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Alper et al.

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(54) **ENGINEERED XYLOSE TRANSPORTERS WITH REDUCED GLUCOSE INHIBITION**

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(51) **Int. Cl.**

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C07K 14/40	(2006.01)
C07K 14/33	(2006.01)
A61K 38/00	(2006.01)

(52) **U.S. Cl.**

CPC ***C07K 14/40*** (2013.01); ***C07K 14/33*** (2013.01); *A61K 38/00* (2013.01)

(58) **Field of Classification Search**

CPC C07K 14/40; C07K 14/39
USPC 435/183, 252.3; 536/23.2
See application file for complete search history.

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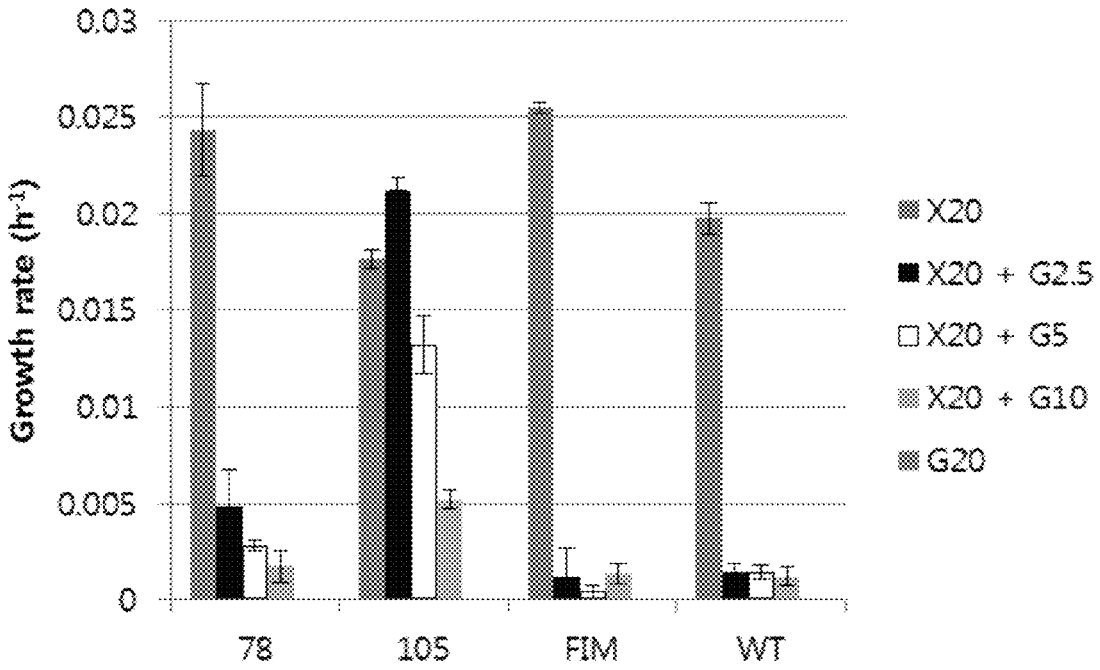
(57) **ABSTRACT**

Provided herein are compositions and methods useful for reducing glucose inhibition in transporting xylose, arabinose and other monosaccharides, into a yeast cell.

9 Claims, 12 Drawing Sheets

FIG. 1


0.03
0.025
0.02
0.015
0.01
0.005
0
Growth rate (h^{-1})
78
105
FIM
WT
X20
X20 + G2.5
X20 + G5
X20 + G10
G20

