
BI00985	703978	704835	+	hypothetical
BI00986	704964	706283	+	tyrosyl-tRNA synthetase
BI00987	706314	708086	+	hypothetical protein BL1050
BI00988	708098	709135	+	Predicted sugar phosphatases of the HAD superfamily
BI00989	709395	710165	+	hemolysin A
BI00990	710153	710719	-	conserved hypothetical protein
BI00991	710729	710881	+	hypothetical protein
BI00992	710965	711624	-	similar to a bacterial K(+)-uptake system
BI00993	711678	713141	-	Cation transport protein domain protein

BI00994	713388	714407	+	poly(P)/ATP-NAD kinase
BI00995	714410	716233	+	DNA repair protein RecN
BI00996	716266	716910	+	hydrolase, haloacid dehalogenase-like family, putative
BI00997	717154	717525	+	transcriptional regulator, GntR family
BI00998	717550	718467	+	ABC transporter, ATP-binding protein
BI01351t	718477	719091	+	membrane protein, putative
BI00999	719985	722768	-	calcium-translocating P-type ATPase, PMCA-type
BI01000	722966	723238	+	hypothetical protein BL1037
BI01001	723291	724778	-	threonine synthase
BI01356t	725001	725699	+	serine hydroxymethyltransferase
BI01002	726028	727116	+	gamma-glutamyl phosphate reductase
BI01003	727134	727694	+	conserved hypothetical protein
BI01004	727694	728476	+	nicotinate (nicotinamide) nucleotide adenylyltransferase
BI01005	728580	729857	-	glycosyl hydrolase, family 3, putative
BI01006	729952	733203	+	Uncharacterized ACR
BI01007	733340	733834	+	phosphinothricin acetyltransferase
BI01008	734033	734629	+	peptidyl-tRNA hydrolase
BI01009	734622	738203	+	transcription-repair coupling factor
BI01010	738346	739290	+	oxidoreductase, putative
BI01011	739444	740739	+	enolase
BI01012	740809	741423	+	hypothetical Septum formation initiator
BI01013	741423	741986	+	conserved hypothetical protein
BI01014	742052	743050	+	possible exopolyphosphatase-like protein
BI01015	743578	744711	+	IS30 family, transposase [imported]
BI01016	744846	747062	+	L-serine dehydratase I
BI01018	747207	747611	+	peptidyl-prolyl cis-trans isomerase, FKBP-type
BI01019	747713	748189	+	transcription elongation factor GreA
BI01020	748250	749191	-	hemolysin, putative
BI01021	749361	750086	+	conserved hypothetical protein
BI01022	750474	751736	+	histidine kinase-like protein
BI01023	751815	752090	-	hypothetical Transcription factor WhiB
BI01024	752207	753922	-	diarrheal toxin
BI01025	754203	755633	-	Transcriptional regulator
BI01389t	755884	756180	+	whiB1
BI01026	756350	759319	+	membrane protein, putative
BI01027	759319	760857	+	LPXTG-motif cell wall anchor domain protein, putative
BI01028	760966	761391	-	conserved hypothetical protein
BI01029	761660	762283	+	conserved hypothetical protein
BI01030	762332	763015	+	Phosphoribosyl transferase domain protein
BI00019g	762937	763509	-	hypothetical Peptidase family S24
BI01031	763391	764464	-	sensory box histidine kinase, putative
BI01032	764464	765183	-	DNA-binding response regulator MtrA
BI01033	765222	767432	-	1,4-alpha-glucan branching enzyme
BI01034	767649	768239	+	possible transcriptional regulator
BI01035	768351	768872	+	2C-methyl-D-erythritol 2,4-cyclodiphosphate synthase
BI01036	768930	769760	-	zinc ABC transporter, permease protein, putative
BI01037	769830	770834	-	ABC transporter, ATP-binding protein
BI01038	770893	772419	-	possible solute binding protein of ABC

				transporter system
BI01039	772190	773062	+	methylenetetrahydrofolate dehydrogenase/methenyltetrahydrofolate cyclohydrolase
BI01040	773185	774657	+	ribosomal protein S1 [imported]
BI01041	774834	775448	+	dephospho-CoA kinase
BI01042	775463	777571	+	excinuclease ABC, B subunit
BI01043	777887	778726	+	TerC family protein [imported]
BI01044	778897	780336	+	pyruvate kinase
BI01045	780490	781086	-	possible NTP pyrophosphatase in MutT family
BI01046	781432	782214	+	response regulator
BI01047	782278	785127	+	DNA polymerase I
BI01048	785291	786217	+	conserved hypothetical protein TIGR00486
BI01049	786266	786937	+	MutT/nudix family protein, putative
BI01050	787135	789132	+	glycogen operon protein GlgX
BI01424t	789186	789413	+	hypothetical protein with helix turn helix motif
BI01051	789420	790067	+	conserved hypothetical protein
BI01052	790243	790794	-	DNA-3-methyladenine glycosylase I
BI01053	791884	792942	-	hypothetical protein
BI01054	793226	793780	+	hypothetical protein
BI01055	793761	794246	-	hypothetical protein
BI00021g	794049	794498	+	transposase B
BI00020g	794300	794749	+	IS1601-D
BI01056	794665	794844	+	transposase subunit B
BI01057	794937	795989	-	integrase/recombinase XerC, probable [imported], putative
BI01434t	795989	796876	-	probable integrase/recombinase
BI01058	796951	798150	-	probable integrase/recombinase
BI01059	798284	799564	-	IS3-Spn1, transposase
BI01060	799635	800477	-	putative transposase subunit
BI01061	800762	802579	-	hypothetical Protein of unknown function DUF262
BI01062	802742	803464	-	hypothetical protein
BI01063	803748	804065	-	conserved hypothetical protein
BI01064	804058	804405	-	hypothetical protein
BI01065	804667	808221	+	DNA polymerase III, alpha chain VC2245 [imported]
BI01066	808312	808743	+	conserved hypothetical protein
BI01067	808952	810826	+	antigen, 67 kDa
BI01068	810916	811413	+	NH2-acetyltransferase
BI01069	817553	818377	-	oxidoreductase, aldo/keto reductase family
BI01070	818538	819956	+	sugar kinase, FGGY family, putative
BI01451t	819972	820262	+	Acylphosphatase
BI01071	820382	821761	+	histidinol dehydrogenase
BI01072	821761	822918	+	histidinol-phosphate aminotransferase
BI01073	823007	823603	+	imidazoleglycerol-phosphate dehydratase
BI01074	823606	824397	+	hypothetical protein Blon020586
BI01075	824435	825079	+	imidazole glycerol phosphate synthase, glutamine amidotransferase subunit
BI01076	825152	825874	+	bifunctional HisA/TrpF protein
BI01077	825984	826103	-	narrowly conserved hypothetical protein
BI01463t	826039	827637	-	conserved hypothetical protein
BI01078	827738	828898	+	Glutamine synthetase, catalytic domain

BI01079	829137	829604	+	transporter, putative
BI01080	829657	830625	-	conserved hypothetical protein
BI01081	830625	834758	-	ATP-dependent helicase HrpA
BI01082	834751	835404	-	conserved hypothetical protein
BI01083	835647	837065	+	GTP-binding protein
BI01084	837405	838208	+	L-lactate dehydrogenase
BI01085	838356	839291	-	cation efflux system protein
BI01086	839460	840182	-	LexA repressor
BI01087	840333	840680	+	LysM domain protein
BI01088	840736	841173	+	conserved hypothetical protein TIGR00244
BI01089	841314	842510	-	D-3-phosphoglycerate dehydrogenase
BI01090	842524	844800	-	COG3973:Superfamily I DNA and RNA helicases
BI01091	845133	845651	+	conserved hypothetical protein TIGR00242
BI01092	845654	846730	+	S-adenosyl-methyltransferase MraW
BI01093	846740	847186	+	hypothetical protein Blon020568
BI01094	847186	848985	+	penicillin-binding protein, putative
BI01095	849015	849884	+	conserved hypothetical protein
BI01096	849936	851384	+	UDP-N-acetylmuramoylalanine-D-glutamyl-2,6- diaminopimelate--D-alanyl-D-alanyl ligase
BI01097	851453	852535	+	phospho-N-acetylmuramoyl-pentapeptide- transferase
BI01098	852593	854035	+	UDP-N-acetylmuramoylalanine--D-glutamate ligase
BI01099	854025	855239	+	cell division protein, FtsW/RodA/SpoVE family, putative
BI01100	855258	856436	+	UDP-N-acetylglucosamine--N-acetylmuramyl- (pentapeptide) pyrophosphoryl-undecaprenol N- acetylglucosamine transferase
BI01101	856651	858075	+	UDP-N-acetylmuramate--alanine ligase
BI01102	858078	859139	+	hypothetical Cell division protein FtsQ
BI01103	859565	860983	+	hypothetical Appr-1-p processing enzyme family
BI01104	861241	861813	+	unknown
BI01105	861640	861885	-	hypothetical protein
BI01106	861906	862391	+	D-tyrosyl-tRNA(Tyr) deacylase
BI01107	862494	863735	-	glucose/galactose transporter, putative
BI01108	863844	864230	-	hypothetical glyoxalase family protein
BI01109	864308	865201	-	fructokinase, putative
BI01110	865277	866488	-	transcription regulator ROK family VC2007 [imported], putative
BI01111	866715	867626	+	glucokinase, putative
BI01112	867792	868913	-	NagC/XylR-type transcriptional regulator
BI01113	869251	870060	+	glucosamine-6-phosphate isomerase
BI01114	870119	871393	+	N-acetylglucosamine-6-phosphate deacetylase
BI01115	871646	873307	+	dipeptide ABC transporter, dipeptide-binding protein
BI01116	873480	874568	+	oligopeptide ABC transporter, permease protein
BI01117	874714	875739	+	dipeptide ABC transporter, permease protein
BI01118	875746	877452	+	ATP binding protein of ABC transporter
BI01119	877508	878026	-	MutT/nudix family protein
BI01120	878078	879670	-	Xaa-Pro aminopeptidase I
BI01121	879977	880954	-	conserved hypothetical protein
BI01122	882044	883672	+	folC

BI01123	883736	887410	+	SMC family, C-terminal domain family
BI01124	887535	888527	-	conserved hypothetical protein
BI01125	888652	890202	-	UDP-N-acetylmuramoylalanyl-D-glutamate-2,6-diaminopimelate ligase
BI01126	890377	891126	+	RNA polymerase sigma-70 factor, ECF subfamily
BI01127	891129	891446	+	conserved hypothetical protein
BI01128	891719	892660	-	Aldose 1-epimerase superfamily
BI01129	892788	893741	-	Aldose 1-epimerase superfamily
BI01130	894032	895021	+	hydroxymethylbutenyl pyrophosphate reductase
BI01131	895067	895573	-	transcriptional regulator, putative
BI01132	895670	896725	-	glyceraldehyde-3-phosphate dehydrogenase, type I
BI01133	896968	897690	-	Thiamin pyrophosphokinase, catalytic domain family
BI01134	897586	898923	+	hypothetical Spermine/spermidine synthase
BI01135	899364	899930	+	Translation initiation factor IF-3, C-terminal domain
BI00041g	899764	900105	+	ribosomal protein L35
BI01136	900161	900541	+	ribosomal protein L20
BI01137	900605	901537	+	Integrase
BI01138	901668	904511	+	ABC transporter, ATP-binding protein
BI01139	904656	905612	+	Soj family protein
BI01140	905634	906545	+	Uncharacterised ACR, COG1354
BI01141	906675	907274	+	conserved hypothetical protein TIGR00281
BI01142	907409	908233	+	MutT/nudix family protein
BI01143	908296	909573	+	quinolinate synthetase complex, A subunit
BI01144	909668	911296	+	L-aspartate oxidase
BI01145	911303	912193	+	nicotinate-nucleotide pyrophosphorylase
BI01146	912292	913443	+	possible pyridoxal-phosphate-dependent aminotransferase
BI01147	913478	914824	+	major facilitator family transporter
BI01148	915142	917070	+	GTP-binding protein TypA
BI01149	917197	917616	+	conserved hypothetical protein
BI01150	917699	918673	+	prephenate dehydratase, putative
BI01151	918670	919734	+	prephenate dehydrogenase
BI01152	919947	920201	+	conserved hypothetical protein
BI01153	920239	921303	+	phage integrase family protein
BI01154	921559	923196	+	solute binding protein of ABC transporter system possibly for peptides
BI01155	923500	924423	+	dppB
BI01156	924445	925446	+	dppC
BI01157	925505	927478	+	ABC-type transporter, duplicated ATPase component
BI01158	927793	928650	-	exodeoxyribonuclease III
BI01159	928775	929626	+	conserved hypothetical protein
BI01160	929645	930400	+	narrowly conserved hypothetical transmembrane protein
BI01161	930393	931658	+	RNA methyltransferase, TrmA family
BI01162	931673	932365	+	lipoprotein, putative
BI01163	932483	935032	+	cation-transporting ATPase, E1-E2 family
BI01164	935156	937852	+	aconitate hydratase I
BI01165	938001	938360	+	Ribbon-helix-helix protein, copG family domain protein

BI01166	938363	938851	+	PIN domain, putative
BI01167	938917	941019	-	Protein of unknown function DUF262 family
BI01168	941112	941777	-	acetyltransferase, GNAT family family
BI01169	941793	942608	-	DNA-binding response regulator, putative
BI01170	942553	943935	-	atypical histidine kinase sensor of two-component system
BI01171	944117	944959	+	conserved hypothetical protein
BI01172	945143	946039	+	membrane protein, putative
BI01173	946326	947195	+	membrane protein, putative
BI01174	947234	948073	-	GTP pyrophosphokinase [imported]
BI01175	948115	949554	+	tRNA-i(6)A37 thiotransferase enzyme MiaB
BI01176	949568	950551	+	tRNA delta(2)-isopentenylpyrophosphate transferase
BI01177	950591	951517	-	Fic protein family family
BI01178	951663	954437	+	cell division protein FtsK
BI01179	954635	955267	+	CDP-diacylglycerol--glycerol-3-phosphate 3-phosphatidyltransferase
BI01180	955282	955812	+	competence/damage-inducible protein CinA domain protein
BI01181	955881	956387	+	possible DNA binding protein
BI01182	956502	956732	+	conserved hypothetical protein
BI01183	957036	958226	+	recA protein
BI01184	958232	958822	+	regulatory protein RecX
BI01185	959702	960361	+	S30AE family protein
BI01186	960556	963417	+	preprotein translocase, SecA subunit
BI00044g	963734	963970	-	COG3464: Transposase and inactivated derivatives
BI01187	963974	964096	-	COG3464: Transposase and inactivated derivatives
BI00045g	964219	964602	+	hypothetical protein BL0497
BI01188	964674	965717	+	anthranilate phosphoribosyltransferase
BI01189	965964	966686	-	hypothetical transmembrane protein with unknown function
BI01190	966447	967418	+	hypothetical Acyltransferase
BI01191	967476	969722	-	serine/threonine protein kinase, putative
BI01192	969893	970858	-	idsA2
BI01193	971179	971838	+	conserved hypothetical protein
BI01194	972002	973465	+	RNA polymerase principal sigma factor, sigma 70
BI01195	973526	975799	+	DNA gyrase, subunit B
BI01196	975969	977192	+	membrane protein, putative
BI01197	977269	978228	+	ribokinase
BI01198	978247	982977	+	DEAD/DEAH box helicase domain protein
BI01199	982994	983779	-	DNA-binding response regulator TcrA, putative
BI01200	983927	986953	-	DNA gyrase A subunit
BI01201	986925	988169	+	conserved hypothetical protein
BI01202	988185	989189	-	conserved hypothetical protein
BI01203	989432	989722	+	conserved hypothetical protein
BI01204	989725	990198	+	deoxyuridine 5triphosphate nucleotidohydrolase
BI01205	990335	992656	+	GTP pyrophosphokinase
BI01206	992780	993058	-	orfB
BI01207	993226	994425	+	probable integrase/recombinase
BI01640t	994500	995387	+	probable integrase/recombinase
BI01208	995387	996439	+	integrase/recombinase XerC, probable [imported],

				putative
BI01209	996532	997095	-	COG2801: Transposase and inactivated derivatives
BI00053g	997107	997619	-	ASOPSNART-11OSRSI
BI01210	997719	998264	-	possible peptidyl-prolyl cis-trans isomerase
BI01211	998331	999296	-	COG3391: Uncharacterized conserved protein
BI01212	999519	999623	-	hypothetical protein
BI01213	999683	1000615	-	membrane protein, putative
BI01214	1000747	1001295	+	Hypothetical cytosolic protein
BI01215	1001329	1002621	-	conserved hypothetical protein
BI01216	1002648	1003532	+	possible phosphoglycerate mutase
BI01217	1003650	1004597	+	magnesium transporter, CorA family
BI01218	1004615	1005538	+	glnH, putative
BI01219	1005776	1008544	+	leucyl-tRNA synthetase
BI01220	1008708	1009484	+	competence protein ComEA helix-hairpin-helix repeat region domain protein
BI01221	1009553	1011235	+	conserved hypothetical transmembrane protein related to ComA
BI01222	1011378	1012721	+	possible prolidase (X-Pro dipeptidase) or chlorohydrolase
BI01223	1012791	1013759	+	conserved hypothetical protein
BI01224	1013783	1014346	+	conserved hypothetical protein TIGR00150
BI01225	1014411	1015289	+	conserved hypothetical protein
BI01226	1015308	1015859	+	ribosomal-protein-alanine acetyltransferase
BI01227	1015859	1016899	+	O-sialoglycoprotein endopeptidase
BI01228	1017438	1017539	-	hypothetical protein
BI01229	1017569	1018501	+	probable integrase/recombinase
BI01230	1018564	1018887	-	conserved hypothetical protein
BI01231	1018909	1019787	-	conserved hypothetical protein
BI01232	1019849	1020361	-	conserved hypothetical protein
BI01233	1020474	1021376	-	Fic protein family family
BI01234	1021357	1021929	-	hypothetical protein BL1463
BI01235	1021949	1023763	-	conserved hypothetical protein
BI01236	1023782	1024864	-	conserved hypothetical protein
BI01237	1024893	1025600	-	conserved hypothetical protein
BI01238	1025761	1026843	-	possible TraG-related protein
BI01239	1026843	1027799	-	hypothetical protein Blon020262
BI01240	1027799	1028164	-	hypothetical protein Blon020261
BI01242	1028379	1028669	+	hypothetical protein Blon020260
BI01241	1028588	1030942	+	DNA topoisomerase III
BI01243	1030771	1031448	+	hypothetical protein Blon020258
BI01244	1031753	1032193	+	COG1758: DNA-directed RNA polymerase, subunit K/omega
BI01245	1032161	1032553	-	hypothetical protein Blon020256
BI01246	1032621	1033400	-	Fic protein family family
BI01247	1033518	1034822	+	MC38, putative
BI01248	1034848	1036128	-	PUTATIVE HIPA TRANSCRIPTION REGULATOR PROTEIN
BI01249	1036128	1036439	-	hypothetical protein Blon020251
BI01250	1036545	1037675	-	conserved hypothetical protein
BI01251	1038618	1040387	-	MC40
BI01252	1040507	1041145	-	conserved hypothetical protein
BI01253	1041250	1042281	-	conserved hypothetical protein