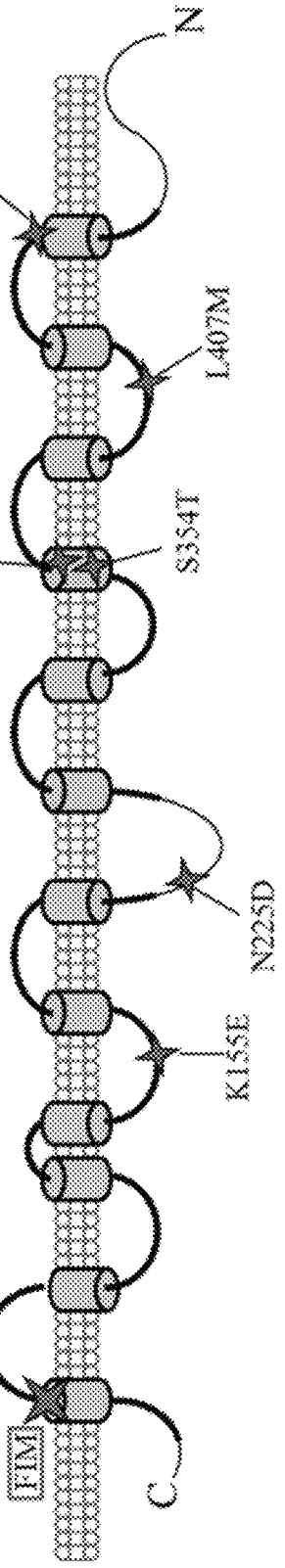


FIG. 2

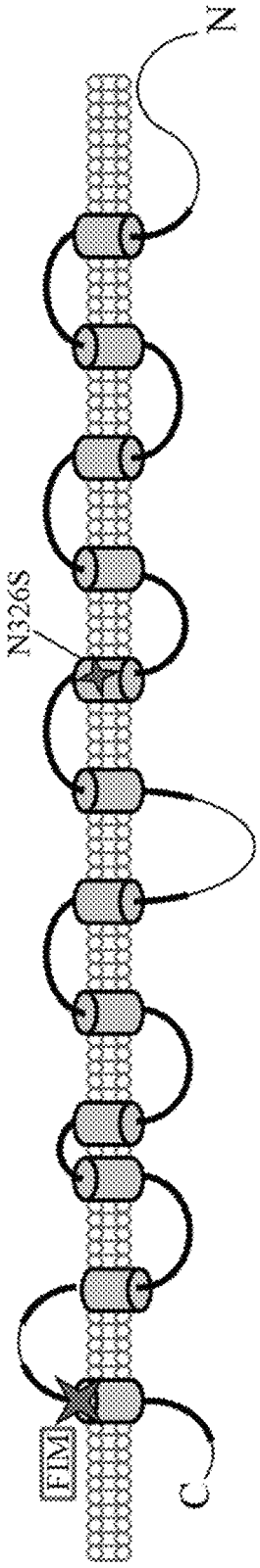


FIG. 3

FIG. 4

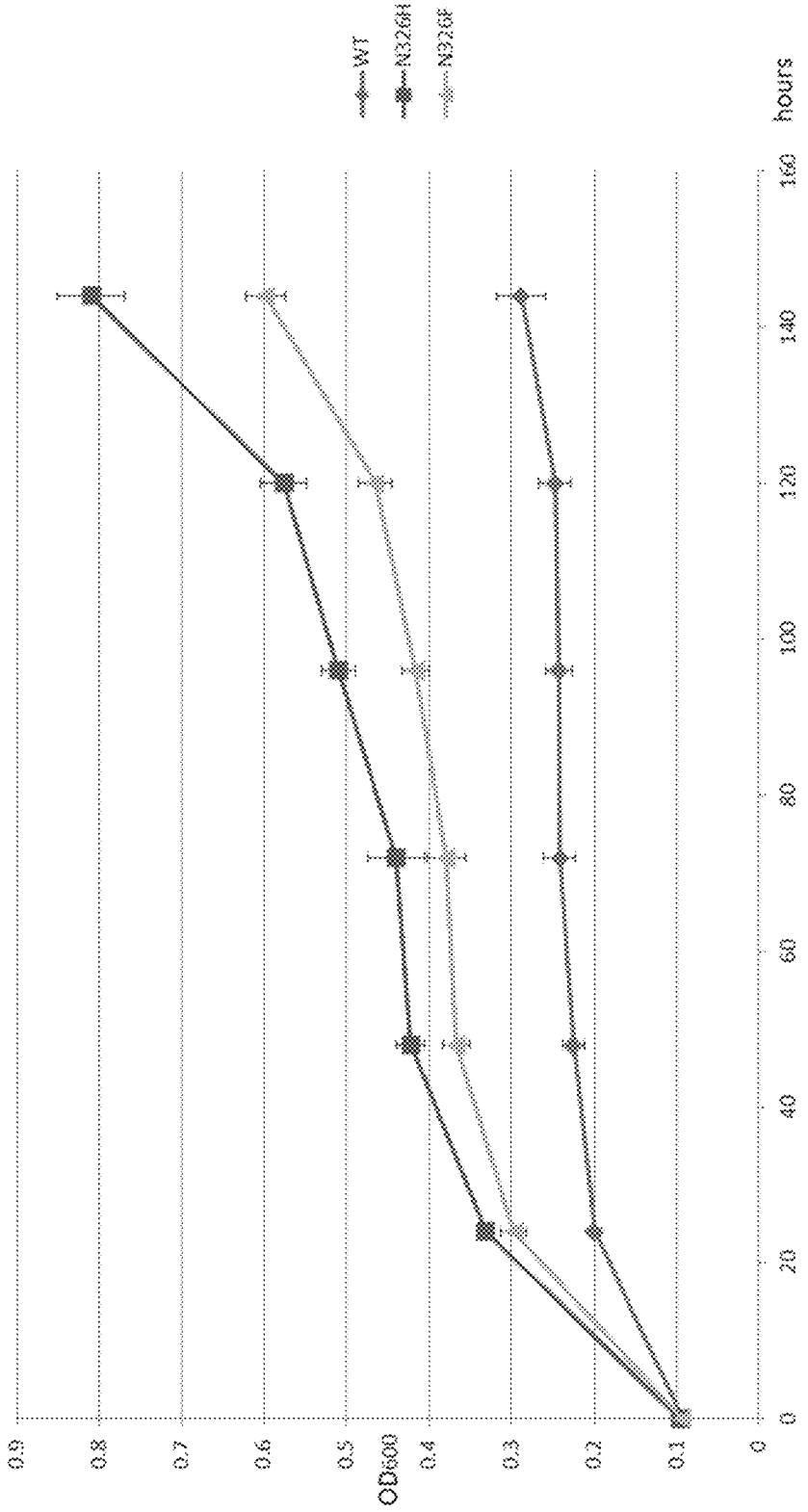

WT
N326H
N326F
hours
OD600
0
20
40
60
80
100
120
140
160
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

FIG. 5

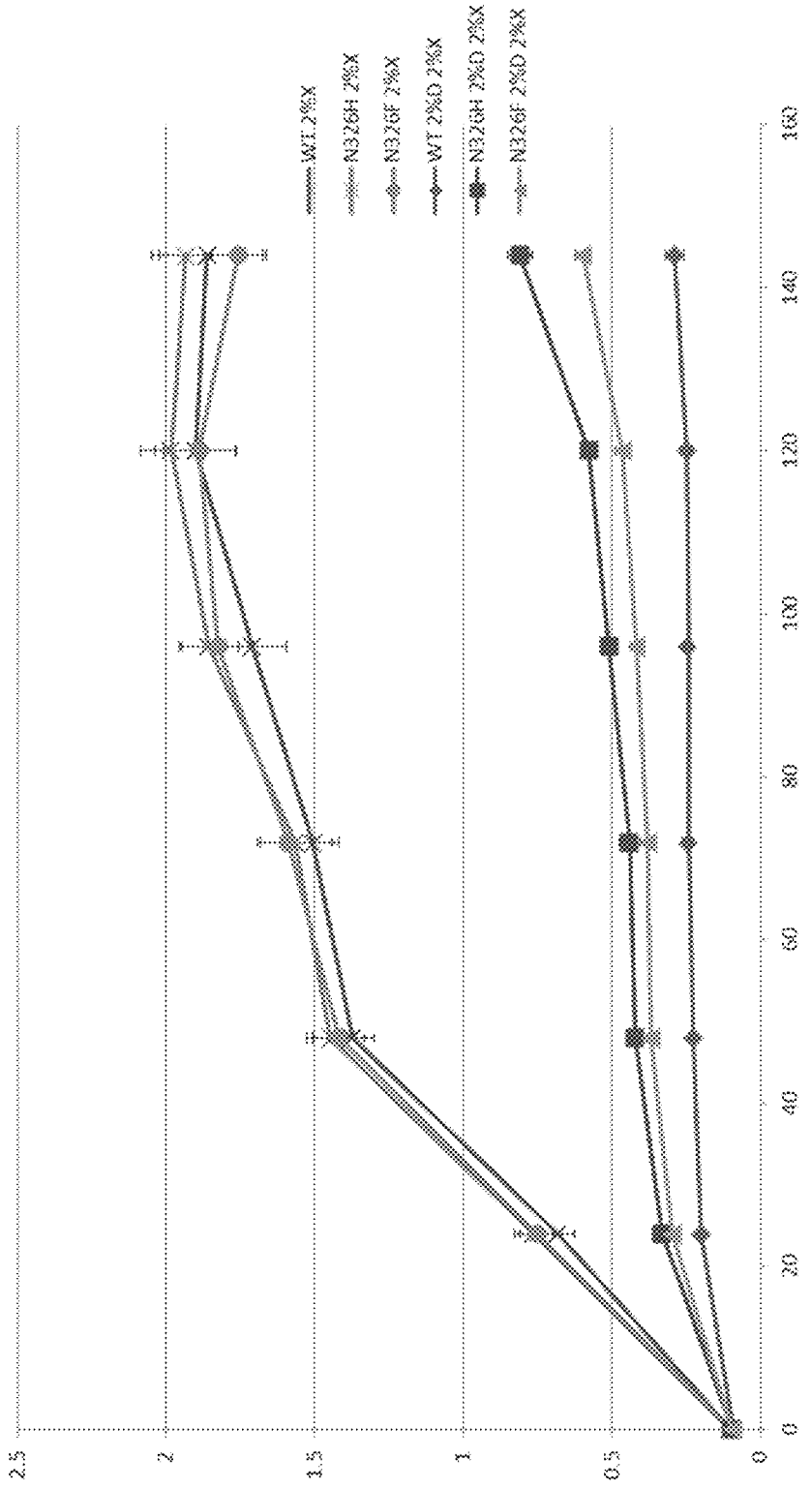

WT 2%X
N326H 2%X
N326F 2%X
WT 2%O 2%X
N326H 2%O 2%X
N326F 2%O 2%X
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160

FIG. 6

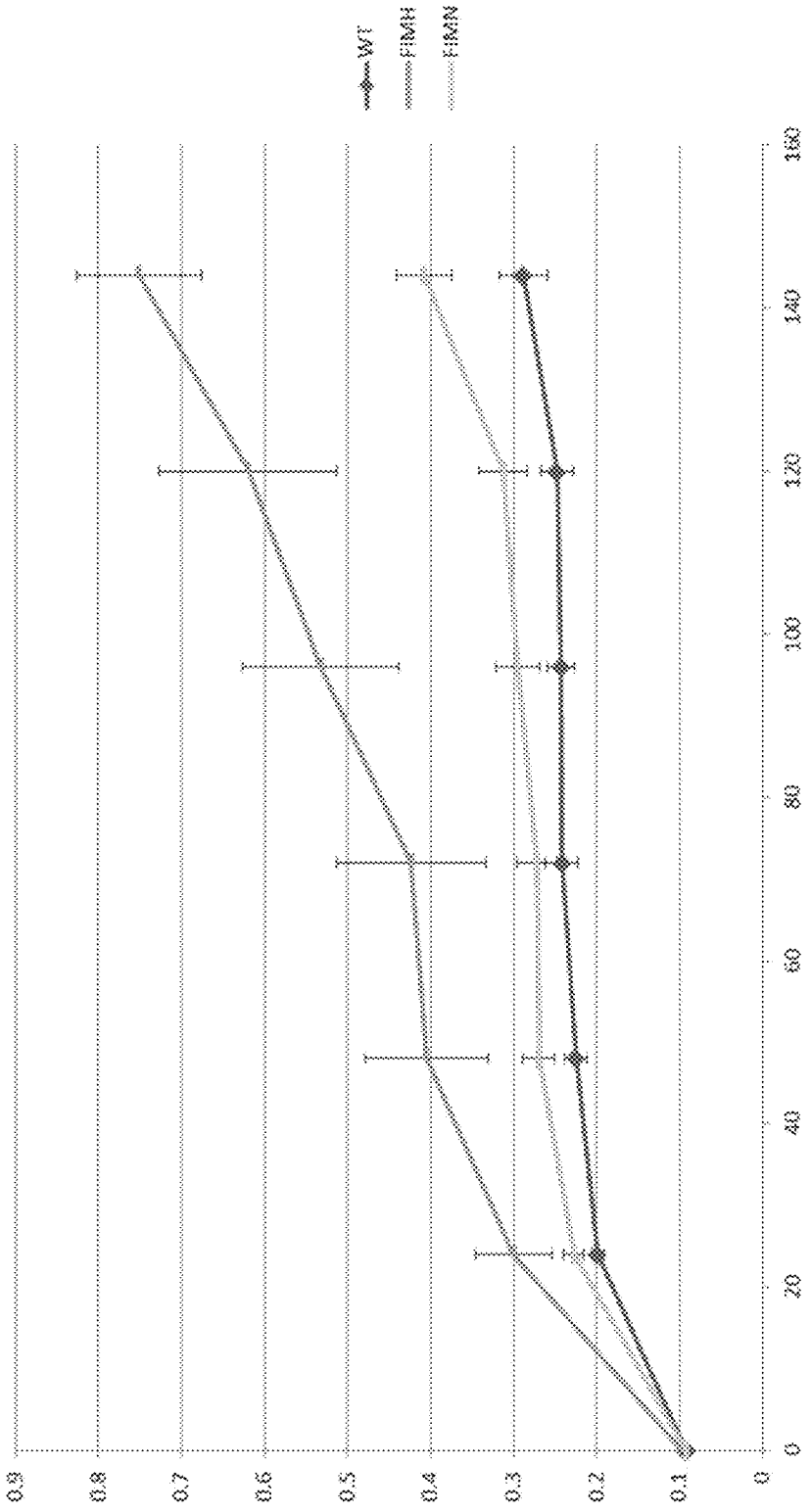

WT
FIMH
FIMN
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140
160

FIG. 7

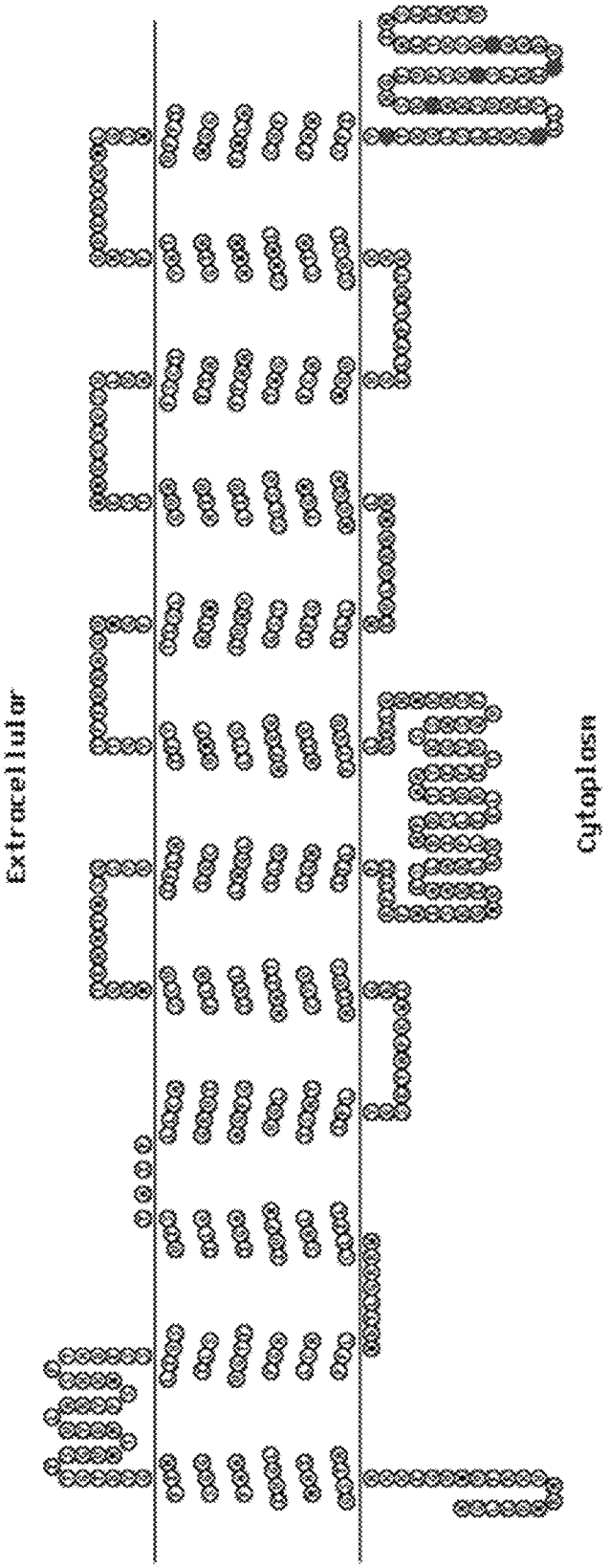


FIG. 8

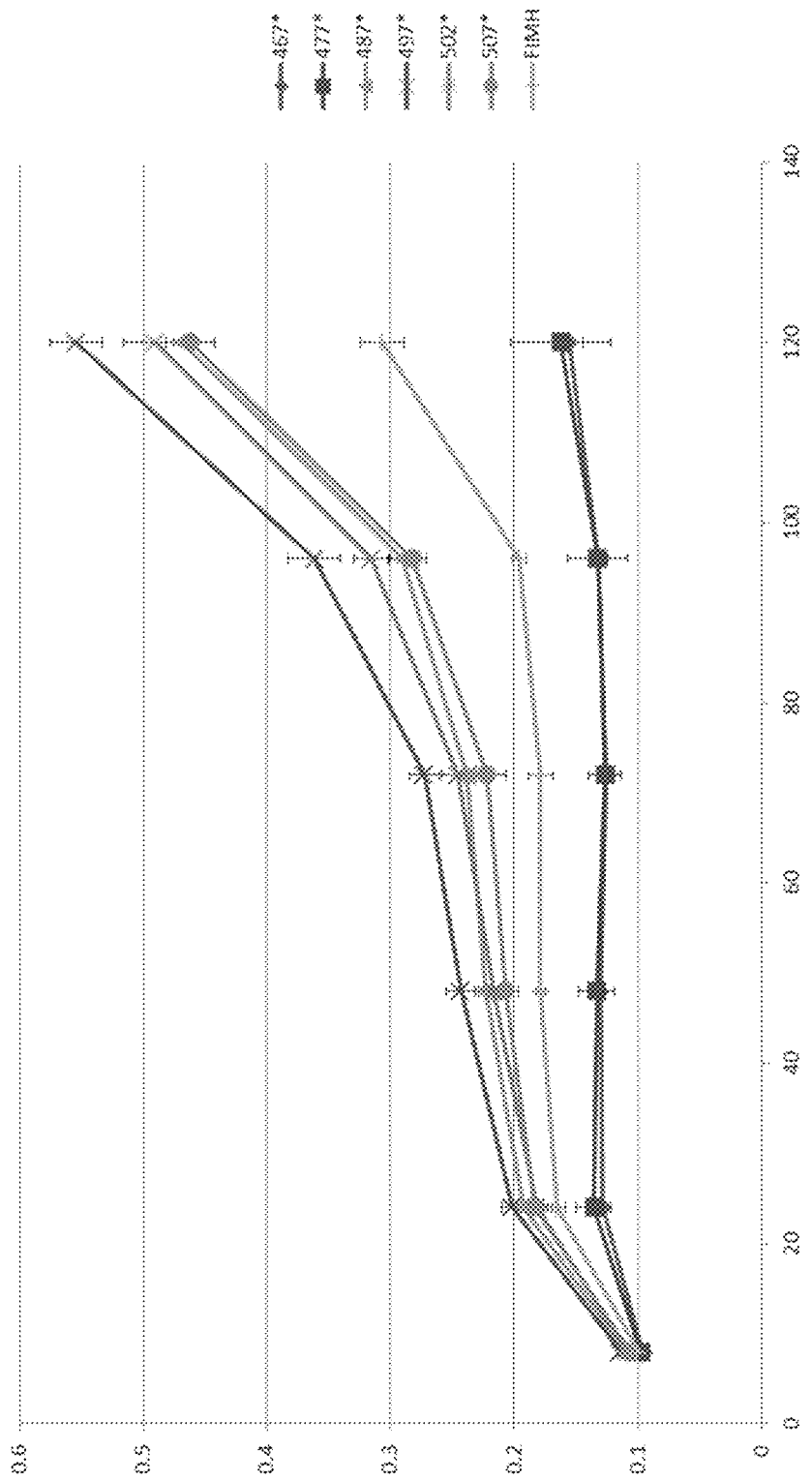

467*
477*
487*
497*
502*
507*
FIMH
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140