BI01254	1042389	1042865	-	conserved hypothetical protein
BI01255	1043244	1044842	-	ATP binding protein-like protein
BI01256	1044857	1046341	-	conserved hypothetical protein
BI01257	1046369	1048195	-	lipoprotein, putative
BI01258	1048370	1048669	-	conserved hypothetical protein
BI01259	1048710	1049189	-	MC47, putative
BI01713t	1049183	1050538	+	hypothetical protein BL1487
BI01260	1049206	1050405	-	hypothetical protein
BI01261	1050435	1051070	-	hypothetical protein Blon020236
BI01262	1051396	1056213	-	hypothetical COG2217: Cation transport ATPase
BI01263	1056508	1057458	-	hypothetical protein Blon020231
BI01264	1057844	1058440	-	hypothetical COG1192: ATPases involved in chromosome partitioning
BI01265	1059167	1059430	-	COG1192: ATPases involved in chromosome partitioning
BI01266	1059569	1060042	-	possible WhiB-like transcription factor
BI01267	1060036	1061400	-	conserved hypothetical protein
BI01727t	1061400	1061597	-	hypothetical protein Blon020220
BI01268	1061748	1061894	-	hypothetical protein
BI01730t	1061882	1062055	-	hypothetical protein Blon020217
BI01269	1062779	1062997	-	conserved hypothetical protein
BI01270	1063127	1063546	+	Helix-turn-helix domain protein
BI01733t	1064092	1064778	+	conserved hypothetical protein
BI01271	1064862	1066490	-	lipoprotein, putative
BI01272	1066742	1067959	-	isocitrate dehydrogenase, NADP-dependent
BI01273	1068051	1069208	+	IMP dehydrogenase family protein
BI01274	1069373	1069861	+	hypothetical protein Blon020211
BI01275	1069955	1072039	+	long-chain-fatty-acid--CoA ligase, putative
BI01276	1072049	1072534	+	polypeptide deformylase
BI01277	1072876	1073736	+	ribosomal protein S2
BI01278	1073818	1074666	+	translation elongation factor Ts
BI01279	1074978	1075580	+	uridylate kinase
BI01280	1075660	1076208	+	ribosome recycling factor
BI01281	1076309	1077217	+	phosphatidate cytidyltransferase
BI01282	1077557	1078597	+	radical SAM enzyme, Cfr family
BI01283	1078604	1079149	-	protease I
BI01284	1079324	1080091	+	imidazoleglycerol phosphate synthase, cyclase subunit
BI01285	1080228	1080620	+	phosphoribosyl-AMP cyclohydrolase
BI01286	1080704	1082257	+	anthranilate synthase component I
BI01287	1082328	1082564	-	conserved hypothetical protein
BI01288	1082576	1084174	+	ATP binding protein of ABC transporter
BI01289	1084221	1084925	+	oxidoreductase, short-chain dehydrogenase/reductase family, putative
BI01290	1084999	1085364	+	narrowly conserved protein with unknown function
BI01291	1085423	1086091	-	conserved hypothetical protein
BI01292	1086091	1087701	-	ABC transporter, ATP-binding protein
BI01293	1087704	1088600	-	possible ABC transporter permease for cobalt
BI01294	1088405	1089049	-	narrowly conserved protein with unknown function
BI01295	1089261	1090877	+	conserved hypothetical protein
BI01296	1090916	1091548	+	conserved hypothetical protein

BI01297	1091551	1095093	+	hypothetical myosin-like protein with unknown function
BI01298	1095170	1096351	+	conserved hypothetical protein
BI01299	1096680	1097084	+	hypothetical protein BL0701
BI01300	1097367	1100384	+	excinuclease ABC, A subunit
BI01301	1100532	1102895	+	excinuclease ABC, C subunit
BI01302	1103007	1103975	+	aroE
BI01303	1103978	1104961	+	Predicted P-loop-containing kinase
BI01304	1105247	1106110	+	Uncharacterized BCR, COG1481
BI01305	1106282	1107484	+	phosphoglycerate kinase
BI01306	1107546	1108346	+	triosephosphate isomerase
BI01307	1108365	1108658	+	preprotein translocase, SecG subunit
BI01308	1108763	1109710	+	L-lactate dehydrogenase
BI01309	1109710	1110558	+	Cof family protein
BI01310	1110672	1112225	+	aminotransferase, class I
BI01311	1112360	1113466	-	membrane protein, putative
BI01312	1113642	1114943	-	branched-chain amino acid transport system II carrier protein
BI01313	1115108	1116208	-	transaldolase
BI01314	1116332	1118392	-	transketolase
BI01315	1118812	1119927	+	heat-inducible transcription repressor HrcA
BI01316	1119986	1121128	+	dnaJ protein
BI01317	1121180	1121968	-	COG3001:Uncharacterized BCR
BI01318	1122113	1122994	+	undecaprenol kinase, putative
BI01319	1123157	1124146	-	conserved hypothetical protein
BI01320	1124807	1126837	+	threonyl-tRNA synthetase
BI01321	1127061	1127561	+	HIT family protein
BI01322	1127703	1128455	+	conserved hypothetical protein TIGR01033
BI01323	1128464	1129045	+	crossover junction endodeoxyribonuclease RuvC
BI01324	1129106	1129729	+	Holliday junction DNA helicase RuvA
BI01325	1129732	1130793	+	Holliday junction DNA helicase RuvB
BI01326	1130876	1131292	+	preprotein translocase, YajC subunit
BI01327	1131359	1131937	+	adenine phosphoribosyltransferase
BI01328	1132037	1133236	+	succinyl-CoA synthetase, beta subunit
BI01329	1133239	1134147	+	succinyl-CoA synthase, alpha subunit
BI01330	1133954	1135546	+	membrane protein, putative
BI01331	1135497	1137131	+	phosphoribosylaminoimidazolecarboxamide formyltransferase/IMP cyclohydrolase
BI01332	1137280	1137579	+	hypothetical protein
BI01333	1137484	1138449	-	aquaporin Z, putative
BI01334	1138645	1139412	+	ribosomal large subunit pseudouridine synthase B
BI01335	1139514	1141538	+	possible GTP-binding protein
BI01336	1141896	1143422	+	UDP-glucose pyrophosphorylase
BI01337	1143565	1145475	+	conserved hypothetical protein
BI01338	1145489	1145803	+	hypothetical protein Blon020144
BI01339	1145819	1148407	+	helY
BI01340	1148524	1148868	+	conserved hypothetical protein
BI01341	1149001	1149717	+	hydrolase, haloacid dehalogenase-like family
BI01833t	1149744	1149995	+	conserved hypothetical protein
BI01342	1150135	1150497	-	hypothetical protein Blon020140
BI01343	1150673	1151302	-	COG0789:Predicted transcriptional regulators
BI01344	1151406	1151846	-	possible signal transduction protein
BI01345	1151856	1152596	-	conserved hypothetical protein

BI01346	1152693	1153022	-	small basic protein
BI01347	1153025	1153999	-	conserved hypothetical protein
BI01348	1153992	1154684	-	CDP-diacylglycerol--glycerol-3-phosphate 3-phosphatidyltransferase, putative
BI01349	1154623	1155471	-	ATP phosphoribosyltransferase
BI01350	1155486	1155746	-	phosphoribosyl-ATP pyrophosphohydrolase
BI01351	1155812	1156477	-	ribulose-phosphate 3-epimerase
BI01352	1156556	1157500	-	prolipoprotein diacylglyceryl transferase
BI01353	1157614	1158480	-	tryptophan synthase, alpha subunit
BI01354	1158507	1160591	-	tryptophan synthase, beta subunit
BI01355	1161120	1161968	-	endonuclease IV
BI00066g	1161414	1162400	+	amino acid permease
BI01356	1162340	1162834	+	amino acid permease
BI01357	1162503	1162667	+	amino acid permease
BI01358	1163206	1164216	-	hypothetical membrane protein with unknown function
BI01359	1164333	1164536	-	hypothetical protein
BI01360	1164570	1164860	-	abortive infection protein AbiGI, putative
BI01361	1164981	1165262	+	hypothetical protein
BI01362	1165260	1165715	-	lin2984
BI01363	1165903	1166406	+	acetyltransferase, GNAT family, putative
BI01364	1166567	1166746	+	lin0863
BI01365	1166793	1167323	-	acetyltransferase, GNAT family
BI01366	1167392	1167961	-	acetyltransferase, GNAT family
BI01367	1168315	1168992	-	hypothetical protein
BI01368	1169017	1169823	-	hypothetical protein
BI01369	1169832	1170527	-	ABC transporter, ATP-binding protein
BI01370	1170352	1171263	+	hypothetical Response regulator receiver domain
BI01371	1171317	1172225	+	hypothetical protein
BI01372	1172194	1172631	-	hypothetical Integral membrane protein
BI01373	1172956	1173576	-	hypothetical protein
BI01374	1173576	1174301	-	hypothetical protein
BI01873t	1174309	1174962	-	bacteriocin ABC transporter, ATP-binding protein, putative
BI01375	1175274	1176518	+	IS30 family, transposase [imported]
BI01376	1176714	1177379	-	DNA-binding response regulator
BI01377	1177379	1179001	-	hypothetical ATPase, histidine kinase-, DNA gyrase B-, and HSP90-like domain protein
BI01378	1179039	1179881	-	hypothetical permease, putative
BI01379	1180057	1180956	-	ABC transporter, ATP-binding protein
BI01380	1181077	1181259	+	hypothetical protein
BI01381	1181154	1181684	-	hypothetical protein
BI01382	1182016	1182315	+	BlsA
BI01383	1182321	1182662	+	hypothetical protein
BI01384	1182847	1183050	-	hypothetical protein
BI01385	1183324	1183446	+	hypothetical protein BL0771
BI01386	1183489	1183932	+	hypothetical protein Blon020116
BI01387	1183955	1184314	-	COG0388: Predicted amidohydrolase
BI01388	1184376	1184531	-	hypothetical protein
BI01389	1184840	1185853	-	inner membrane protein, 60 kDa VC0004 [imported]
BI01390	1186097	1186555	-	hypothetical protein
BI01391	1186942	1187067	+	hypothetical protein

BI01392	1187122	1188783	+	amino acid permease
BI01393	1188993	1189640	-	Signal peptidase I
BI00067g	1189800	1190303	+	conserved hypothetical protein
BI01394	1189721	1190146	-	hypothetical protein Blon020104
BI01395	1190467	1191420	+	lin0466
BI01396	1191479	1191799	+	narrowly conserved hypothetical protein
BI01397	1191887	1192165	+	narrowly conserved hypothetical protein
BI01398	1192540	1193727	+	Unknown, putative
BI01399	1193770	1195530	+	YjeF family protein, putative
BI01400	1195635	1196261	+	possible alpha beta hydrolase
BI01401	1196417	1197286	+	transcriptional regulator, LysR family
BI01402	1197447	1198565	-	conserved hypothetical protein
BI01403	1198783	1198932	-	hypothetical protein
BI01404	1199044	1199736	-	orotate phosphoribosyltransferase
BI01405	1199748	1200716	-	dihydroorotate dehydrogenase
BI01406	1200722	1201543	-	dihydroorotate dehydrogenase, electron transfer subunit
BI01407	1201682	1202632	-	orotidine 5'-phosphate decarboxylase
BI01408	1202653	1203939	-	dihydroorotase
BI01921t	1204146	1204562	-	Aspartate carbamoyltransferase regulatory chain, allosteric domain
BI01409	1204565	1205524	-	aspartate carbamoyltransferase
BI01410	1205669	1208896	-	glutamate-ammonia ligase adenyltransferase family
BI01411	1208955	1209905	-	EF0040
BI01412	1210042	1210893	-	5,10-methylenetetrahydrofolate reductase
BI01413	1210955	1213255	-	5-methyltetrahydropteroyltriglutamate--homocysteine S-methyltransferase
BI01414	1213369	1213923	-	phosphohistidine phosphatase SixA, putative
BI01415	1214024	1215091	-	conserved hypothetical protein
BI01416	1215168	1215803	+	serine esterase, putative
BI01417	1215850	1216806	-	oxidoreductase, aldo/keto reductase 2 family
BI01418	1217063	1217995	+	lipC, putative
BI01419	1218234	1219178	+	hypothetical oxidoreductase, zinc-binding dehydrogenase family
BI01420	1219340	1219642	-	probable ATP binding protein of ABC transporter
BI01421	1220459	1221484	+	transposase (25) BH3998 [imported], putative
BI00069g	1221277	1221948	+	hypothetical protein
BI01422	1221948	1222706	+	Tpase2
BI01423	1222896	1223972	+	hypothetical protein
BI01424	1224236	1224811	+	hypothetical protein
BI01425	1224888	1225190	-	transcriptional regulator, HTH_3 family
BI01426	1225221	1226144	-	hypothetical protein
BI01427	1226238	1227140	-	hypothetical protein
BI01428	1227158	1228765	-	hypothetical protein
BI01429	1229279	1230097	-	hypothetical ADP-ribosylglycohydrolase
BI01430	1231271	1231726	-	hypothetical protein
BI01431	1232085	1232906	+	conserved hypothetical protein
BI01432	1233000	1233539	-	bcp
BI01433	1233681	1234511	-	probable amidase [imported]
BI01434	1234511	1235365	-	hydrolase, haloacid dehalogenase-like family, putative
BI01435	1235520	1236365	-	amino acid transport protein

BI01436	1236462	1237709	-	possible glycosyltransferase
BI01437	1237841	1238302	-	conserved hypothetical protein
BI01438	1238382	1239917	-	gltD
BI01439	1239922	1244265	-	Conserved region in glutamate synthase family
BI01440	1244835	1245116	+	transcription regulator, LacI family [imported]
BI01441	1245175	1246197	-	conserved hypothetical protein
BI01442	1246656	1246979	+	conserved hypothetical protein
BI01443	1247042	1247227	-	hypothetical protein
BI01444	1247493	1248536	-	transcriptional regulator, LacI family, putative
BI01445	1249246	1250073	+	conserved hypothetical protein
BI01446	1250275	1250571	-	hypothetical protein
BI00071g	1250541	1250888	-	conserved hypothetical protein
BI01447	1250658	1250807	+	hypothetical protein
BI01448	1251252	1252538	+	MATE efflux family protein, putative
BI01449	1252678	1252794	-	hypothetical protein
BI01450	1253083	1254216	+	IS30 family, transposase [imported]
BI01451	1254323	1255327	-	glycerate kinase
BI01452	1255679	1256734	+	transcriptional regulator, LacI family, putative
BI01453	1256820	1258094	-	oxygen-independent coproporphyrinogen III oxidase, putative
BI01454	1258229	1259890	-	GTP-binding protein LepA
BI01455	1260253	1260510	+	ribosomal protein S20
BI01456	1260768	1261556	-	conserved hypothetical transmembrane protein with unknown function
BI01457	1261807	1262703	-	transcriptional regulator, MazG family
BI01458	1262903	1264027	-	branched-chain amino acid aminotransferase
BI01459	1264254	1264871	-	ribosomal 5S rRNA E-loop binding protein Ctc/L25/TL5
BI01460	1265298	1266332	+	conserved hypothetical protein
BI01461	1266474	1267895	-	NAD(P) transhydrogenase, beta subunit [imported]
BI01462	1267898	1268200	-	NAD(P) transhydrogenase, alpha subunit
BI01463	1268219	1269379	-	NAD(P) transhydrogenase, alpha subunit [imported]
BI01464	1269798	1271828	+	long-chain-fatty-acid--CoA ligase
BI01465	1271887	1272948	-	GTP-binding protein Era
BI01466	1272953	1274383	-	CBS domain protein
BI01467	1274462	1275052	-	conserved hypothetical protein TIGR00043
BI01468	1275000	1276172	-	PhoH family protein
BI01469	1276194	1276529	-	Hit family protein
BI01470	1276581	1277375	-	conserved hypothetical protein TIGR00046
BI01471	1277619	1278494	+	spoU rRNA methylase family protein
BI01472	1278758	1279939	+	glucose-1-phosphate adenyltransferase
BI01473	1280035	1280532	-	mrp protein homolog
BI01474	1280635	1281171	-	SUF system FeS assembly protein, NifU family
BI01475	1281201	1282472	-	aminotransferase, class-V
BI01476	1282614	1283390	-	FeS assembly ATPase SufC
BI01477	1283419	1284651	-	FeS assembly protein SufD
BI01478	1284660	1286156	-	FeS assembly protein SufB
BI01479	1286383	1287849	-	conserved hypothetical protein
BI01480	1288225	1289883	-	CTP synthase
BI01481	1290032	1291585	-	dipeptidase, putative
BI01482	1291684	1292127	-	3-dehydroquinate dehydratase, type II