FIG. 9A

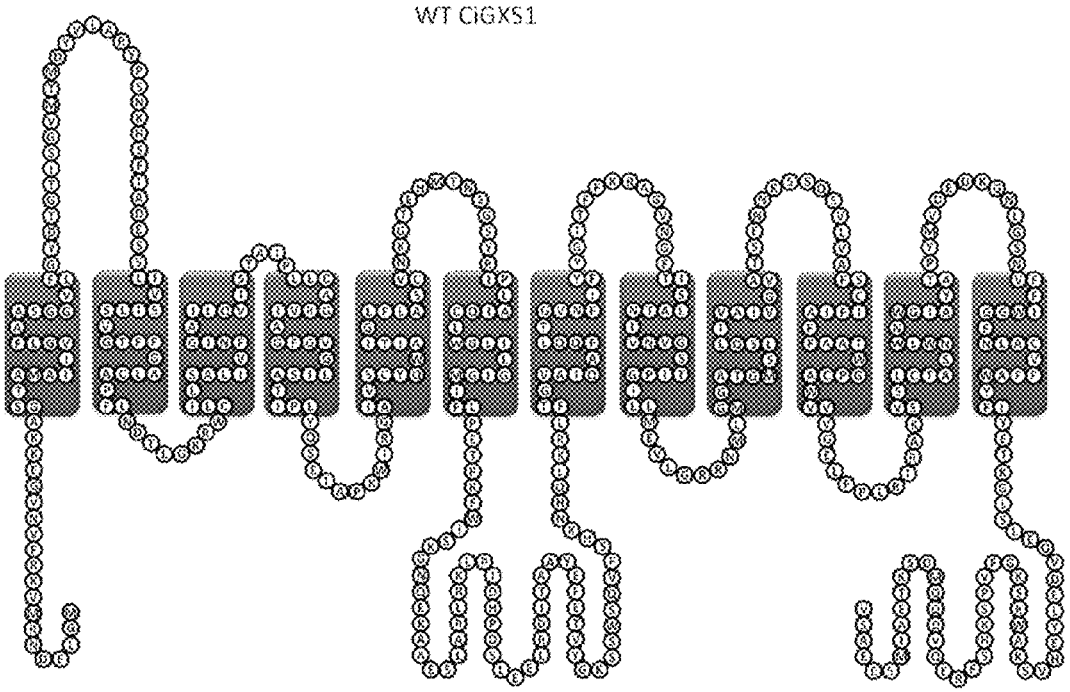


FIG. 9B

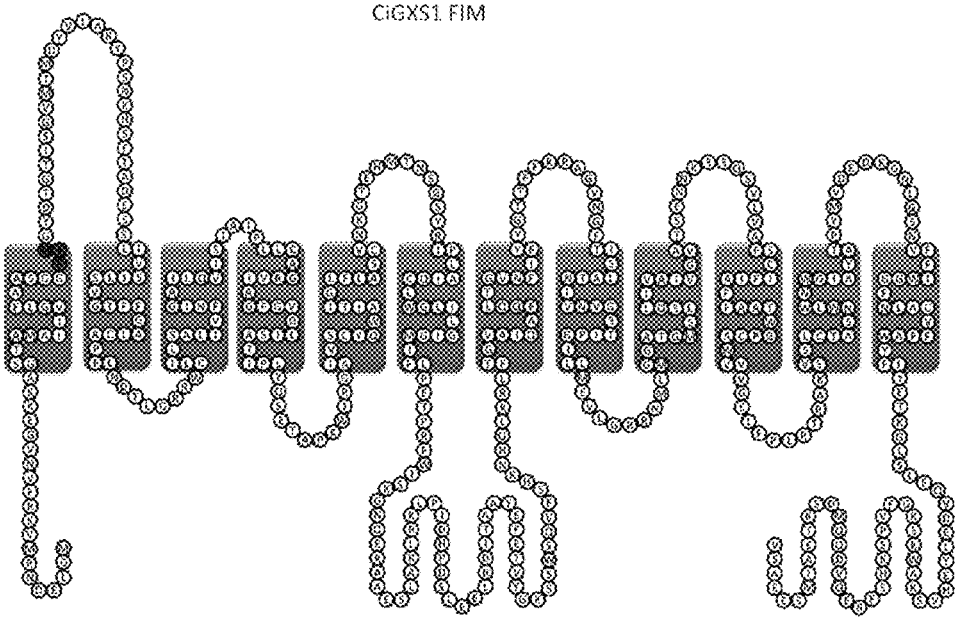


FIG. 9C

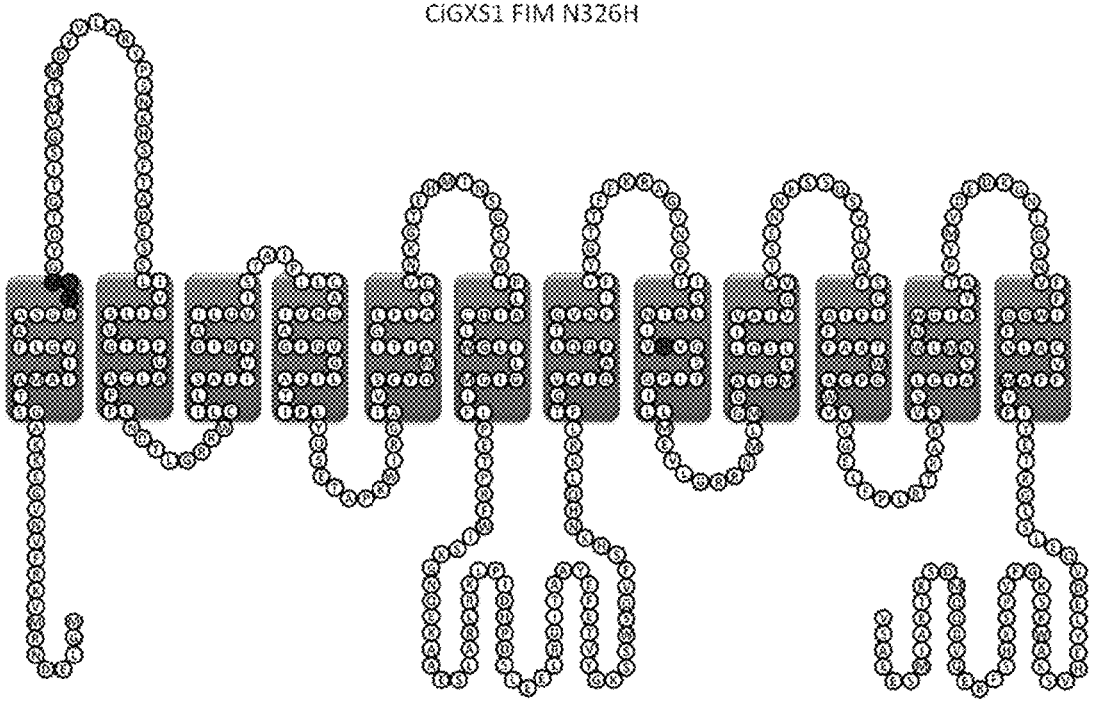


FIG. 9D

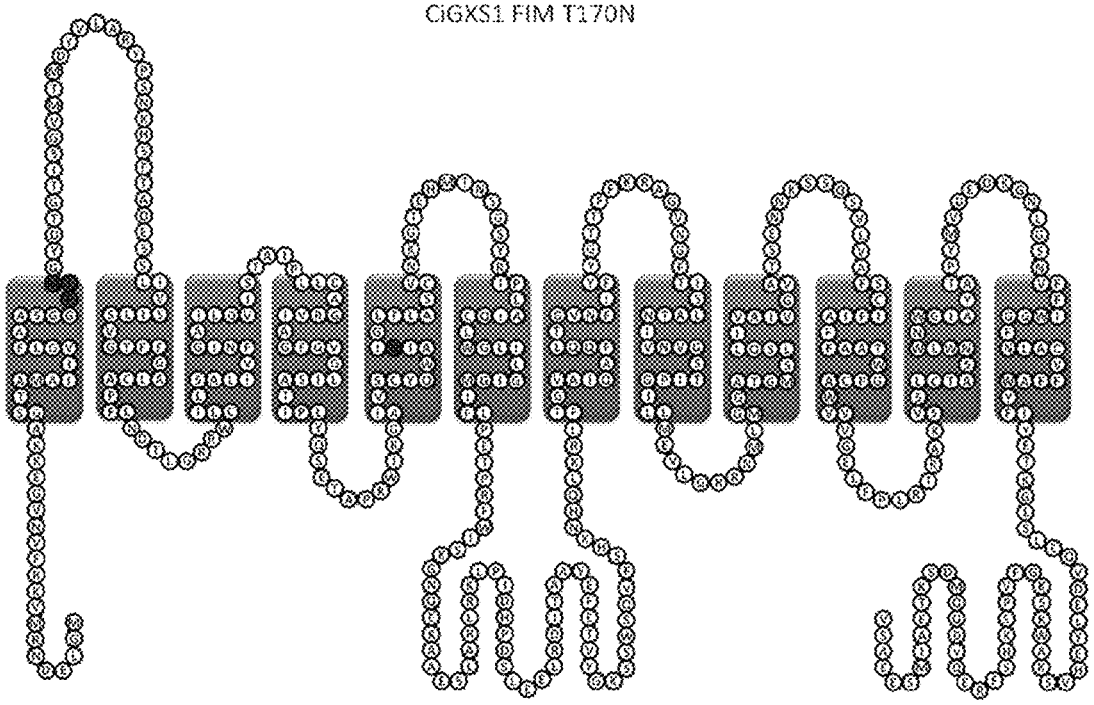


FIG. 9E

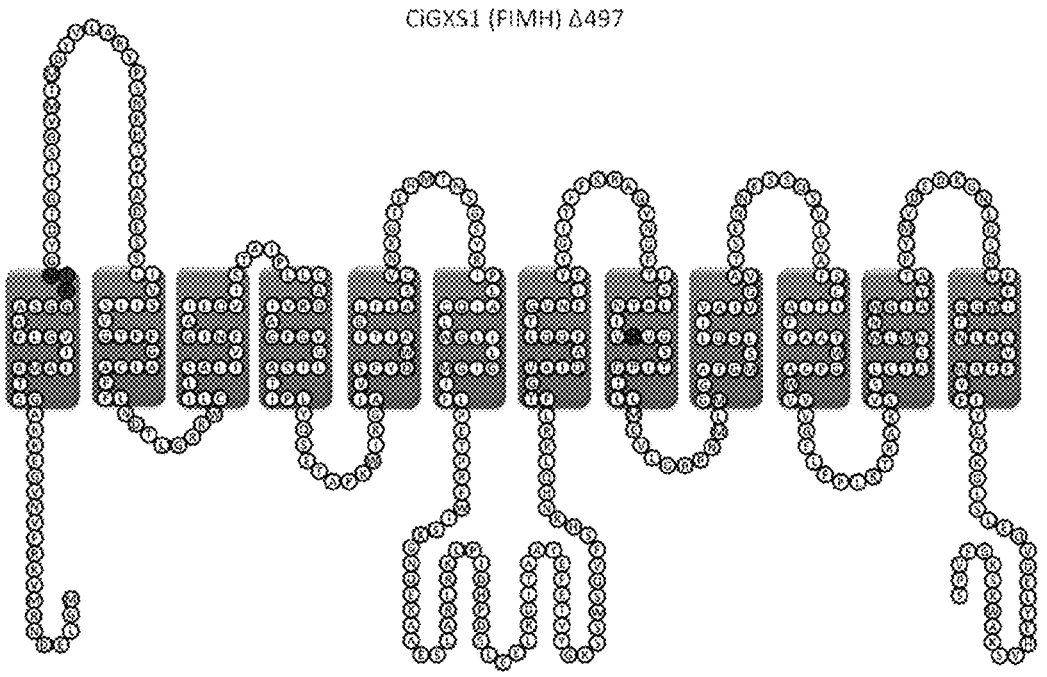


FIG. 9F

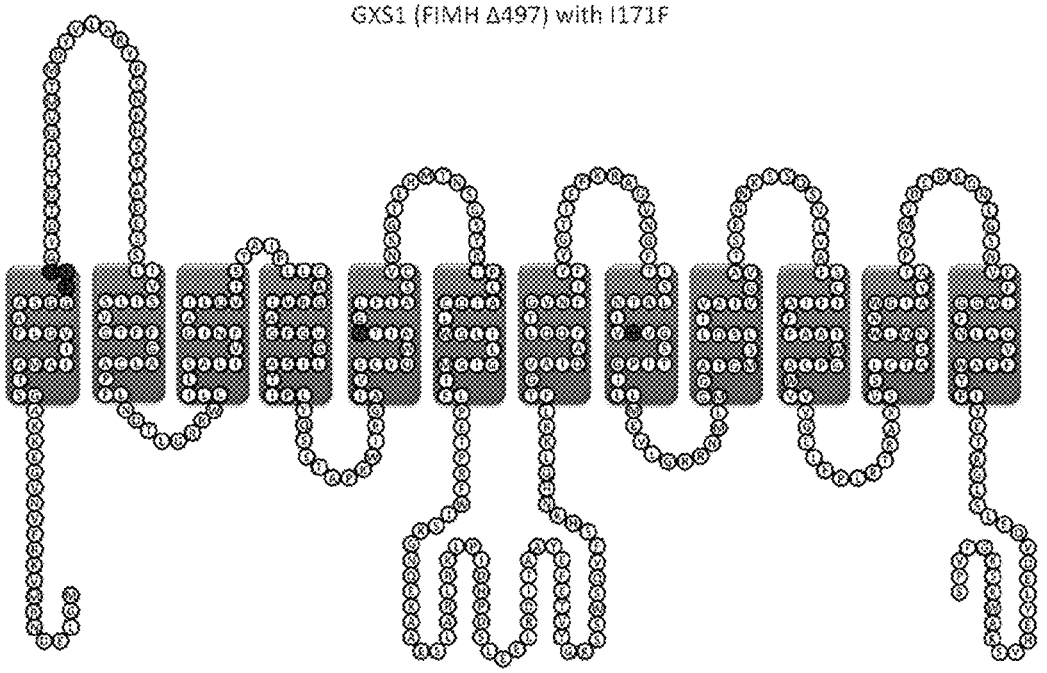
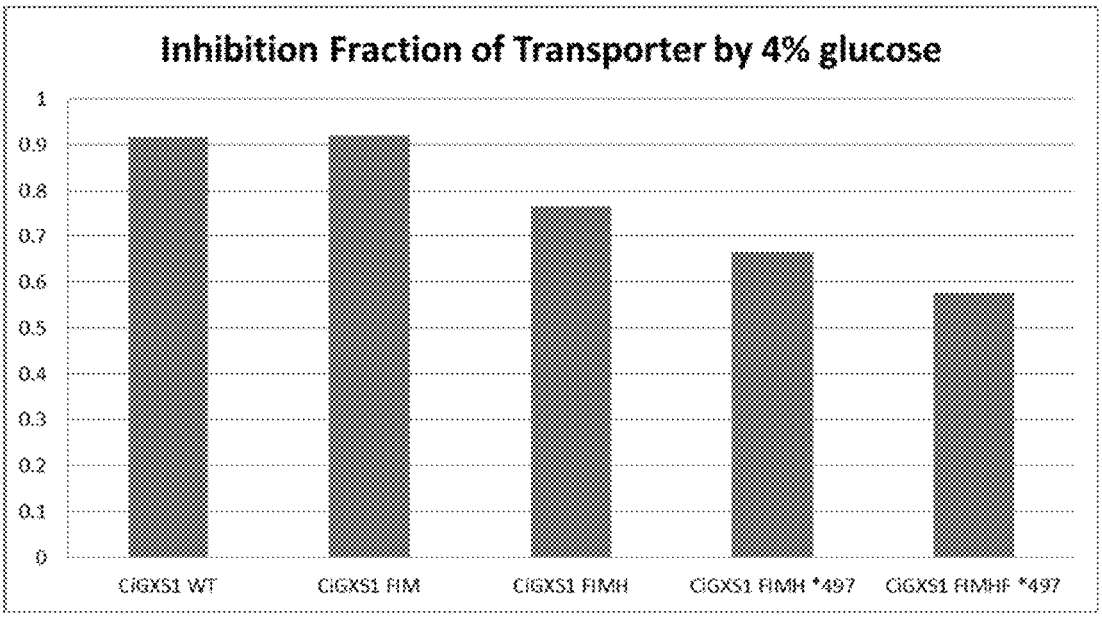


FIG. 10


Inhibition Fraction of Transporter by 4% glucose
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CiGXS1 WT
CiGXS1 FIM
CiGXS1 FIMH
CiGXS1 FIMH *497
CiGXS1 FIMHF *497

ENGINEERED XYLOSE TRANSPORTERS WITH REDUCED GLUCOSE INHIBITION

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 62/001,495, filed May 21, 2014, the disclosure of which is incorporated herein in its entirety and for all purposes.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

This invention was made with government support under grant no. CBET1067506, awarded by the National Science Foundation. The government has certain rights in the invention.

REFERENCE TO A "SEQUENCE LISTING," A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISK

The Sequence Listing written in file 48932-525001US_ST25.TXT, created on May 21, 2015, 171,093 bytes, machine format IBM-PC, MS Windows operating system, is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

The quest for an optimal xylose pathway in yeast is of utmost importance along the way to realizing the potential of lignocellulosic biomass conversion into fuels and chemicals. An often overlooked aspect of this catabolic pathway is the molecular transport of this sugar. Molecular transporter proteins facilitate monosaccharide uptake and serve as the first step in catabolic metabolism. In this capacity, the preferences, regulation, and kinetics of these transporters ultimately dictate total carbon flux (1-3); and optimization of intracellular catabolic pathways only increases the degree to which transport exerts control over metabolic flux (4, 5). Thus, monosaccharide transport profiles and rates are important design criteria and a driving force to enable metabolic engineering advances (6-10). Furthermore, the presence of other hexose sugars, such as glucose, can hamper efficient transport of xylose by inhibiting sugar transporters. There is a need in the art for efficient transport systems for xylose in yeast when glucose is present. Provided herein are solutions to these and other problems in the art.

BRIEF SUMMARY OF THE INVENTION

Provided herein are compositions and methods useful for transporting xylose, arabinose, and galactose into a yeast cell in the presence of glucose.

Recombinant transporter proteins are provided herein that transport hexoses or pentoses. In one aspect, the recombinant transporter is a recombinant xylose transporter protein that includes a xylose transporter motif sequence and a glucose mitigation mutation. In another aspect, the recombinant transporter is a recombinant arabinose transporter protein that includes an arabinose transporter motif sequence and a glucose mitigation mutation. In yet another aspect, the recombinant transporter protein is a recombinant galactose transporter protein that includes a galactose transporter motif sequence and a glucose mitigation mutation.