BI01483	1292294	1293835	-	3-dehydroquinate synthase
BI01484	1293999	1295132	-	chorismate synthase
BI01485	1295247	1295717	+	COG0477: Permeases of the major facilitator superfamily
BI01486	1295891	1297003	-	Uncharacterized BCR, YceG family COG1559
BI01487	1297083	1297535	-	conserved hypothetical protein TIGR00250
BI01488	1297550	1300228	-	alanyl-tRNA synthetase
BI01489	1300359	1300592	-	hypothetical protein Blon020010
BI01490	1300595	1300990	-	conserved hypothetical protein
BI01491	1301196	1301921	-	phosphoglycerate mutase
BI01492	1302158	1304008	+	Acyltransferase family domain protein
BI01493	1304105	1304728	-	ribosomal protein S4
BI01494	1304930	1305895	-	ABC transporter, ATP-binding protein
BI01495	1305900	1307114	-	hypothetical transmembrane protein with unknown function
BI01496	1307208	1307603	-	conserved hypothetical protein
BI01497	1307751	1310450	-	hypothetical UvrD/REP helicase
BI01498	1310567	1311145	+	xanthine phosphoribosyltransferase
BI01499	1311199	1312560	+	xanthine/uracil permease family protein
BI01500	1312696	1312902	-	transcription regulator, Cro/CI family [imported]-related protein
BI01501	1312912	1313169	-	hypothetical protein
BI01502	1313326	1314144	-	hydrolase, alpha/beta fold family, putative
BI01503	1314432	1315367	+	conserved hypothetical protein
BI01504	1315462	1315860	-	glyoxalase family protein
BI01505	1316019	1316630	+	isochorismatase
BI01506	1316885	1318360	+	conserved hypothetical protein
BI01507	1318371	1319780	-	membrane protein, putative
BI01508	1319770	1321005	-	membrane protein, putative
BI01509	1321109	1322089	-	daunorubicin resistance ATP-binding protein
BI01510	1322192	1322296	-	hypothetical protein
BI01511	1322475	1323824	+	histidine kinase sensor of two-component system
BI01512	1323917	1324477	+	DNA-binding response regulator
BI01513	1324667	1325287	-	Protein of unknown function subfamily
BI01514	1325308	1326324	-	phosphate transporter family protein
BI01515	1326480	1326674	-	conserved hypothetical protein
BI01516	1326735	1329005	-	carbon starvation protein A
BI01517	1329406	1330668	+	glycosyl hydrolase, family 13, putative
BI01518	1330703	1331404	-	transcriptional regulator, TetR family, putative
BI01519	1331486	1333669	-	possible ATP-dependent RNA helicase
BI01520	1334052	1335338	-	uracil-xanthine permease
BI01521	1335446	1336273	-	phosphoglycerate mutase family domain protein
BI01522	1336327	1336905	-	conserved hypothetical protein
BI01523	1337061	1337612	+	conserved hypothetical protein
BI01524	1337738	1338898	-	conserved hypothetical protein
BI01525	1339275	1340816	-	conserved hypothetical protein
BI01526	1341250	1341687	+	hypothetical COG0653: Preprotein translocase subunit SecA (ATPase, RNA helicase)
BI01527	1341752	1343449	+	Protein kinase domain protein
BI01528	1343493	1344980	-	permease, putative
BI01529	1345295	1347565	-	drug resistance transporter, EmrB/QacA subfamily
BI01530	1347576	1347776	-	hypothetical protein

BI01531	1347947	1348309	+	hypothetical Domain of unknown function (DUF307)
BI01532	1348405	1349910	-	hypothetical protein
BI01533	1349906	1351072	-	hypothetical protein
BI01534	1351166	1351474	-	hypothetical protein
BI02085t	1351280	1351477	+	hypothetical protein Blon021394
BI01535	1351807	1352478	+	COG4186: Predicted phosphoesterase or phosphohydrolase
BI01536	1352565	1354004	+	conserved hypothetical protein
BI01537	1354044	1354253	+	hypothetical protein BL0925
BI01538	1354253	1354612	+	hypothetical protein BL0925
BI01539	1354729	1355193	+	hypothetical protein
BI01540	1355496	1356380	-	hypothetical protein
BI01541	1356380	1357450	-	hypothetical Phage integrase family
BI01542	1357650	1358675	+	transposase (25) BH3998 [imported], putative
BI00076g	1358468	1359139	+	hypothetical protein
BI01543	1359139	1359897	+	Tpase2
BI01544	1360305	1361546	-	GTP-binding protein YchF
BI01545	1361533	1362351	-	pyrroline-5-carboxylate reductase
BI01546	1362416	1363891	-	proline iminopeptidase
BI01547	1363977	1366433	+	histidine kinase sensor of two-component system
BI01548	1366551	1367345	+	DNA-binding response regulator
BI01549	1367384	1370233	-	possible transport protein
BI01550	1370265	1371176	-	ABC transporter, ATP-binding protein
BI01551	1371528	1372841	-	O-acetylhomoserine sulfhydrylase
BI01552	1373315	1374184	+	pyridoxal kinase, putative
BI01553	1374424	1374924	+	conserved hypothetical protein TIGR00252
BI01554	1374983	1376515	+	Mg chelatase-related protein
BI01555	1376515	1378212	+	DNA processing protein DprA, putative
BI01556	1378272	1380134	+	sdhA
BI01557	1380233	1381195	+	sdhB
BI01558	1381277	1381954	+	probable methyltransferase
BI01559	1382006	1382944	-	conserved hypothetical protein TIGR00730
BI01560	1383180	1384595	-	Na ⁺ /H ⁺ antiporter [imported]
BI01561	1385070	1386485	-	ATP-dependent Clp protease, ATP-binding subunit ClpX
BI01562	1386610	1387308	-	ATP-dependent Clp protease, proteolytic subunit ClpP
BI01563	1387317	1387907	-	ATP-dependent Clp protease, proteolytic subunit ClpP
BI01564	1388046	1388423	-	hypothetical protein Blon021418
BI01565	1388538	1390001	-	voltage-gated chloride channel family protein, putative
BI01566	1390189	1391565	-	trigger factor
BI01567	1391623	1392921	-	3-5 exonuclease domain protein
BI01568	1392921	1393730	-	COG0477: Permeases of the major facilitator superfamily
BI01569	1393622	1394500	-	pyruvate formate-lyase 1 activating enzyme
BI01570	1394613	1396985	-	formate acetyltransferase
BI01571	1397254	1397475	-	conserved hypothetical protein
BI01572	1397531	1399093	-	NH(3)-dependent NAD ⁺ synthetase
BI01573	1399577	1400725	-	Peptidase, M20/M25/M40 family
BI01574	1400817	1401500	-	permease protein of ABC transporter system

BI01575	1401500	1402702	-	ABC transporter, ATP-binding protein
BI01576	1402839	1403816	-	lipoprotein, YaeC family
BI01577	1404020	1404847	+	hydrolase, haloacid dehalogenase-like family
BI01578	1404975	1407449	-	D-xylulose 5-phosphate/D-fructose 6-phosphate phosphoketolase
BI01579	1407895	1409454	+	GMP synthase
BI01580	1409723	1410304	+	COG0798: Arsenite efflux pump ACR3 and related permeases
BI01581	1410343	1410720	+	arsenical resistance protein/arsenate reductase
BI01582	1411265	1411771	+	hypothetical Transposase IS66 family
BI00078g	1411579	1412214	+	hypothetical protein Blon021471
BI01583	1412111	1413136	+	transposase (25) BH3998 [imported], putative
BI00079g	1412929	1413600	+	hypothetical protein
BI01584	1413600	1414358	+	Tpase2
BI01585	1414423	1414911	+	hypothetical COG3436: Transposase and inactivated derivatives
BI02159t	1415037	1416323	-	COG0477: Permeases of the major facilitator superfamily
BI01586	1416510	1417160	+	putative ATP-binding protein
BI01587	1417164	1418444	+	Uncharacterized conserved protein
BI01588	1418440	1418820	+	hypothetical protein Blon021466
BI01589	1418965	1420548	+	conserved hypothetical protein
BI01590	1420796	1422598	+	acyltransferase, putative
BI01591	1422687	1423706	+	prsA
BI01592	1423991	1425370	+	UDP-N-acetylglucosamine pyrophosphorylase
BI01593	1425377	1425787	+	iojap-related protein
BI01594	1425942	1426637	+	phosphoglycerate mutase, putative
BI01595	1427363	1428961	+	phosphate acetyltransferase
BI01596	1429099	1429695	+	acetate kinase
BI01597	1429811	1430326	+	hypothetical COG0282: Acetate kinase
BI01598	1430503	1431867	-	3-phosphoshikimate 1-carboxyvinyltransferase
BI01599	1431867	1433036	-	membrane protein, putative
BI01600	1433757	1434125	-	hypothetical COG2217: Cation transport ATPase
BI01601	1434688	1436172	-	galactoside symporter
BI01602	1436515	1439583	+	beta-galactosidase, putative
BI01603	1440389	1441246	+	hypothetical protein
BI01604	1441301	1441966	-	hypothetical protein Blon020709
BI01605	1442167	1442559	-	hypothetical protein
BI01606	1442574	1442990	-	hypothetical protein
BI01607	1442990	1444792	-	hypothetical protein
BI01608	1444688	1445566	+	COG3757: Lysozyme M1 (1,4-beta-N-acetylmuramidase)
BI01609	1445667	1445948	+	hypothetical protein
BI01610	1446119	1446796	+	hypothetical protein
BI01611	1447212	1448801	+	hypothetical C-5 cytosine-specific DNA methylase
BI01612	1448804	1449997	-	hypothetical protein Psc022392
BI01613	1450130	1450393	+	hypothetical protein
BI01614	1450514	1450891	-	hypothetical protein
BI01615	1451253	1452203	-	hypothetical protein
BI01616	1452503	1452802	-	TnpB
BI01617	1452909	1453127	+	IS861, transposase OrfB
BI01618	1453248	1453586	+	putative transposase subunit

BI01619	1455179	1455604	-	cell division protein FtsZ
BI01620	1455752	1459864	-	hypothetical UvrD/REP helicase
BI01621	1459861	1463163	-	COG3857: ATP-dependent nuclease, subunit B
BI01622	1463295	1465877	-	hypothetical DNA polymerase III, alpha subunit
BI01623	1466012	1467055	+	conserved hypothetical protein
BI01624	1467089	1467886	-	narrowly conserved hypothetical membrane protein
BI01625	1468160	1468507	-	hypothetical protein BL0124
BI01626	1468949	1469908	-	Pseudouridylate synthases, 23S RNA-specific
BI01627	1469911	1470456	-	lipoprotein signal peptidase
BI01628	1470481	1471857	-	conserved hypothetical protein
BI01629	1472000	1472299	-	COG0762: Predicted integral membrane protein
BI01630	1472424	1472900	-	conserved hypothetical protein
BI01631	1472916	1473830	-	hypothetical Tubulin/FtsZ family, C-terminal domain
BI01632	1474239	1475480	-	TIM-barrel protein, NifR3 family
BI01633	1475628	1476938	-	glycyl-tRNA synthetase
BI01634	1477533	1478474	+	hydroxyethylthiazole kinase
BI01635	1478743	1481310	+	thiamine biosynthesis protein ThiC
BI01636	1481353	1481679	-	hypothetical protein
BI01637	1481820	1482626	+	phosphomethylpyrimidine kinase
BI01638	1482680	1483054	+	COG0011: Uncharacterized ACR
BI01639	1483563	1484939	+	permease, putative
BI02235t	1485571	1485978	+	conserved hypothetical protein
BI01640	1486039	1487433	+	Serpin (serine protease inhibitor) superfamily
BI01641	1487717	1488517	+	transcriptional regulator, LacI family, putative
BI01642	1488728	1490068	+	sucrose transport protein
BI01643	1490082	1491635	+	sucrose-6-phosphate hydrolase, putative
BI01644	1491833	1492612	+	ABC transporter, permease protein, cysTW family, putative
BI01645	1492927	1493943	+	pyrimidine precursor biosynthesis enzyme, putative
BI02246t	1494070	1495254	+	inosine-uridine preferring nucleoside hydrolase
BI01646	1495416	1496207	-	undecaprenyl diphosphate synthase
BI01647	1496207	1496923	-	DNA repair protein RecO
BI01648	1496975	1498684	-	conserved hypothetical protein
BI01649	1498808	1500028	-	1-hydroxy-2-methyl-2-(E)-butenyl 4-diphosphate synthase
BI01650	1500028	1501215	-	1-deoxy-D-xylulose 5-phosphate reductoisomerase
BI01651	1501215	1502915	-	conserved hypothetical protein
BI01652	1503387	1503809	-	conserved hypothetical protein
BI01653	1503919	1504797	-	PDZ domain family protein
BI01654	1505129	1506760	+	conserved hypothetical protein
BI01655	1506836	1508407	-	ATP-dependent DNA helicase PcrA
BI01656	1508553	1510205	+	conserved hypothetical protein
BI01657	1510357	1510578	+	putative ATP-binding protein
BI01658	1510645	1511535	-	PHP domain N-terminal region family
BI01659	1511673	1512407	+	narrowly conserved hypothetical transmembrane protein
BI01660	1512419	1513309	-	diaminopimelate epimerase
BI01661	1513417	1514208	+	glutamate racemase
BI01662	1514340	1515182	+	Patatin family

BI01663	1515255	1516151	-	Unknown
BI01664	1516314	1516580	-	trans-sulfuration enzyme
BI00087g	1516749	1517024	-	ABC transporter, ATP-binding protein, putative
BI00086g	1517139	1517573	+	conserved hypothetical protein in upf0074
BI01665	1517692	1517940	-	conserved hypothetical protein
BI01666	1518187	1519422	-	cystathionine beta-lyase
BI01667	1519661	1520560	-	glutamine ABC transporter, periplasmic glutamine-binding protein (glnH)
BI01668	1520629	1521417	-	amino acid ABC transporter, ATP-binding protein
BI01669	1521413	1521952	-	amino acid ABC transporter, permease protein SP0710 [imported]
BI01670	1522074	1522730	-	amino acid ABC transporter, permease protein
BI01671	1522793	1523605	+	hypothetical Phospholipase/Carboxylesterase
BI01672	1523620	1525872	-	Tn916, tetracycline resistance protein, putative
BI01673	1526091	1526723	+	DNA polymerase III, epsilon subunit
BI01674	1526731	1527318	-	guanylate kinase
BI01675	1527501	1528418	-	orotidine 5'-phosphate decarboxylase, putative
BI01676	1528421	1531801	-	carbamoyl-phosphate synthase, large subunit
BI01677	1531806	1533176	-	carbamoyl-phosphate synthase, small subunit
BI01678	1533219	1533788	-	transcription antitermination factor NusB
BI01679	1533846	1534154	-	Elongation factor P (EF-P)
BI01680	1534514	1535248	+	Unknown, putative
BI01681	1535248	1536033	+	conserved hypothetical protein TIGR00245
BI01682	1536066	1536770	-	Unknown
BI01683	1536878	1539436	-	hypothetical EAL domain
BI01684	1539444	1540751	-	Probable hydrolase transmembrane protein
BI01685	1541332	1543257	+	glycosyltransferase
BI01686	1543387	1543551	-	hypothetical protein
BI01687	1543710	1544600	-	3-hydroxyacyl-CoA dehydrogenase
BI01688	1544959	1546782	-	alpha-xylosidase
BI01689	1546897	1547199	-	hypothetical COG1653: ABC-type sugar transport system, periplasmic component
BI01690	1547359	1549491	-	possible beta-hexosaminidase A
BI01691	1549605	1550417	-	ABC transporter, permease protein, MalFG family
BI01692	1551035	1551862	+	conserved hypothetical protein
BI01693	1552142	1553254	-	mrp
BI01694	1553434	1556193	-	DNA ligase, NAD-dependent
BI01695	1556261	1559881	-	conserved hypothetical protein
BI01696	1560102	1562237	+	membrane protein, putative
BI01697	1562555	1564141	+	hypothetical protein Blon021196
BI01698	1564204	1564977	-	ABC transporter, ATP-binding protein, putative
BI01699	1565037	1566299	-	aminotransferase, class I, putative
BI01700	1566573	1567337	-	ROK family protein
BI01701	1567583	1568365	+	Nitroreductase family protein
BI01702	1568413	1569423	-	probable glycosyltransferase
BI01703	1569675	1570325	+	conserved hypothetical protein
BI01704	1570459	1572888	+	ABC transporter, ATP-binding protein, putative
BI01705	1572963	1573265	+	Predicted RNA-binding protein containing KH domain
BI01706	1573370	1573732	-	conserved hypothetical protein
BI01707	1573842	1574456	+	hypothetical TM2 domain
BI01708	1574885	1575301	+	hypothetical protein Blon021592