Also provided herein are nucleic acids that encode recombinant transporter proteins described herein. Thus, in one aspect is a nucleic acid encoding a recombinant xylose transporter as described herein, including embodiments thereof. In another aspect is a nucleic acid encoding a recombinant arabinose transporter as described herein, including embodiments thereof. In yet another aspect is a nucleic acid encoding a recombinant galactose transporter as described herein, including embodiments thereof.

Recombinant yeast cells are described herein which include a recombinant transporter protein as described herein. In one aspect is a recombinant yeast cell that includes a recombinant xylose transporter as described herein, including embodiments thereof. In another aspect is a recombinant yeast cell that includes a recombinant arabinose transporter as described herein, including embodiments thereof. In another aspect is a recombinant yeast cell that includes a recombinant galactose transporter as described herein, including embodiments thereof.

Methods of transporting xylose into a recombinant yeast cell are also described herein. In one aspect, the method includes contacting a recombinant yeast cell with a xylose compound, where the recombinant yeast cell includes a recombinant xylose transporter protein as described herein, including embodiments thereof. The recombinant xylose transporter protein transports the xylose compound into the recombinant yeast cell. In another aspect, the method includes contacting a recombinant yeast cell with a xylose compound, where the xylose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant xylose transporter protein as described herein, including embodiments thereof.