BI01709	1575432	1576415	-	D-isomer specific 2-hydroxyacid dehydrogenase family protein
BI01710	1576714	1578168	+	drug resistance transporter, EmrB/QacA family, putative
BI01711	1578399	1579418	-	ribose ABC transporter, permease protein VCA0129 [imported], putative
BI01712	1579418	1580485	-	ribose ABC transporter, permease protein VCA0129 [imported], putative
BI01713	1580490	1582028	-	ATP binding protein of ABC transporter
BI01714	1582172	1583152	-	ribose ABC transporter, periplasmic D-ribose-binding protein
BI01715	1583472	1585199	-	lipoprotein, putative
BI01716	1585199	1586752	-	sensor histidine kinase MtrB
BI01717	1586893	1587837	-	hypothetical Response regulator receiver domain
BI01718	1587674	1589005	-	conserved ATP/GTP binding protein
BI01719	1589136	1591535	-	COG0513:Superfamily II DNA and RNA helicases
BI01720	1591837	1592907	-	Domain of unknown function (DUF344) family
BI02350t	1592976	1593215	-	conserved hypothetical protein
BI01721	1593208	1593801	-	COG0737: 5'-nucleotidase/2',3'-cyclic phosphodiesterase and related esterases
BI01722	1593841	1595364	-	hypothetical secreted protein with probable acid phosphatase domain
BI01723	1595471	1596568	-	glutamine ABC transporter, glutamine-binding protein/permease protein, putative
BI01724	1596577	1597251	-	glutamine ABC transporter, permease protein
BI01725	1597254	1598090	-	amino acid ABC transporter, amino acid-binding protein, putative
BI01726	1598125	1598964	-	amino acid ABC transporter, ATP-binding protein
BI01727	1599401	1600468	+	conserved hypothetical protein
BI01728	1600932	1602728	-	aspartyl-tRNA synthetase
BI01729	1602767	1604107	-	histidyl-tRNA synthetase
BI01730	1604264	1605721	+	conserved hypothetical protein
BI01731	1605933	1607723	-	5'-nucleotidase family protein, putative
BI01732	1607898	1608653	-	creatinine amidohydrolase, creatininase
BI01733	1608742	1610115	-	proline/betaine transporter
BI01734	1610158	1610328	+	hypothetical protein
BI01735	1610308	1611378	-	hypothetical protein weakly similar to putative transcriptional regulator from Streptomyces
BI01736	1611950	1613266	+	N-acyl-D-amino-acid deacylase family protein, putative
BI01737	1613452	1616058	-	ATP-dependent Clp protease, ATP-binding subunit ClpC
BI01738	1616208	1617170	+	demannu, putative
BI01739	1617288	1618208	-	hypothetical protein Blon021510
BI01740	1618484	1618870	-	cspB
BI01741	1618943	1620931	-	sensor histidine kinase
BI01742	1620965	1621738	-	DNA-binding response regulator
BI01743	1621689	1622492	-	conserved hypothetical protein
BI01744	1622567	1622854	+	conserved hypothetical protein
BI01745	1622957	1624579	-	chaperone
BI01746	1624820	1625056	-	cold-shock domain family protein
BI01747	1625289	1625870	-	hypothetical protein Blon020592
BI01748	1626163	1626771	+	uracil-DNA glycosylase

BI01749	1626814	1627890	+	ATPase, MoxR family
BI01750	1628022	1628837	+	Protein of unknown function family
BI01751	1628840	1629388	+	conserved hypothetical protein
BI01752	1629388	1630443	+	conserved hypothetical protein
BI01753	1630443	1631471	+	conserved hypothetical protein
BI01754	1631444	1632070	+	platelet binding protein GspB, putative
BI01755	1632316	1632660	+	conserved hypothetical protein
BI01756	1632660	1634261	+	conserved hypothetical protein
BI01757	1634531	1634893	+	conserved hypothetical protein
BI01758	1635034	1635672	-	hypothetical membrane protein with unknown function
BI01759	1635805	1637238	+	adenylosuccinate lyase VC1126 [imported]
BI01760	1637373	1639931	+	narrowly conserved hypothetical membrane protein
BI01761	1640080	1640358	+	DNA-binding protein HU
BI01762	1640480	1641937	-	possible DNA-binding protein
BI01763	1641940	1642203	-	hypothetical Protein of unknown function (DUF797)
BI01764	1642234	1643133	-	possible inositol monophosphatase
BI01765	1643139	1644803	-	hypothetical proteasome-associated protein
BI01766	1644828	1646390	-	cell division control protein 48, AAA family
BI01767	1646454	1647149	-	DedA family protein
BI01768	1647410	1647919	+	phosphoserine phosphatase SerB
BI01769	1648166	1650271	+	primosomal protein N
BI01770	1650333	1651034	+	possible alpha beta hydrolase
BI01771	1651061	1652044	+	methionyl-tRNA formyltransferase
BI01772	1652142	1653908	-	dihydroxy-acid dehydratase
BI01773	1654203	1654484	+	DNA-directed RNA polymerase, omega subunit
BI01774	1654765	1655982	+	S-adenosylmethionine synthetase
BI02420t	1656352	1657425	+	hypothetical protein CV1232

The Open reading frames (ORF) listed in Table 1 are defined by their position in the genomic sequence of SEQ ID No. 1. For example BI00001 is defined by the nucleotide sequence of base numbers 1667321 and 1667608 (inclusive) of SEQ ID No. 1.

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Examples

The following examples further describe and demonstrate embodiments within the scope of the invention. The examples are given solely for the purpose of illustration and are not to be construed as limitations of the present invention, as many variations thereof are possible without departing from the spirit and scope of the invention.

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Example 1 - Isolation of *Bifidobacterium longum* biotype infantis UCC 35624

Appendices and sections of the large and small intestine of the human G.I.T., obtained during reconstructive surgery, were screened for probiotic bacterial strains. All samples were stored immediately after surgery at -80°C in sterile containers. Frozen tissues were thawed,

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weighed and placed in cysteinated (0.05%) one quarter strength Ringers' solution. Each sample was gently shaken to remove loosely adhering microorganisms. Following transfer to a second volume of Ringers' solution, the sample was vortexed for 7 min to remove tightly adhering bacteria. In order to isolate tissue embedded bacteria, samples were also homogenised in a Braun blender. The solutions were serially diluted and spread-plated (100µl) on to the following agar media: RCM (reinforced clostridial media) and RCM adjusted to pH 5.5 using acetic acid; TPY (trypticase, peptone and yeast extract), Chevalier, P. *et al.* (1990). MRS (deMann, Rogosa and Sharpe); ROG (acetate medium (SL) of Rogosa); LLA (Liver-lactose agar of Lapiere); BHI (brain heart infusion agar); LBS (Lactobacillus selective agar) and TSAYE (tryptone soya agar supplemented with 0.6% yeast extract). All agar media was supplied by Oxoid Chemicals with the exception of TPY agar. Plates were incubated in anaerobic jars (BBL, Oxoid) using CO₂ generating kits (Anaerocult A, Merck) for 2-5 days at 37°C.

Gram positive, catalase negative rod-shaped or bifurcated/pleomorphic bacteria isolates were streaked for purity on to complex non-selective media (TPY). Isolates were routinely cultivated in TPY medium unless otherwise stated at 37°C under anaerobic conditions. Presumptive Bifidobacteria species were stocked in 40% glycerol and stored at -20° and -80°C.

Approximately fifteen hundred catalase negative bacterial isolates from different samples were chosen and characterised in terms of their Gram reaction, cell size and morphology, growth at 15°C and 45°C and fermentation end-products from glucose. Greater than sixty percent of the isolates tested were Gram positive, homofermentative cocci arranged either in tetrads, chains or bunches. Eighteen percent of the isolates were Gram negative rods and heterofermentative coccobacilli.

The remaining isolates (twenty-two percent) were predominantly homofermentative coccobacilli. Thirty eight strains were characterised in more detail. All thirty eight isolates tested negative both for nitrate reduction and production of indole from tryptophan.

Bifidobacterium longum biotype infantis strain 35624 was chosen for full genome sequencing from this group of strains due to its proven anti-inflammatory activity in murine models of colitis (McCarthy et.al., 2004) and its immunomodulatory effects following oral consumption by Irritable Bowel Syndrome (IBS) patients (O'Mahony *et al.*, 2005).

Example 2- Sequencing the genome of *Bifidobacterium longum infantis* 35624

The *Bifidobacterium longum* biotype infantis strain 35624 genome sequence was determined using a whole shotgun approach. For this purpose two libraries were constructed: a small insert library (insert size ranging between 2 and 4 kb) employing pGEM-T easy vector

(Promega) and a large insert (insert size ranging between 40 and 45 kb) cosmid library (Epicentre Technologies). Sequence sampling from these banks generated just over 26,828,618 base pairs of useable sequence data, which represented about 11.9-fold coverage of the *Bifidobacterium longum* biotype infantis strain 35624 genome (performed by MWG-Biotech, Ebersberg, Germany). Sequence reads were assembled using Phrap (Green) into 11 contigs. Gap closure and quality improvement of the initial sequence assembly was achieved by additional primer-directed sequencing using pre-identified clones from the libraries resulting in a single contig, which represented a circular chromosome of 2,264,374 bp long. Based on the final consensus quality scores, we estimate an overall error rate of <1 per 4×10^5 bases

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Example 3 - Analysing the genome of *Bifidobacterium longum* biotype infantis 35624

Protein-encoding open reading frames (ORFs) were predicted using a combination of the methods Glimmer (Delcher *et al.*, 1999b; Salzberg *et al.*, 1998) and GeneBuilder (Internally developed software), as well as comparative analysis involving BLASTX (Altschul *et al.*, 1997)

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Results from the gene finder programs were manually combined, and preliminary identification of ORFs was made on the basis of BLASTP (Altschul *et al.*, 1997) analysis against a non-redundant protein database provided by the National Centre for Biotechnology Information (Wheeler *et al.*, 2005). Artemis (Rutherford *et al.*, 2000), was used to inspect the identified ORFs and its associated BLASTP results. A manual inspection was performed in order to verify or, if necessary, redefine the start and stop of each predicted coding region. Annotation made use of the GC frame plot feature of Artemis, ribosome-binding site information obtained from RBSfinder (Suzek *et al.*, 2001), alignments with similar ORFs from other organisms and G+C content analysis.

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Example 4- Identifying unique genes in the genome of *Bifidobacterium longum* infantis 35624

Assignment of protein function to predicted coding regions of the *Bifidobacterium longum* biotype infantis strain 35624 genome was performed using internally developed software and manual inspection. Primary functional classification of the *Bifidobacterium longum* biotype infantis strain 35624 gene products was performed according to the Riley rules (Riley, 1998a; Riley, 1993). The COG assignment was performed using XUGNITOR (Tatusov.). HMMER (Eddy,) was used to assign PFAM (Bateman *et al.*, 2002) classification to the predicted proteins. TMHMM (Krogh *et al.*, 2001) was used to predict transmembrane sequences, and SignalP (Bendtsen *et al.*, 2004) was used for the prediction of signal peptides. Ribosomal RNA genes were detected on the basis of BLASTN searches and annotated manually. Transfer RNA genes

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were identified using tRNAscan-SE (Lowe and Eddy, 1997). Miscellaneous-coding RNAs were identified using the Rfam database (Griffiths-Jones *et al.*, 2005) utilizing the INFERNAL software package (Eddy, 2002). Insertion sequence elements were identified using Repeatfinder (Volfovsky *et al.*, 2001), Reputer (Kurtz & Schleiermacher, 1999) and BLAST (Altschul *et al.*, 1990) and annotated manually. IS families were assigned using ISFinder (<http://www-is.biotoul.fr/is.html>). Carbohydrate-active enzymes were identified based on similarity to the carbohydrate-active enzyme (CAZy) database entries (Coutinho & Henrissat, 1999), and COG and PFAM classes annotated with carbohydrate enzyme activity. Transporter classification was performed according to the TC-DB scheme (Busch & Saier, 2002).

10 We identified a region from base numbers 44824 to 472245 (inclusive) of SEQ ID No. 1 that we designated exopolysaccharide (EPS) region 1 (SEQ ID No. 2). The EPS region 1 encodes the following genes:

Table 2 – Open reading frames of EPS region 1 of the UCC 35624 genome

Gene ID	Strand	Description	DNA sequence	Protein sequence
BI00778	+	glycosyl transferase CpsE	SEQ. ID No. 93	SEQ. ID No. 133
BI00779	+	COG0840: Methyl-accepting chemotaxis protein	SEQ. ID No. 94	SEQ. ID No. 134
BI00780	+	possible Etk-like tyrosine kinase involved in Eps biosynthesis	SEQ. ID No. 95	SEQ. ID No. 135
BI00781	+	hypothetical glycosyl transferase, group 1 family protein	SEQ. ID No. 96	SEQ. ID No. 136
BI00782	+	putative glycosyltransferase protein	SEQ. ID No. 97	SEQ. ID No. 137
BI00783	+	NAD dependent epimerase/dehydratase family protein	SEQ. ID No. 98	SEQ. ID No. 138
BI00784	+	UDP-glucose 6-dehydrogenase	SEQ. ID No. 99	SEQ. ID No. 139
BI00785	+	hypothetical glycosyl transferase, group 1 family protein	SEQ. ID No. 100	SEQ. ID No. 140
BI00786	+	hypothetical Eps11I	SEQ. ID No. 101	SEQ. ID No. 141
BI00787	+	hypothetical Bacterial transferase hexapeptide (three repeats)	SEQ. ID No. 102	SEQ. ID No. 142
BI00788	+	hypothetical Capsular polysaccharide synthesis protein	SEQ. ID No. 103	SEQ. ID No. 143
BI00789	+	hypothetical protein	SEQ. ID No. 104	SEQ. ID No. 144
BI00790	+	Eps9K	SEQ. ID No. 105	SEQ. ID No. 145
BI00791	+	hypothetical Polysaccharide biosynthesis protein	SEQ. ID No. 106	SEQ. ID No. 146
BI00792	+	hypothetical Bacterial transferase hexapeptide (three repeats)	SEQ. ID No. 107	SEQ. ID No. 147
BI00793	-	NAD-dependent epimerase/dehydratase family protein, putative	SEQ. ID No. 108	SEQ. ID No. 148

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BI00794	-	transposase, degenerate	SEQ. ID No. 109	SEQ. ID No. 149
BI00795	-	hypothetical COG2963: Transposase and inactivated derivatives	SEQ. ID No. 110	SEQ. ID No. 150
BI00796	+	dTDP-glucose 4,6-dehydratase	SEQ. ID No. 111	SEQ. ID No. 151
BI00797	+	dTDP-4-dehydrorhamnose 3,5-epimerase	SEQ. ID No. 112	SEQ. ID No. 152
BI00798	+	glucose-1-phosphate thymidyltransferase	SEQ. ID No. 113	SEQ. ID No. 153

We also identified a region from base numbers 2071426 to 2097099 (inclusive) of SEQ ID No. 1 that we designated EPS region 2 (SEQ ID No. 3). The EPS region 2 encodes the following genes:

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Table 3 – Open reading frames of EPS region 2 of the UCC 35624 genome

Gene ID	Strand	Description	DNA sequence	Protein sequence
BI00319	+	dTDP-glucose 4,6-dehydratase	SEQ. ID No. 114	SEQ. ID No. 154
BI00320	+	conserved hypothetical protein	SEQ. ID No. 115	SEQ. ID No. 155
BI00321	+	conserved hypothetical protein	SEQ. ID No. 116	SEQ. ID No. 156
BI00423t	+	conserved putative transposase	SEQ. ID No. 117	SEQ. ID No. 157
BI00322	-	IS1533, OrfB	SEQ. ID No. 118	SEQ. ID No. 158
BI00323	-	transposase (25) BH3998 [imported], putative	SEQ. ID No. 119	SEQ. ID No. 159
BI00324	-	glycosyltransferase, putative	SEQ. ID No. 120	SEQ. ID No. 160
BI00325	-	conserved sialic acid-specific 9-O-acetylerase	SEQ. ID No. 121	SEQ. ID No. 161
BI00326	+	hypothetical Acyltransferase family	SEQ. ID No. 122	SEQ. ID No. 162
BI00327	-	conserved> hypothetical membrane protein with unknown function	SEQ. ID No. 123	SEQ. ID No. 163
BI00328	-	hypothetical Glycosyl transferase family 8	SEQ. ID No. 124	SEQ. ID No. 164
BI00329	-	hypothetical glycosyl transferase, group 2 family protein	SEQ. ID No. 125	SEQ. ID No. 165
BI00330	-	polysaccharide ABC transporter, ATP-binding protein	SEQ. ID No. 126	SEQ. ID No. 166
BI00331	-	polysaccharide ABC transporter, permease protein, putative	SEQ. ID No. 127	SEQ. ID No. 167
BI00332	+	hypothetical Glycosyl transferase family 8	SEQ. ID No. 128	SEQ. ID No. 168
BI00333	-	UDP-glucose 6-dehydrogenase	SEQ. ID No. 129	SEQ. ID No. 169
BI00334	+	hypothetical NAD dependent epimerase/dehydratase family	SEQ. ID No. 130	SEQ. ID No. 170
BI00335	-	membrane protein, putative	SEQ. ID No. 131	SEQ. ID No. 171
BI00336	-	conserved hypothetical protein	SEQ. ID No. 132	SEQ. ID No. 172

Example 5 – Isolation and screening of EPS-producing Bifidobacterial strain from fecal samples

10 Fecal Sample Preparation

Fecal samples were collected by the subjects using a Kendall precision commode specimen collection system. The collected samples were stored chilled in a cold pack prior to sample processing. Only samples that are less than twenty four hours old were used in the evaluations.

5 A 10.0 gm sample of mixed fecal material was placed into a plastic stomaching bag containing 90 ml of saline. The suspension was stomached for 2 minutes. The suspension was filtered through a gauze pad contained within a disposable funnel. Following the filtration, 45 ml of the filtered fecal homogenate was transferred to a 50 ml disposable centrifuge tube. This fecal suspension was further used for DNA extraction or for bacterial isolation.

10 Screening Fecal Samples Using Three TaqMan Real-Time PCR Assays.

Fecal Sample DNA Preparation. A 2.0 ml aliquot of the fecal homogenate was pelleted using a microcentrifuge. The pellets were resuspended in 20 mg/ml lysozyme, for 2 hours at 37°C. DNA was extracted using a QIAamp DNA Stool Mini Kit (Qiagen). The DNA concentration
15 was measured by Pico Green assay (Molecular Probes). Once the DNA concentration was measured, the DNA was stored at 4°C.

TaqMan Real-Time PCR Reactions. The test samples were diluted to a concentration of DNA of 2 ng/ul so that 5 µl contained a total of 10 ng DNA. Samples were assayed by a total of three
20 separate assays.

The following reaction mix was made:

Water	15.75µl	
25 10 µM forward primer	1.5µl	(300 nM final concentration)
10 µM reverse primer	1.5µl	(300 nM final concentration)
10 µM TaqMan probe	1µl	(200 nM final concentration)
BSA (20 mg/ml)	0.25µl	(0.1ug/ml final concentration)
TaqMan Universal Master Mix	25µl	

30 A bulk mix was made for the number of samples to be assayed. A 45µl aliquot was dispensed into each well of a 96 well microtitre plate, then 5µl DNA was added to each well. The plate was spun briefly, and placed into the thermocycler (ABI 7900 HT). The standard TaqMan thermocycling protocol was used.

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TaqMan RT-PCR Program. The standard TaqMan quantitative PCR thermocycling protocol is as follows:

- 5 Step 1: 95°C for 10 minutes (to activate the AmpliTaq Gold polymerase)
 Step 2: 95°C for 15 seconds (the denaturation step)
 Step 3: 60°C for 60 seconds (the priming/polymerization step)
 Steps 2 and 3 are repeated 40 times. Fluorescent data is collected at step 3.

- 10 **Primers and Probes for Three TaqMan RT-PCR assays.** The fecal sample DNAs were screened using a EPS gene-specific assay and two *B. infantis* 35624 Unknown gene-specific assays (Unknown genes UNK1 and UNK2). The specific genes used and their TaqMan primer sets are shown in Table 4 below.

15 **Table 4 – UCC 35624 Primer set for TaqMan PCR**

Target Gene	Name	Sequence 5'-3'	Genome start	Genome end	TaqMan Probe label
BI01615 (UNK-1)	UNK1-F1	CCATGAGCGGTTTCACGAA (SEQ ID No. 4)	1451446	1451428	5' 6-FAM 3' NFQ-MG
	UNK1-R1	TTGGACGGTGCCTGTGATTA (SEQ ID No. 5)	1451393	1451412	
	UNK1-MGB1	CGGGCAATCAAC (SEQ ID No. 6)	1451426	1451415	
BI02420t (UNK-2)	UNK2-F1	ACTTGACGTACCGTTTTGAGATTTC (SEQ ID No. 7)	1656479	1656503	5' 6-FAM 3' NFQ-MGB
	UNK2-R1	CTAAGCATGGCAAGGCTGATAGT (SEQ ID No. 8)	1656562	1656540	
	UNK2-MGB1	TGCGACCAACACGC (SEQ ID No. 9)	1656525	1656538	
BI00783 (EPS)	EPS-F1	GGGTCCAATAAGAAGGTTCCATATT (SEQ ID No. 10)	456491	456515	5' 6-FAM 3' TAMR
	EPS-R1	GCATGTGCCAACAGCTCATC (SEQ ID No. 11)	456591	456572	
	EPS-TAMRA	CGGATGACAAGGTAGATAATCCAGTGAGCCTATAC (SEQ ID No. 12)	456519	456553	

The fecal samples which showed high DNA concentration by the *B. infantis* 35624 EPS gene-specific assay, but negative reactions by using *B. infantis* 35624 Unknown gene-specific assays, were further used for the isolation of potential EPS-producing bacteria.

5 Example 6 - Isolation and Characterization of BL1207 from Fecal Samples.

One milliliter of bacterial suspension (see Example 5 above) was transferred to 9.0 ml of sterile phosphate-buffered saline which constituted the 10^{-1} dilution. One milliliter of this 10^{-1} dilution was transferred to 9.0 ml of sterile phosphate-buffered saline which was the 10^{-2} dilution. This process was continued until the 10^{-10} dilution was prepared. Then, 0.1 ml of each
10 dilution was plated onto the surfaces of Reinforced Clostridial Agar (RCA) plates (BD or equivalent) and Lactobacillus Man-Rogosa Sharpe agar (MRSA) plates (BD or equivalent). The plates were incubated under anaerobic condition (COY anaerobic Chamber) at $33^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 48-72 hours.

Following incubation, single colonies (a total of approximately 100 colonies) were
15 picked from RCA and MRSA plates and further streaked on new plates for isolate purification. The plates with the streaked colonies were incubated under anaerobic conditions (COY anaerobic Chamber) at $33^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 48 to 72 hours. After incubation, the pure colonies observed on plates were then submitted for DNA extraction.

20 Screening fecal isolates using three TaqMan Real-Time PCR assays

The bacterial DNA was extracted using the PremanTM Ultra Sample Preparation Reagent and Protocol (Applied Biosystems). The DNA was further analyzed using three TaqMan RT-PCR assays (EPS gene-specific assay [EPS-1] and two *B. infantis* 35624 Unknown gene-specific assays [UNK1 and UNK2] as described above in Example 5. Only one isolate showed *B.*
25 *infantis* 35624 EPS gene-specific assay positive, but *B. infantis* 35624 Unknown gene-specific assays-negative. This isolate was further identified using 16S rDNA sequencing.

Identification of potential EPS-producing strain by 16S rDNA sequencing.

The 16S rRNA gene fragment was amplified and sequenced using ABI Full Gene PCR
30 kit (Applied Biosystems, Foster City, CA).

(1). 16S rRNA Gene amplification:

PCR amplification was carried out on a GeneAmp PCR System 9700 thermal cycler with the following program:

Initial Hold: 95°C for 10 minutes

30Cycles: 95°C for 30 seconds (Denaturing)
60 °C for 30 seconds (Annealing)
72°C for 45 seconds (Extension)

Final Extension: 72 °C for 10 minutes

10 (2). 16S rRNA Gene sequencing:

Sequencing was further performed on the thermal cycler using the following program:

25 Cycles: 96 °C for 10 seconds (Denaturing)
50 °C for 5 seconds (Annealing)
60 °C for 4 minutes (Extension)

Final step Hold at 4°C

The sequencing PCR product was further purified using DyeEX™ 2.0 spin kit and
sequenced using 3130 xl Genetic Analyzer (Applied Biosystems, Foster City, CA).

(3) Sequence data analysis:

Comparison of the consensus sequences with GenBank sequences was done by using Basic Local Alignment Search Tool (BLAST). The GenBank search indicated that the *B. infantis* 35624 EPS gene-specific positive, but *B. infantis* 35624 Unknown gene-specific negative strain is *Bifidobacterium longum*. This strain is designated BL1207.

Example 7 - Isolation and screening of EPS-expressing Bifidobacterial longum strains

Isolation of bacterial strains

Bacteria were isolated from bowel tissue and/or fecal samples using the methodology described in Example 1 above. In particular, *Bifidobacterium longum* strain AH121a was isolated from feline bowel tissue and *Bifidobacterium longum* strain AH1714 was isolated from colonic biopsy tissue from healthy human subjects.

EPS gene cluster screen

Bacterial strains were screened for the presence of genes from EPS cluster 1 (Table 2 above) and EPS cluster 2 (Table 3 above) using the primers listed in Tables 5 and 6 below. Briefly, the following methodology was used for the PCR EPS cluster gene screen:

5

10ml Modified Rogosa broth media (+ 0.05% cysteine) was inoculated aseptically with a freshly grown colony of the bacterial strain and incubated anaerobically at 37°C until turbid (about 16 to about 24 hours). The broth cultures were centrifuged and DNA was isolated from the resultant pellet using a SigmaTM extraction procedure. A nanodrop was used to ascertain the concentration of DNA in the sample and samples were diluted using DEPC water to a final concentration of 50ng/μl DNA per sample. The template DNA samples were used in individual PCR reactions with the primer sets listed in Tables 5 and 6 below under the following conditions:

10

Step	Temp (°C)	Time (sec)	
1	95	240	
2	95	45	
3	60	45	
4	72	45	repeat steps 2 to 4, 25 times
5	4	hold	

15

The primers were specifically designed to amplify a PCR product of approximately 500 base pair for the 40 genes of EPS clusters 1 and 2. PCR products were visualised following agarose gel electrophoresis with an appropriate DNA ladder for reference sizing. The presence (YES) or absence (NO) of a 500 bp PCR product is indicated in Tables 7 and 8 below.

20

Table 5 – Primers for screening bacterial strains for the presence of genes from EPS cluster 1

Gene ID	Primer name	LRFR	Sequence	SEQ ID NO.
BI00778	1.01	L	tat gtt gcc ggc att tat ca	SEQ ID No. 13
BI00778	1.01	R	tgc gcg ttc atg tca ata at	SEQ ID No. 14
BI00779	1.02	L	ggc gta gca agt tca agg ag	SEQ ID No. 15
BI00779	1.02	R	aat aac cgc tgc agg aac ac	SEQ ID No. 16
BI00780	1.03	L	gtg cag gac ggt aat gga gt	SEQ ID No. 17
BI00780	1.03	R	gct tgc ggt ctg gat cat ta	SEQ ID No. 18
BI00781	1.04	L	tgc tga caa gtg gag tct gg	SEQ ID No. 19
BI00781	1.04	R	cca cgt cta cga gca act ca	SEQ ID No. 20

BI00782	1.05	L	gaa agc gaa gag tgg tct gg	SEQ ID No. 21
BI00782	1.05	R	ccg gct gat ttg atg aga tt	SEQ ID No. 22
BI00783	1.06	L	tgc cgc tgt act ggt cac	SEQ ID No. 23
BI00783	1.06	R	gca tgt gcc aac agc tca	SEQ ID No. 24
BI00784	1.07	L	cca aca cgt atc tgg cac tg	SEQ ID No. 25
BI00784	1.07	R	tcg gag cca aag aag gta ga	SEQ ID No. 26
BI00785	1.08	L	ata ccg cgt atg ctt tgg ac	SEQ ID No. 27
BI00785	1.08	R	aaa cgg taa cca ctc gct tg	SEQ ID No. 28
BI00786	1.09	L	atg gga tcg atg cat gaa at	SEQ ID No. 29
BI00786	1.09	R	ttc tcg gca ata aac cgt tc	SEQ ID No. 30
BI00787	1.10	L	cca gcg gtt att tcg ttg tt	SEQ ID No. 31
BI00787	1.10	R	ggg ggc atg atc ctt atg ct	SEQ ID No. 32
BI00788	1.11	L	gct atc ttc acc gca ttg gt	SEQ ID No. 33
BI00788	1.11	R	cca gtc agg gaa ggt cac at	SEQ ID No. 34
BI00789	1.12	L	tga aat aca cgc aac ccg ta	SEQ ID No. 35
BI00789	1.12	R	aatgcgtcaaaaccgatacc	SEQ ID No. 36
BI00790	1.13	L	gga aag caa tga gga agc tg	SEQ ID No. 37
BI00790	1.13	R	gat ttg atg caa agc aag ca	SEQ ID No. 38
BI00791	1.14	L	gtg agt acc gtt tcc gca at	SEQ ID No. 39
BI00791	1.14	R	ttc ctt ggt tcc cgt gat ag	SEQ ID No. 40
BI00792	1.15	L	gct ggg att ttg gaa gtg aa	SEQ ID No. 41
BI00792	1.15	R	tgt tac ccc cgg cat aat aa	SEQ ID No. 42
BI00793	1.16	L	acc ggt aac gtt cag att gc	SEQ ID No. 43
BI00793	1.16	R	gca ata ccg cct tga cct ta	SEQ ID No. 44
BI00794	1.17	L	ttg tac cac cac acg tac cg	SEQ ID No. 45
BI00794	1.17	R	cgc gag ttc aat ggc tat g	SEQ ID No. 46
BI00795	1.18	L	aca tcg acc tcc atc tcc ag	SEQ ID No. 47
BI00795	1.18	R	ata cgt aac agc ggc tcc ac	SEQ ID No. 48
BI00796	1.19	L	aag tac gat gtg cgc tac ca	SEQ ID No. 49
BI00796	1.19	R	cat cac ggt cag gat gtc ac	SEQ ID No. 50
BI00797	1.20	L	cga ata cac gga cat caa cg	SEQ ID No. 51
BI00797	1.20	R	gag aat cga gca gct gga ac	SEQ ID No. 52
BI00798	1.21	L	tgg gag agg agt tca tcg ac	SEQ ID No. 53
BI00798	1.21	R	gta tcc agc cat gcg taa cc	SEQ ID No. 54

Table 6 – Primers for screening bacterial strains for the presence of genes from EPS cluster**2**

Gene ID	Primer name	LRFR	Sequence	SEQ ID NO.
BI00319	2.01	L	acg gac tca aaa cca cca tc	SEQ ID No. 55
BI00319	2.01	R	acc ctg ctt ccg gta ctt tt	SEQ ID No. 56
BI00320	2.02	L	gcc tac gca aga cct tat gc	SEQ ID No. 57
BI00320	2.02	R	cgt tat acg cgt gct tga ga	SEQ ID No. 58
BI00321	2.03	L	tgg aac gca ata ttc aac ga	SEQ ID No. 59
BI00321	2.03	R	cca agt atg gct cca cga at	SEQ ID No. 60
BI00423t	2.04	L	acg cct gtc tat ggt tgg aa	SEQ ID No. 61
BI00423t	2.04	R	cgg tag gac tcg ttc tcg tc	SEQ ID No. 62
BI00322	2.05	L	tcg agg ttc gag gtg aag at	SEQ ID No. 63