In another aspect is a method of transporting arabinose into a recombinant yeast cell. The method includes contacting a recombinant yeast cell with an arabinose compound, where the recombinant yeast cell includes a recombinant arabinose transporter protein as described herein, including embodiments thereof. The recombinant arabinose transporter protein transports the arabinose compound into the recombinant yeast cell. In another aspect, the method includes contacting a recombinant yeast cell with an arabinose compound, where the arabinose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant arabinose transporter protein as described herein, including embodiments thereof.

In another aspect is a method of transporting galactose into a recombinant yeast cell. The method includes contacting a recombinant yeast cell with a galactose compound, where the recombinant yeast cell includes a recombinant galactose transporter protein as described herein, including embodiments thereof. The recombinant galactose transporter protein transports the galactose compound into the recombinant yeast cell. In another aspect, the method includes contacting a recombinant yeast cell with a galactose compound, where the galactose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant galactose transporter protein as described herein, including embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**: The growth of *S. cerevisiae* expressing mutants (78 and 105), FIM, wild-type CiGXS1 transporters on xylose medium supplemented with different concentration

of glucose: X20: xylose 20 g/L, X20+G2.5: xylose 20 g/L+glucose 2.5 g/L, X20+G5: xylose 20 g/L+glucose 5 g/L, X20+G10: xylose 20 g/L+glucose 10 g/L, G20: glucose 20 g/L.

FIG. **2**: SACS HMMTOP Prediction of the mutant 105 xylose transporter and mutant positions: mutations are indicated with arrows.

FIG. **3**: SACS HMMTOP Prediction of the mutant 78 xylose transporter and mutant positions: mutations are indicated with arrows.

FIG. **4**: Mutations to residue N326 to convert to a histidine or phenylalanine were explored in the background of the gxs1 (FIM) mutant containing the xylose transporter motif sequence G-G-F-I-M-G (SEQ ID NO:107). Mutations in residue N326 improve assimilation rates and growth rates in pure xylose over the wild-type GXS1 and N326H is a better mutation than N326F.

FIG. **5**: Mutations to residue N326 to convert to a histidine or phenylalanine were explored in the background of the gxs1 (FIM) mutant containing the xylose transporter motif sequence G-G-F-I-M-G (SEQ ID NO:107). Mutations in residue N326 improve assimilation rates and growth rates in a mixture of 2% glucose and 2% xylose over the wild-type GXS1 and N326H is a better mutation than N326F.

FIG. **6**: Mutations to residue N326 to convert to a histidine (N326H) are compared with an additionally discovered mutation T170N in the background of the gxs1 (FIM) mutant containing the xylose transporter motif sequence G-G-F-I-M-G (SEQ ID NO:107). Both mutants improved xylose growth rates over the wild-type transporter with the mutation of N326H stronger than T170N.

FIG. **7**: An additional round of mutagenesis and selection was completed in the background of gxs1 (FIM) containing N326H (SEQ ID NO:3). These experiments were conducted in the presence of 4% glucose and 2% xylose. Several mutations in the tail region of the transporter were identified including a stop codon (dark dots on schematic of tail with circle indicating location of stop codon). To assess the potential inhibition of this tail region, several truncations of this transporter protein were created (see vertical lines in the sequence on the bottom).

FIG. **8**: The gxs1 (FIM) strain with the N326H mutation was truncated at various amino acid residues (indicated by number) and assessed for growth in the presence of 4% glucose, 2% xylose. Several truncations were superior with respect to growth over the starting transporter with a truncation after amino acid residue 497 giving the highest performance. Truncations before residue 487 were detrimental to performance.

FIG. **9**A-**9**F: Schematics of the transporter structures for the wild-type GXS1 and gxs1 mutant showing the location of the F-I-M xylose transporter sequence motif. FIG. **9**A: WT CiGXS1 (SEQ ID NO:1). FIG. **9**B: CiGXS1FIM (SEQ ID NO:2). FIG. **9**C: CiGXS1FIM N326H (SEQ ID NO:3). FIG. **9**D: CiGXS1FIM T170N (SEQ ID NO:4). FIG. **9**E: CiGXS1(FIMH)Δ497 (SEQ ID NO:5). FIG. **9**F: CiGXS1 (FIMH-Δ497) with I171F (SEQ ID NO:6).

FIG. **10**: The inhibition fraction (the ratio of the transporter capacity in 4% glucose compared to the transporter capacity in pure xylose) for various mutants. The gxs1 mutant with the F-I-M xylose transporter sequence motif and the N326H mutation along with the tail region after truncating past residue 497 and the T171F mutation performed best and was the least inhibited by high glucose levels.

DETAILED DESCRIPTION OF THE INVENTION

Unless defined otherwise, all technical and scientific terms used herein generally have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Generally, the nomenclature used herein and the laboratory procedures in cell culture, molecular genetics, organic chemistry, and nucleic acid chemistry and hybridization described below are those well-known and commonly employed in the art. Standard techniques are used for nucleic acid and peptide synthesis. The techniques and procedures are generally performed according to conventional methods in the art and various general references (see generally, Sambrook et al. MOLECULAR CLONING: A LABORATORY MANUAL, 2d ed. (1989) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., which is incorporated herein by reference), which are provided throughout this document.

"Nucleic acid" refers to deoxyribonucleotides or ribonucleotides and polymers thereof in either single- or double-stranded form, and complements thereof. The term "polynucleotide" refers to a linear sequence of nucleotides. The term "nucleotide" typically refers to a single unit of a polynucleotide, i.e., a monomer. Nucleotides can be ribonucleotides, deoxyribonucleotides, or modified versions thereof. Examples of polynucleotides contemplated herein include single and double stranded DNA, single and double stranded RNA (including siRNA), and hybrid molecules having mixtures of single and double stranded DNA and RNA. Nucleic acid as used herein also refers nucleic acids that have the same basic chemical structure as a naturally occurring nucleic acids. Such analogues have modified sugars and/or modified ring substituents, but retain the same basic chemical structure as the naturally occurring nucleic acid. A nucleic acid mimetic refers to chemical compounds that have a structure that is different the general chemical structure of a nucleic acid, but that functions in a manner similar to a naturally occurring nucleic acid. Examples of such analogues include, without limitation, phosphorothiolates, phosphoramidates, methyl phosphonates, chiral-methyl phosphonates, 2-O-methyl ribonucleotides, and peptide-nucleic acids (PNAs).

"Synthetic mRNA" as used herein refers to any mRNA derived through non-natural means such as standard oligonucleotide synthesis techniques or cloning techniques. Such mRNA may also include non-proteinogenic derivatives of naturally occurring nucleotides. Additionally, "synthetic mRNA" herein also includes mRNA that has been expressed through recombinant techniques or exogenously, using any expression vehicle, including but not limited to prokaryotic cells, eukaryotic cell lines, and viral methods. "Synthetic mRNA" includes such mRNA that has been purified or otherwise obtained from an expression vehicle or system.

The words "complementary" or "complementarity" refer to the ability of a nucleic acid in a polynucleotide to form a base pair with another nucleic acid in a second polynucleotide. For example, the sequence A-G-T is complementary to the sequence T-C-A. Complementarity may be partial, in which only some of the nucleic acids match according to base pairing, or complete, where all the nucleic acids match according to base pairing.

Nucleic acid is "operably linked" when it is placed into a functional relationship with another nucleic acid sequence. For example, DNA for a presequence or secretory leader is operably linked to DNA for a polypeptide if it is expressed as a preprotein that participates in the secretion of the

polypeptide; a promoter or enhancer is operably linked to a coding sequence if it affects the transcription of the sequence; or a ribosome binding site is operably linked to a coding 15 sequence if it is positioned so as to facilitate translation. Generally, "operably linked" means that the DNA sequences being linked are near each other, and, in the case of a secretory leader, contiguous and in reading phase.