BI00322	2.05	R	cct gtt cga gaa gga gaa cg	SEQ ID No. 64
BI00323	2.06	L	atg gaa gca tgt ggt cct tc	SEQ ID No. 65
BI00323	2.06	R	att tcc tgg tgg tgt cgt tc	SEQ ID No. 66
BI00324	2.07	L	atg gcg aaa ctg ttg gac tc	SEQ ID No. 67
BI00324	2.07	R	gct acc gtg cct tct cat tc	SEQ ID No. 68
BI00325	2.08	L	gcc gaa tcg ctt ttg aaa ta	SEQ ID No. 69
BI00325	2.08	R	aaa tcc tca tcg ggg aaa ac	SEQ ID No. 70
BI00326	2.09	L	gtt tat ttt cgc cgt gcc ta	SEQ ID No. 71
BI00326	2.09	R	aat tcc aat ggc ttt tgc tg	SEQ ID No. 72
BI00327	2.10	L	atg tgc gaa tcc gac ata ca	SEQ ID No. 73
BI00327	2.10	R	tgc tta tct cgt ccc cat tc	SEQ ID No. 74
BI00328	2.11	L	gca aaa tgc ttg gct tct tc	SEQ ID No. 75
BI00328	2.11	R	ctg gat tcc gat gat gct tt	SEQ ID No. 76
BI00329	2.12	L	ctg cac gta tcg gga ttt tt	SEQ ID No. 77
BI00329	2.12	R	ctc ggc aga gga cag gat ag	SEQ ID No. 78
BI00330	2.13	L	gat cat cga cac gca atg ac	SEQ ID No. 79
BI00330	2.13	R	taa ggc cat cct cat caa gg	SEQ ID No. 80
BI00331	2.14	L	tct ggg gaa agc agg tta tg	SEQ ID No. 81
BI00331	2.14	R	ctg tgc ggt acc tgt ttg tg	SEQ ID No. 82
BI00332	2.15	L	aat tac gtc ccg atg ctc ac	SEQ ID No. 83
BI00332	2.15	R	caa tac acc ggc ttg gaa gt	SEQ ID No. 84
BI00333	2.16	L	tgt aga cct tgt cgc tca cg	SEQ ID No. 85
BI00333	2.16	R	gca tcg gtg acg gct ata at	SEQ ID No. 86
BI00334	2.17	L	gtg ctc gac aag ctg acg ta	SEQ ID No. 87
BI00334	2.17	R	gtg ttc cgc ata cca atc g	SEQ ID No. 88
BI00335	2.18	L	ggc gag tgc acc aaa taa at	SEQ ID No. 89
BI00335	2.18	R	cga ttc cgt cta ttg gtt cg	SEQ ID No. 90
BI00336	2.19	L	ata agt ccg gtg gca atc ag	SEQ ID No. 91
BI00336	2.19	R	caa tgg atg ata cgg tgc tg	SEQ ID No. 92

Table 7 – Results of EPS cluster 1 gene screen

Gene ID	Primer set	B. longum 35624	B. longum 1207	B. longum AH121A	B. longum 1714
BI00778	1.01	YES	YES	NO	YES
BI00779	1.02	YES	YES	NO	YES
BI00780	1.03	YES	YES	NO	YES
BI00781	1.04	YES	YES	YES	YES
BI00782	1.05	YES	YES	YES	YES
BI00783	1.06	YES	YES	YES	YES
BI00784	1.07	YES	YES	YES	YES
BI00785	1.08	YES	YES	YES	YES
BI00786	1.09	YES	YES	YES	YES
BI00787	1.10	YES	YES	YES	YES
BI00788	1.11	YES	YES	YES	NO
BI00789	1.12	YES	YES	YES	YES
BI00790	1.13	YES	YES	YES	YES
BI00791	1.14	YES	YES	YES	YES

BI00792	1.15	YES	YES	YES	YES
BI00793	1.16	YES	YES	NO	YES
BI00794	1.17	YES	YES	NO	YES
BI00795	1.18	YES	YES	NO	YES
BI00796	1.19	YES	YES	YES	YES
BI00797	1.20	YES	NO	NO	NO
BI00798	1.21	YES	YES	YES	YES

In which YES indicates the presence and NO indicates the absence of a 500 bp PCR product.

Table 8 – Results of EPS cluster 1 gene screen

Gene ID	Primer set	B. longum 35624	B. longum 1207	B. longum AH121A	B. longum 1714
BI00319	2.01	YES	NO	NO	NO
BI00320	2.02	YES	NO	NO	NO
BI00321	2.03	YES	NO	NO	NO
BI00423t	2.04	YES	NO	NO	NO
BI00322	2.05	YES	NO	NO	NO
BI00323	2.06	YES	NO	NO	NO
BI00324	2.07	YES	NO	NO	NO
BI00325	2.08	YES	NO	NO	NO
BI00326	2.09	YES	NO	NO	NO
BI00327	2.10	YES	NO	NO	NO
BI00328	2.11	YES	NO	NO	NO
BI00329	2.12	YES	NO	NO	NO
BI00330	2.13	YES	NO	NO	NO
BI00331	2.14	YES	NO	NO	NO
BI00332	2.15	YES	NO	NO	NO
BI00333	2.16	YES	NO	NO	NO
BI00334	2.17	YES	NO	NO	NO
BI00335	2.18	YES	YES	NO	YES
BI00336	2.19	YES	YES	YES	YES

In which YES indicates the presence and NO indicates the absence of a 500 bp PCR product.

5

Congo red agar screen

A Congo red agar screen was used to phenotypically screen for EPS expressing bacterial strains. Briefly, 10ml Modified Rogosa broth media (+ 0.05% cysteine) was inoculated aseptically with a freshly grown colony of the bacterial strain and incubated anaerobically at 37°C until turbid (about 16 to about 24 hours). The broth cultures were aseptically streaked onto Congo Red Agar plates and incubated anaerobically at 37°C for 48 hours. It is believed that EPS produced as a by-product of the growth and/or metabolism of certain strains prevents the uptake of the Congo red stain resulting in a cream/white colony morphology. Strains that produce less EPS take up the Congo red stain easily, resulting in a pink/red colony morphology. Strains that do not produce an EPS stain red and look almost transparent in the red agar background.

15

Referring to Figs. 6 to 12, the following colony morphologies were observed:

Table 9 – Colony morphologies from Congo red agar screen

<u>Bacterial Strain</u>	<u>Colony morphology</u>
B. longum 35624 (Fig. 6)	Convex, mucoid, bright white colonies
B. longum AH121A (Fig. 7)	Convex, mucoid, bright white colonies
B. longum AH1714 (Fig. 8)	Convex, mucoid, bright white colonies
B. longum AH0119 (Fig. 9)	Convex, mucoid, pale pink / off white colonies
B. breve UCC2003 (Fig. 10)	Convex, mucoid, pale pink / off white colonies
L. rhamnosus AH308 (Fig. 11)	Flat, semi-mucoid, pale pink / off white colonies
L. salivarius UCC1 (Fig.12)	Flat, non-mucoid, clear/transparent colonies

5

Example 8 - *B. infantis* 35624 and *BL1207* Induce Nearly Identical Cytokine Profiles in PBMCs.

Peripheral blood mononuclear cells (PBMCs) were isolated from fresh human peripheral blood using BD Vacutainer CPT tubes (BD catalog 362761), as per the manufacturer's instructions. PBMCs were washed and resuspended in Dulbecco's MEM (Gibco catalog 10569-010) plus 25 mM HEPES, 10% fetal bovine serum (Sigma catalog F4135), and 1% penicillin/streptomycin (Sigma catalog P0781). 2×10^5 PBMCs (in 200 μ l of DMEM) were plated into each well of a 96-well culture plate.

Bacteria were grown in Difco MRS media and harvested just after entering into stationary phase. All cells were grown under anaerobic conditions at 37°C. Growth curves (OD vs # of live cells) were constructed for each growth condition, and washed cells were normalized by cell number before addition to the PBMCs.

Bacteria (20 μ l in phosphate buffered saline (PBS)) were added to each well of PBMCs to give the total number of bacteria as indicated for each experiment. Three different amounts of bacteria were tested: 1.25×10^7 , 6.25×10^6 , and 3.13×10^6 were added to separate wells of PBMCs. A no-bacteria control also was run. All assays were done in triplicate. After a 2-day incubation at 37°C, the plates were spun at 300 x g, and the supernatants were removed and stored frozen at -80°C until analysis.

Cytokines in the culture supernatants were assayed using a 96-well assay kit from Meso Scale Discovery (Gaithersburg, MD; catalog K15008B-1). Human Interleukin-1 beta (IL-1b), Interleukin 10 (IL-10), Interleukin 12p70 (IL12p70), and Tumor Necrosis Factor alpha (TNFa) were quantitated and reported as picograms per milliliter. Each sample was assayed in duplicate.

25

Figs 2 to 5 show the results of a representative experiment. For each cytokine shown, *B. infantis* 35624 and *BL1207* induce nearly identical levels of cytokines. These levels are very different than the levels induced by the three other Bifidobacterial strains that they were compared to.

5

Example 9 - Bifidobacteria with similar EPS genes and high EPS production induce a significantly elevated IL-10:IL-12 ratio compared to strains lacking these genes.

Peripheral blood mononuclear cells (PBMCs) were isolated from healthy human peripheral blood using BD Vacutainer CPT tubes (BD catalog 362761), as per the manufacturer's

10 instructions. PBMCs were washed and resuspended in Dulbecco's Modified Eagle Medium-GlutamaxTM (Glutamax (Glutamine substitute) + pyruvate + 4.5 g/l glucose (Gibco catalog 10569-010) 10% fetal bovine serum (Sigma catalog F4135), and 1% penicillin/streptomycin (Sigma catalog P0781). PBMCs were incubated (2×10^5 cells per well) in flat-bottomed 96-well plates and 20 μ L of a bacterial suspension (at a concentration of 1×10^7 CFU/mL) was added.

15 PBMCs were co-incubated with bacteria for 48 hours at 37°C / 5% CO₂ in an incubator. After the 2 day incubation period, the plates were centrifuged at 300 x g, and the supernatants were removed and stored frozen at -80°C until analysis. Interleukin-10 (IL-10) and Interleukin-12p70 (IL-12p70) levels in the culture supernatants were quantified using a 96-well assay kit from Meso Scale Discovery (Gaithersburg, MD; catalog K15008B-1)

20 Bacteria were prepared for co-culture experiments in two formats. (a) Freshly grown bacteria were grown in Difco MRS media and harvested just after entering into stationary phase. All cells were grown under anaerobic conditions at 37°C. (b) Bacteria were grown under anaerobic conditions at 37°C in Difco MRS media and harvested just after entering into stationary phase. Freeze dried powders were generated for each of these bacteria and stored at -

25 80°C in pre-aliquoted 100mg vials. Immediately prior to their use, one aliquot of each strain was removed from the freezer and allowed to reach room temperature. Each strain was washed 3 times in 10ml ringers followed by centrifugation. A fresh vial was used on each occasion. Growth curves (OD vs number of live cells) were constructed for each growth condition, and washed cells were normalized by cell number before addition to the PBMCs. A no-bacteria

30 control was also included in all experiments. All assays were done in triplicate.

The Bifidobacteria which contained many of the EPS genes exhibited a similar effect on IL-10:IL-12 induction while bacterial strains which do not contain the EPS genes induced a significantly lower IL-10:IL-12 ratio (Fig.13). Both freshly grown and freeze-dried cultures

exhibited a similar effect in that the strains containing similar EPS genes induced a higher IL-10:IL-12 ratio than those strains that did not contain these genes.

The control of inflammatory diseases is exerted at a number of levels. The controlling factors include hormones, prostaglandins, reactive oxygen and nitrogen intermediates, leukotrienes and cytokines. Cytokines are low molecular weight biologically active proteins that are involved in the generation and control of immunological and inflammatory responses. A number of cell types produce these cytokines, with neutrophils, monocytes and lymphocytes being the major sources during inflammatory reactions due to their large numbers at the injured site.

Multiple mechanisms exist by which cytokines generated at inflammatory sites influence the inflammatory response. Chemotaxis stimulates homing of inflammatory cells to the injured site, whilst certain cytokines promote infiltration of cells into tissue. Cytokines released within the injured tissue result in activation of the inflammatory infiltrate. Most cytokines are pleiotropic and express multiple biologically overlapping activities. As uncontrolled inflammatory responses can result in diseases such as IBD, it is reasonable to expect that cytokine production has gone astray in individuals affected with these diseases.

Interleukin-10 (IL-10) is an anti-inflammatory cytokine which is produced by many cell types including monocytes, macrophages, dendritic cells, mast cells and lymphocytes (in particular T regulatory cells). IL-10 down-regulates the expression of pro-inflammatory Th1 cytokines, MHC class II antigens, and co-stimulatory molecules on antigen presenting cells. It also enhances B cell survival, proliferation, and antibody production. This cytokine can block NF- κ B activity, and is involved in the regulation of the JAK-STAT signaling pathway. Murine knock-out studies have demonstrated the essential role for IL-10 in immunoregulation as IL-10KO mice develop severe colitis. In addition, bacteria which are potent inducers of IL-10 have been shown to promote T regulatory cell differentiation *in vivo* thus contributing to immunological homeostasis (O'Mahony et al., AJP 2006; O'Mahony et al., PLoS Pathogens 2008).

Interleukin-12 (IL-12) is a pro-inflammatory cytokine associated with polarisation of Th1 effector T cell responses and stimulates the production of other pro-inflammatory Th1 cytokines, such as interferon-gamma (IFN- γ) and tumor necrosis factor-alpha (TNF- α), from T and natural killer (NK) cells. High levels of IL-12 expression is associated with autoimmunity. Administration of IL-12 to people suffering from autoimmune diseases was shown to worsen

disease symptoms. In contrast, IL-12 knock-out mice or treatment of mice with IL-12 neutralising antibodies ameliorated the disease.

Cytokine cascades and networks control the inflammatory response, rather than the action of a particular cytokine on a particular cell type. The relative levels of expression, or
5 balance, of two cytokines (such as IL-10 and IL-12) is more informative than the expression of a single cytokine. In these studies, we stimulated human PBMCs with a range of different bacterial strains. All strains induced IL-10 and all strains induced IL-12. However, examination of the ratio between IL-10 and IL-12 induction revealed that some bacterial strains induced a higher ratio (i.e. more IL-10 with less IL-12) compared to other strains. This is a meaningful
10 observation as it is the balance between each of these opposing signals that ultimately determines the immunological outcome. It is anticipated that a high IL-10:IL-12 ratio would promote an anti-inflammatory response associated with appropriate immunoregulatory activity while a low IL-10:IL-12 ratio would contribute to Th1 polarisation of the immune response. Thus, the PBMC IL-10:IL-12 ratio is a important selection criterion for identification of bacterial strains
15 with immunoregulatory properties.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range
20 surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm.”

All documents cited in the Detailed Description of the Invention are, in relevant part, incorporated herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present invention. To the extent that any meaning
25 or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and
30 modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

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Claims

1. An isolated and purified *Bifidobacterium longum* strain, excluding *Bifidobacterium longum* strain 35624 (NCIMB 41003), wherein the strain:
 - a) expresses an exopolysaccharide; and
 - b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto.
2. A *Bifidobacterium longum* strain as claimed in claim 1 wherein the strain does not comprise the nucleic acid sequence of SEQ ID No. 112.
3. A *Bifidobacterium longum* strain as claimed in claim 1 or claim 2 wherein the strain comprises at least one nucleic acid sequence selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto.
4. A *Bifidobacterium longum* strain as claimed in claim 1 or claim 2 wherein the strain comprises a single nucleic acid sequence selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least sequence homology thereto.
5. A *Bifidobacterium longum* strain as claimed in claim 4 wherein the strain comprises a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence with at least sequence homology thereto.
6. A *Bifidobacterium longum* strain as claimed in claim 1 or claim 2 wherein the strain comprises two nucleic acid sequences selected from the group comprising SEQ ID No. 114 to SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto
7. A *Bifidobacterium longum* strain as claimed in claim 6 wherein the strain comprises the nucleic acid sequences of SEQ ID No. 131 and SEQ ID No. 132 or nucleic acid sequences with at least 85% sequence homology thereto.

8. An isolated and purified *Bifidobacterium longum* strain wherein the strain:
- a) expresses an exopolysaccharide; and
 - b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto; and
 - c) comprises a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence with at least 85% sequence homology thereto; and/or
 - d) comprises a nucleic acid sequence of SEQ ID No. 131 or a nucleic acid sequence with at least 85% sequence homology thereto.
9. An isolated and purified *Bifidobacterium longum* strain as claimed in any one of claims 1 to 8 wherein 1×10^7 CFU/ml of the strain induces an [IL10] : [IL12] ratio of at least 10 in a peripheral blood mononuclear cell (PMBC) co-incubation assay.
10. An isolated and purified *Bifidobacterium longum* strain as claimed in claim 9 wherein the strain is in the form of a bacterial broth.
11. An isolated and purified *Bifidobacterium longum* strain as claimed in claim 9 wherein the strain is in the form of a freeze-dried powder.
12. An isolated and purified *Bifidobacterium longum* strain wherein the strain:
- a) expresses an exopolysaccharide; and
 - b) comprises at least two nucleic acid sequences selected from the group comprising SEQ ID NO. 93 to SEQ ID No. 113 or nucleic acid sequences with at least 85% sequence homology thereto; and
 - c) comprises a nucleic acid sequence of SEQ ID No. 132 or a nucleic acid sequence with at least 85% sequence homology thereto; and/or a nucleic acid sequence of SEQ ID No. 131 or a nucleic acid sequence with at least 85% sequence homology thereto; and
 - d) induces an [IL10] : [IL12] ratio of at least 10 in a peripheral blood mononuclear cell (PMBC) co-incubation assay at a concentration of 1×10^7 CFU/ml bacteria.
13. An isolated strain of *Bifidobacterium longum* BL1207 (PTA-9608).

14. An isolated strain of *Bifidobacterium longum* AH121A (NCIMB 41675).

15. An isolated strain of *Bifidobacterium longum* AH1714 (NCIMB 41676).

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16. An isolated strain as claimed in any one of claims 1 to 15 in the form of viable cells.

17. An isolated strain as claimed in any one of claims 1 to 15 in the form of non-viable cells.

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18. A formulation comprising an isolated strain of *Bifidobacterium longum* as claimed in any one of claims 1 to 17.

19. A formulation as claimed in claim 18 which comprises an ingestable carrier.

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20. A formulation as claimed in claim 19 wherein the ingestable carrier is a pharmaceutically acceptable carrier such as a capsule, tablet or powder.

21. A formulation as claimed in claim 19 wherein the ingestable carrier is a food product such as acidified milk, yoghurt, frozen yoghurt, milk powder, milk concentrate, cheese spreads, dressings or beverages.

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22. A formulation as claimed in any one of claims 19 to 22 wherein the strain is present at more than 10^6 cfu per gram of ingestable carrier.

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23. A composition comprising an isolated strain of *Bifidobacterium longum* as claimed in any one of claims 1 to 17 and a pharmaceutically acceptable carrier.

24. Use of a *Bifidobacterium longum* strain as claimed in any one of claims 1 to 17 as a probiotic strain.

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25. A method for identifying an exopolysaccharide expressing *Bifidobacterium longum* strain comprising the steps of:

- a) obtaining a sample comprising bacteria;
- b) extracting nucleic acid from the sample;

- c) amplifying the extracted nucleic acid in the presence of at least two primers derived from a nucleic acid sequence selected from the group comprising: SEQ ID No. 2, SEQ ID No. 3, SEQ ID No. 10 to SEQ ID No. 12, SEQ ID No. 93 to SEQ ID No. 132 or a nucleic acid sequence with at least 85% sequence homology thereto;
- d) identifying a bacterial strain that expresses an exopolysaccharide.

26. A method as claimed in claim 25 wherein the primer comprises at least 10 consecutive bases from a nucleic acid sequence selected from the group comprising: SEQ ID No. 2, SEQ ID No. 3, SEQ ID No. 10 to SEQ ID No. 12 and SEQ ID No. 93 to SEQ ID No. 132.

27. A method as claimed in claim 25 or 26 wherein the primer comprises a nucleic acid sequence selected from the group comprising: SEQ ID No. 10 to SEQ ID No. 12, SEQ ID No. 13 to SEQ ID No. 92 or a nucleic acid sequence with at least 85% sequence homology thereto.

28. A method as claimed in any one of claims 25 to 27 wherein the step of identifying a bacterial strain that expresses an exopolysaccharide comprises growing the bacterial strain on a Congo red agar plate.

29. A method as claimed in any one of claims 25 to 28 wherein the sample is a mammalian sample.

30. A method as claimed in claim 29 wherein the sample is a human derived sample.

31. A method as claimed in claim 29 or 30 wherein the sample is a fecal sample.

32. A *Bifidobacterium longum* strain identified by a method as claimed in any one of claims 25 to 31.

33. A *Bifidobacterium longum* strain as claimed in claim 32 in the form of viable cells.

34. A *Bifidobacterium longum* strain as claimed in claim 32 in the form of non-viable cells.

35. A formulation comprising a *Bifidobacterium longum* strain as claimed in any one of claims 32 to 34.

36. A formulation as claimed in claim 35 which comprises an ingestable carrier.

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37. A formulation as claimed in claim 36 wherein the ingestable carrier is a pharmaceutically acceptable carrier such as a capsule, tablet or powder.

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38. A formulation as claimed in claim 36 wherein the ingestable carrier is a food product such as acidified milk, yoghurt, frozen yoghurt, milk powder, milk concentrate, cheese spreads, dressings or beverages.

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39. A formulation as claimed in any one of claims 36 to 38 wherein the strain is present at more than 10^6 cfu per gram of ingestable carrier.

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40. A composition comprising a *Bifidobacterium longum* strain as claimed in any one of claims 32 to 34 and a pharmaceutically acceptable carrier.

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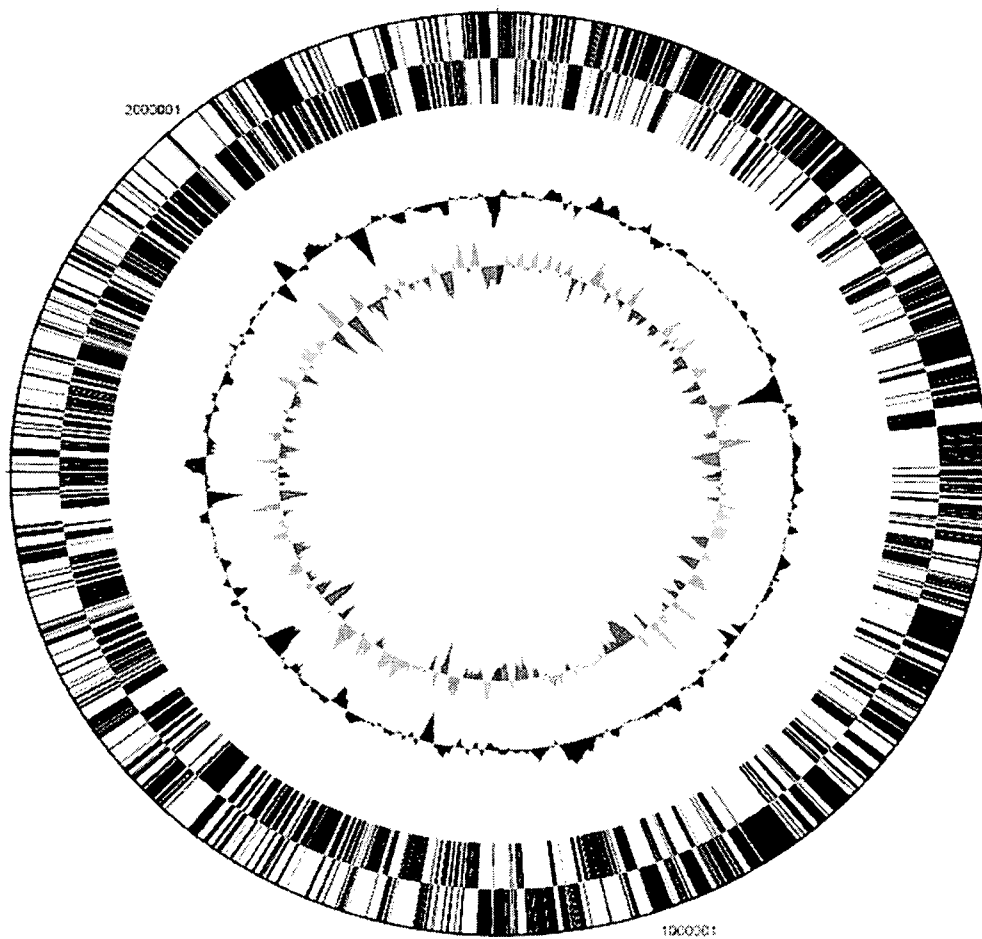


Fig. 1

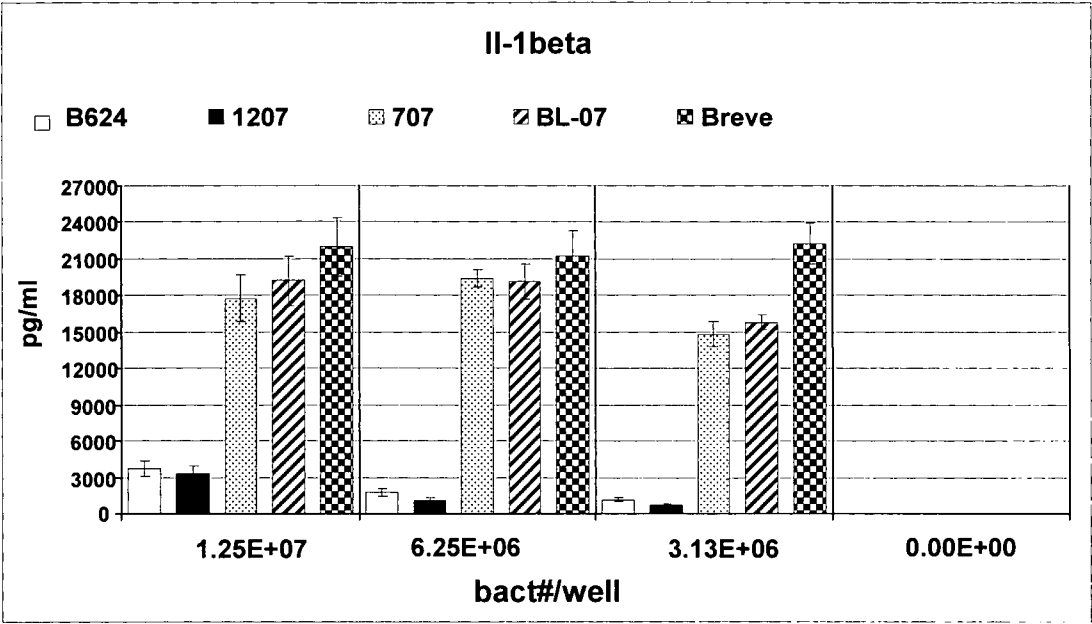


Fig. 2

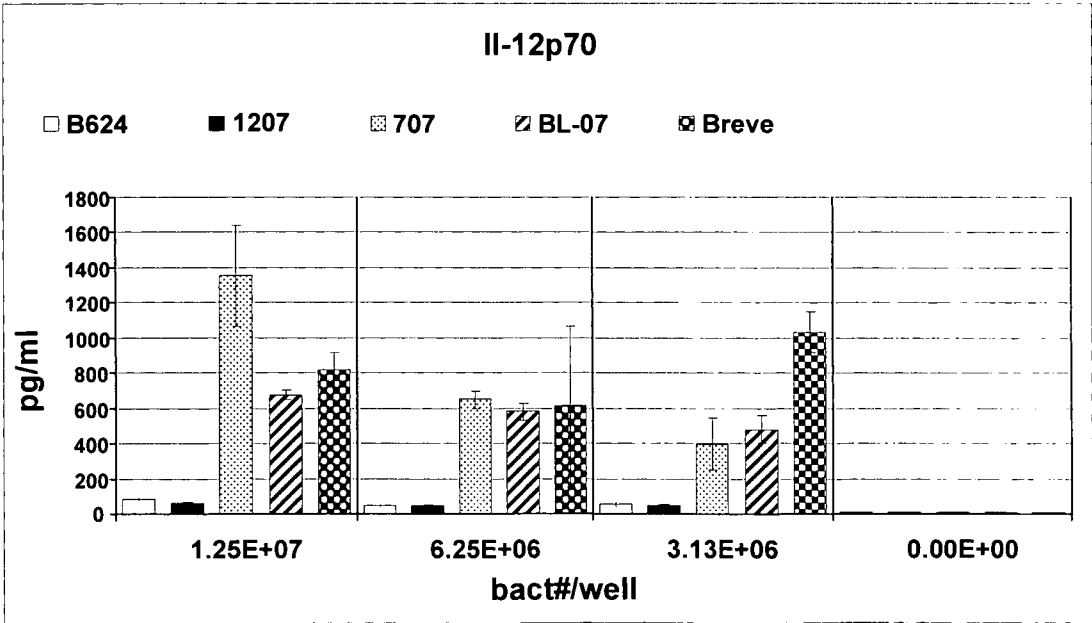


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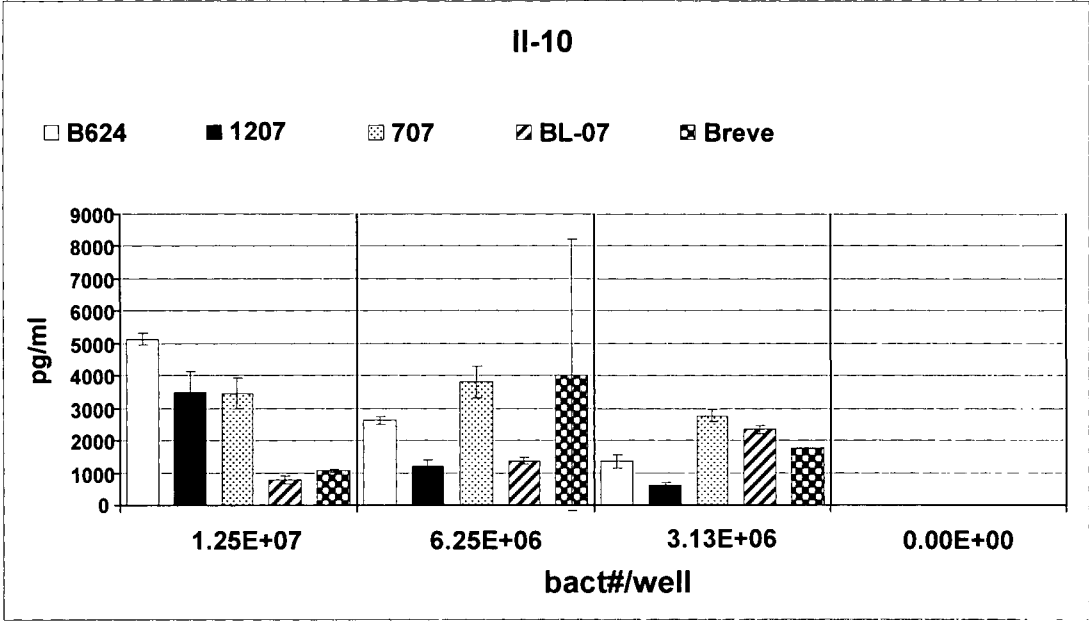


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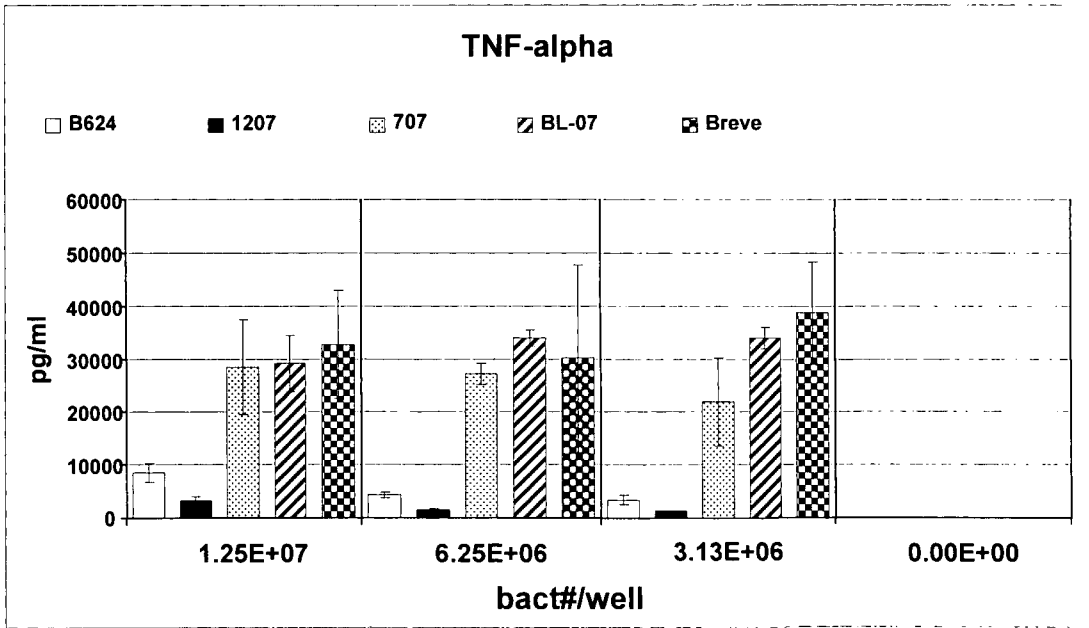


Fig. 5

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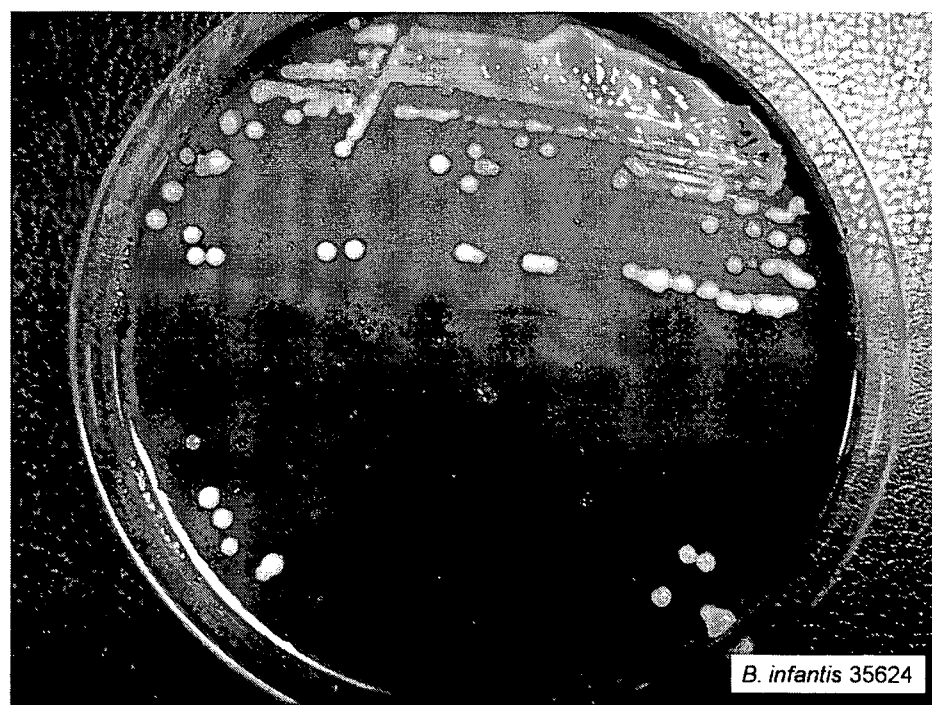


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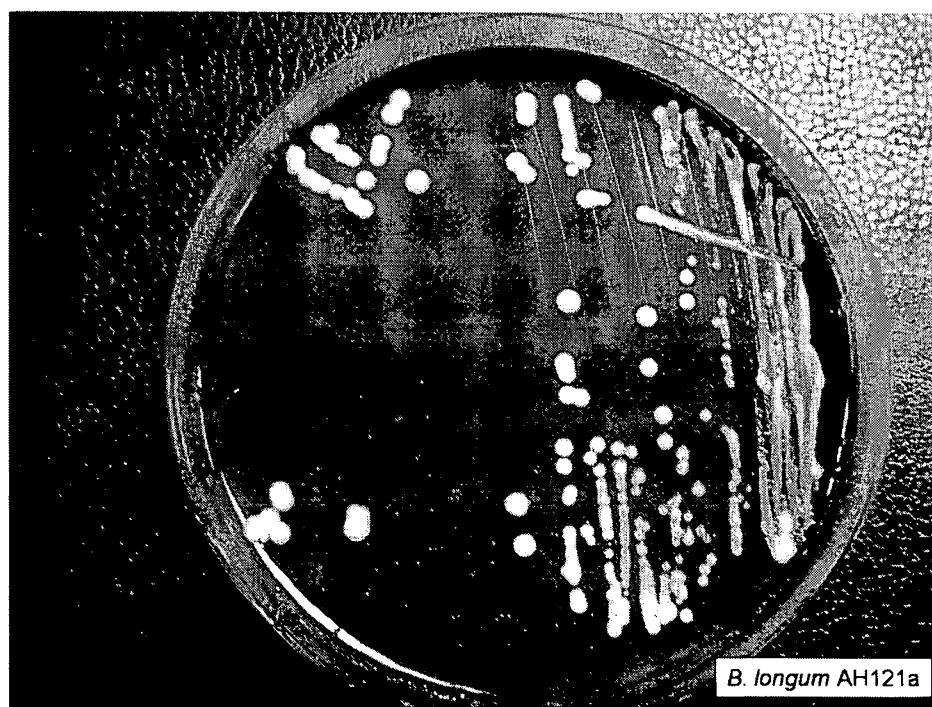


Fig. 7

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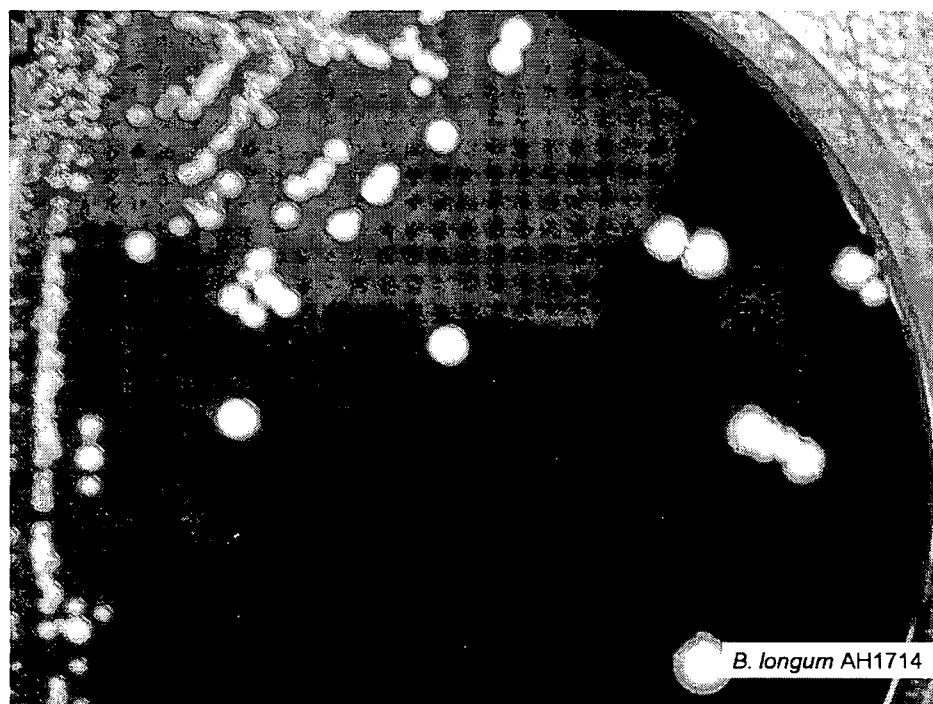


Fig. 8

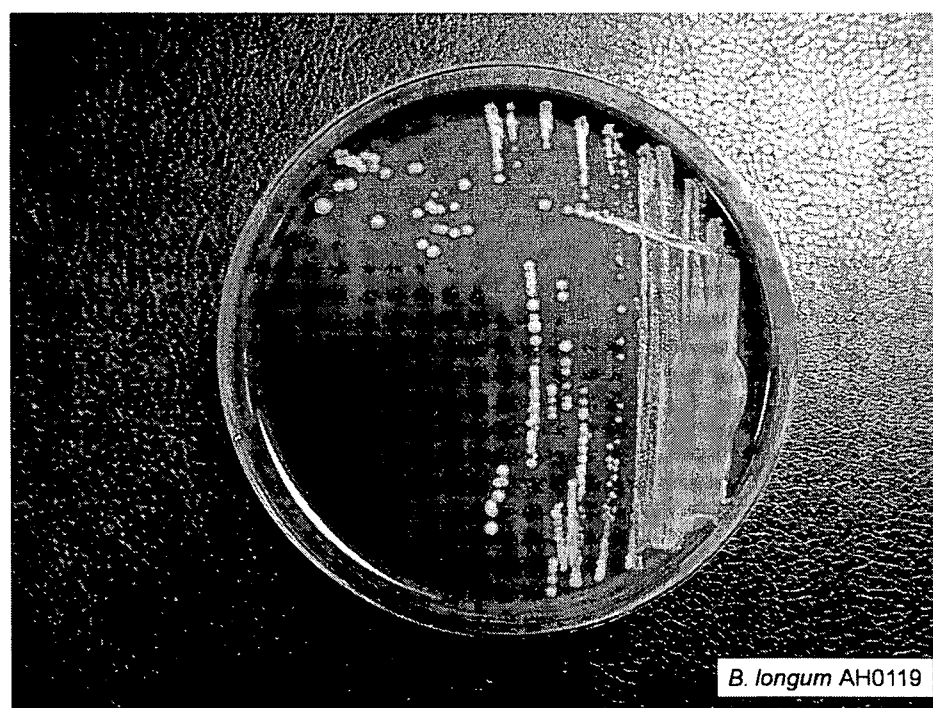


Fig. 9

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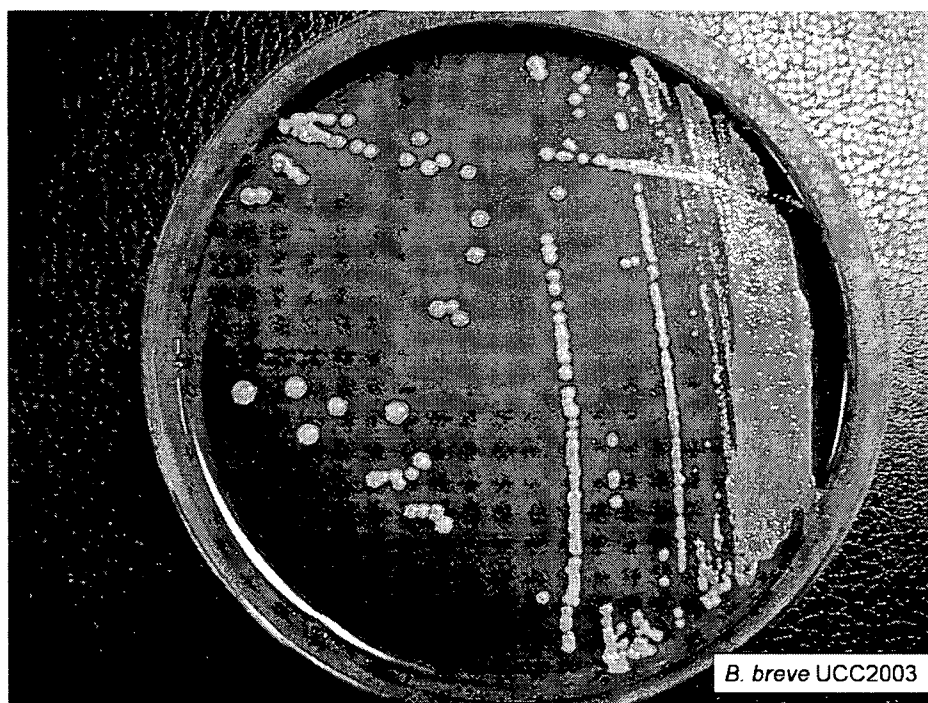


Fig. 10

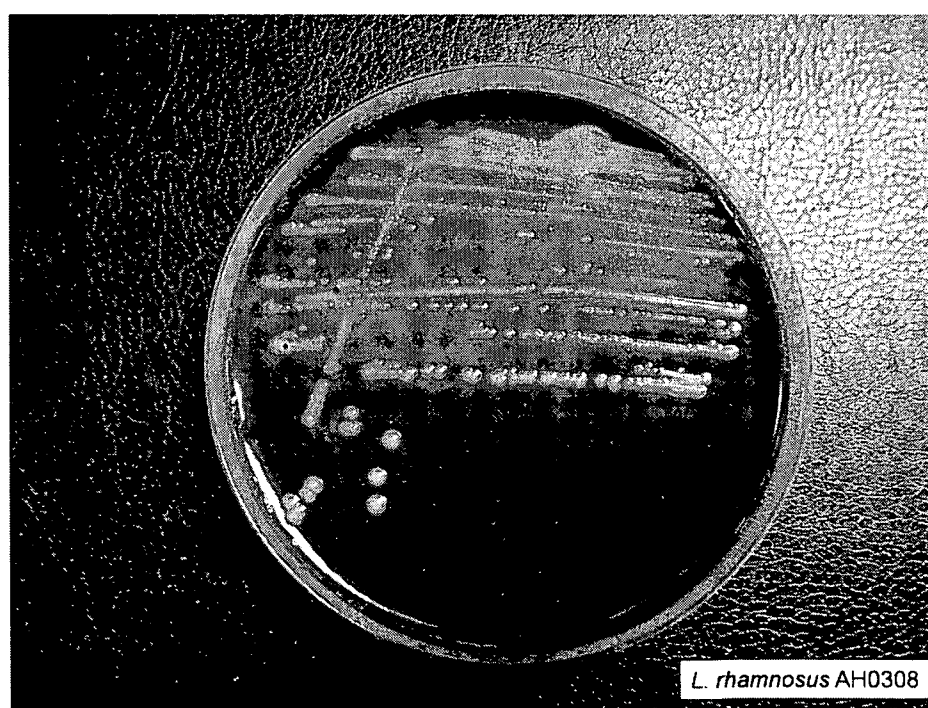


Fig. 11

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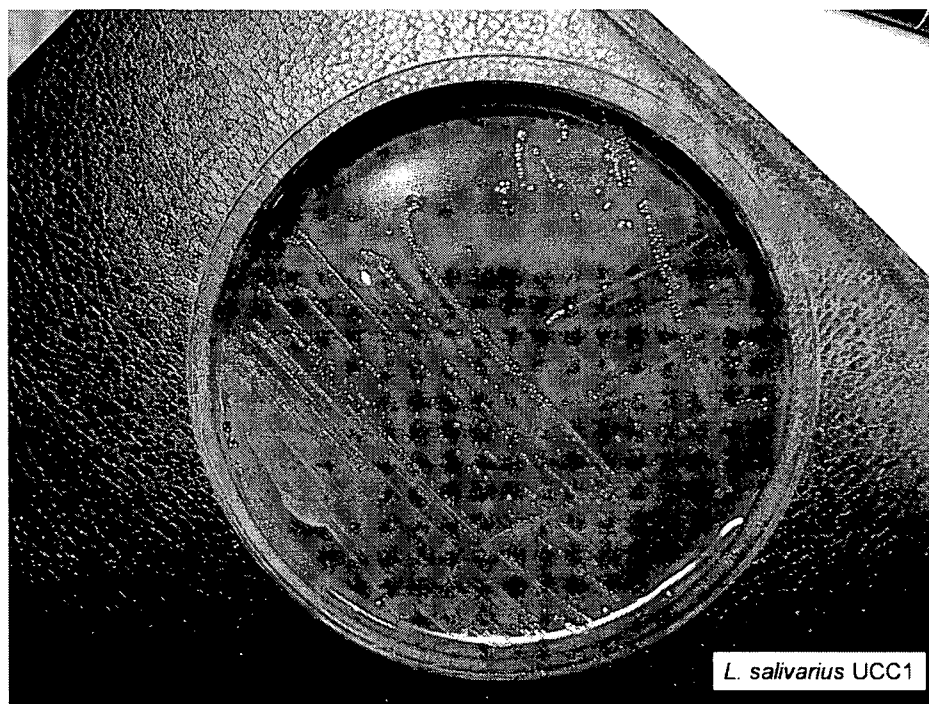


Fig. 12

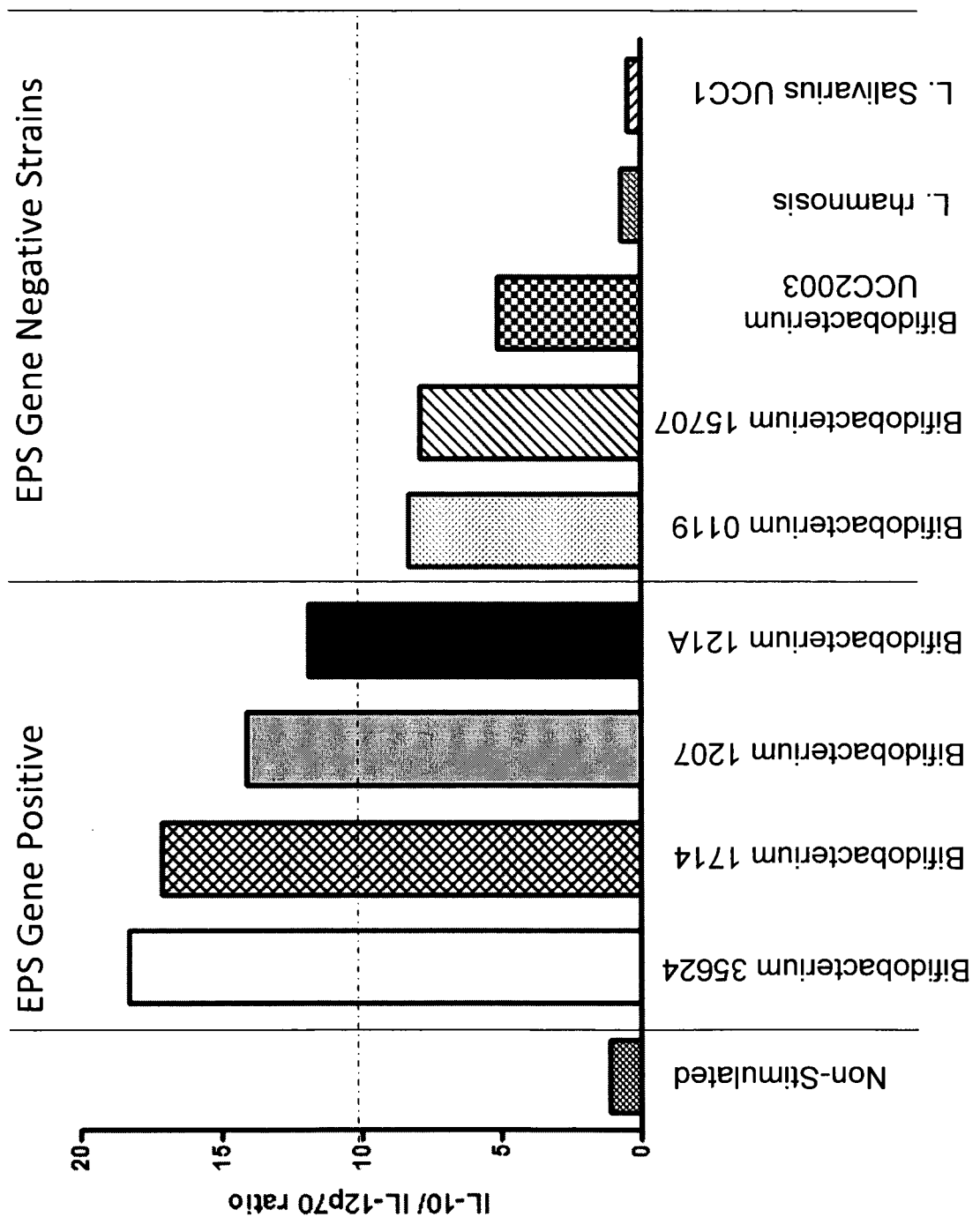


Fig. 13