The terms "polypeptide," "peptide" and "protein" are used interchangeably herein to refer to a polymer of amino acid residues. The terms apply to amino acid polymers in which one or more amino acid residue is an artificial chemical mimetic of a corresponding naturally occurring amino acid, as well as to naturally occurring amino acid polymers and non-naturally occurring amino acid polymer.

The term "amino acid" refers to naturally occurring and synthetic amino acids, as well as amino acid analogs and amino acid mimetics that function in a manner similar to the naturally occurring amino acids. Naturally occurring amino acids are those encoded by the genetic code, as well as those amino acids that are later modified, e.g., hydroxyproline, γ-carboxyglutamate, and O-phosphoserine. Amino acid analogs refers to compounds that have the same basic chemical structure as a naturally occurring amino acid, i.e., an α carbon that is bound to a hydrogen, a carboxyl group, an amino group, and an R group, e.g., homoserine, norleucine, methionine sulfoxide, methionine methyl sulfonium. Such analogs have modified R groups (e.g., norleucine) or modified peptide backbones, but retain the same basic chemical structure as a naturally occurring amino acid. Amino acid mimetics refers to chemical compounds that have a structure that is different from the general chemical structure of an amino acid, but that functions in a manner similar to a naturally occurring amino acid.

Amino acids may be referred to herein by either their commonly known three letter symbols or by the one-letter symbols recommended by the IUPAC-IUB Biochemical Nomenclature Commission. Nucleotides, likewise, may be referred to by their commonly accepted single-letter codes.

A "conservative substitution" as used with respect to amino acids, refers to the substitution of an amino acid with a chemically similar amino acid. Amino acid substitutions which often preserve the structural and/or functional properties of the polypeptide in which the substitution is made are known in the art and are described, for example, by H. Neurath and R. L. Hill, 1979, in "The Proteins," Academic Press, New York. The most commonly occurring exchanges are isoleucine/valine, tyrosine/phenylalanine, aspartic acid/glutamic acid, lysine/arginine, methionine/leucine, aspartic acid/asparagine, glutamic acid/glutamine, leucine/isoleucine, methionine/isoleucine, threonine/serine, tryptophan/phenylalanine, tyrosine/histidine, tyrosine/tryptophan, glutamine/arginine, histidine/asparagine, histidine/glutamine, lysine/asparagine, lysine/glutamine, lysine/glutamic acid, phenylalanine/leucine, phenylalanine/methionine, serine/alanine, serine/asparagine, valine/leucine, and valine/methionine. The following eight groups each contain amino acids that are conservative substitutions for one another: 1) Alanine (A), Glycine (G); 2) Aspartic acid (D), Glutamic acid (E); 3) Asparagine (N), Glutamine (Q); 4) Arginine (R), Lysine (K); 5) Isoleucine (I), Leucine (L), Methionine (M), Valine (V); 6) Phenylalanine (F), Tyrosine (Y), Tryptophan (W); 7) Serine (S), Threonine (T); and 8) Cysteine (C), Methionine (M) (see, e.g., Creighton, *Proteins* (1984)). In some embodiments, there may be at least 1, at least 2, at least 3, at least 4, at least 5, at least 6, at least 7, at least 8, at least 9, at least 10, at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 conservative substitutions. In some embodiments, there may be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, or 40 conservative substitutions.

As to amino acid sequences, one of skill will recognize that individual substitutions, deletions or additions to a nucleic acid, peptide, polypeptide, or protein sequence which alters, adds or deletes a single amino acid or a small percentage of amino acids in the encoded sequence is a "conservatively modified variant" where the alteration results in the substitution of an amino acid with a chemically similar amino acid. Conservative substitution tables providing functionally similar amino acids are well known in the art. Such conservatively modified variants are in addition to and do not exclude polymorphic variants, interspecies homologs, and alleles of the invention.

An amino acid or nucleotide base "position" is denoted by a number that sequentially identifies each amino acid (or nucleotide base) in the reference sequence based on its position relative to an N-terminus (or 5'-end). Due to deletions, insertions, truncations, fusions, and the like that must be taken into account when determining an optimal alignment, in general the amino acid residue number in a test sequence determined by simply counting from the N-terminus will not necessarily be the same as the number of its corresponding position in the reference sequence. For example, in a case where a variant has a deletion relative to an aligned reference sequence, there will be no amino acid in the variant that corresponds to a position in the reference sequence at the site of deletion. Where there is an insertion in an aligned reference sequence, that insertion will not correspond to a numbered amino acid position in the reference sequence. In the case of truncations or fusions there can be stretches of amino acids in either the reference or aligned sequence that do not correspond to any amino acid in the corresponding sequence.

The terms "numbered with reference to" or "corresponding to," when used in the context of the numbering of a given amino acid or polynucleotide sequence, refers to the numbering of the residues of a specified reference sequence when the given amino acid or polynucleotide sequence is compared to a reference sequence. In embodiments the reference sequence is a *Candida intermedia* GXS1 protein having SEQ ID NO: 1. In embodiments, the comparison to the reference sequence is a sequence alignment between the given amino acid or polynucleotide sequence and the reference sequence.

"GXS1 protein" or "*Candida intermedia* GXS1 protein" is used according to its common, ordinary meaning and refers to proteins of the same or similar names and functional fragments and homologs thereof. The term includes recombinant or naturally occurring forms of GXS1 protein (e.g. Genbank ID: CAI44932.1; GI: 85057135; SEQ ID NO: 1), or variants thereof that maintain GXS1 protein activity (e.g. within at least 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95%, or 100% as compared to SEQ ID NO: 1). The term includes recombinant or naturally occurring forms of GXS1 protein or variants thereof that have sequence identity to SEQ ID NO: 1 (e.g. about 65%, 70%, 75%, 80%, 85%, 90%, 95%, 99% or 100% identity to SEQ ID NO: 1). GXS1 protein may refer to variants having mutated amino acid residues that modulate (e.g. increase or decrease when compared to GXS1 protein) GXS1 protein activity, expression, cellular targeting, or protein translocation. GXS1 protein may be modified as described herein (e.g. modified with a transporter motif sequence and/or glucose mitigation mutation).

SEQ ID NO: 1:
MGLEDNRMVK RFVNVGEKKA GSTAMAIIVG LFAAS**GGVLF**

GYDTGTISGV MTMDYVLARY PSNKHSFTAD ESSLIVSILS

VGTFFGALCA PFLNDTLGRR WCLILSALIV FNIGAILQVI

STAIPLLCAG RVIAGFGVGL ISATIPLYQS ETAPKWIRGA

IVSCYQWAIT IGLFLASCVN KGTEHMTNSG SYRIPLAIQC

LWGLILGIGM IFLPETPRFW ISKGNQEKAA ESLARLRKLP

IDHPDSLEEL RDITAAYEFE TVYGKSSWSQ VFSHKNHQLK

RLFTGVAIQA FQQLTGVNFI FYYGTTFFKR AGVNGFTISL

ATNIVNVGST IPGILLMEVL GRRNMLMGGA TGMSLSQLIV

AIVGVATSEN NKSSQSVLVA FSCIFIAFFA ATWGPCAWVV

VGELFPLRTR AKSVSLCTAS NWLWNWGIAY ATPYMVDEDK

GNLGSNVFFI WGGFNLACVF FAWYFIYETK GLSLEQVDEL

YEHVSKAWKS KGFVPSKHSF REQVDQQMDS KTEAIMSEEA

SV

Residues corresponding to positions 36-41 are underlined and bolded for reference. Residues corresponding to positions 155, 225, 326, 354, 361, 407 and 446 are underlined for reference.

The term "recombinant" when used with reference to, for example, a cell, nucleic acid, or protein, indicates that the cell, nucleic acid, or protein, has been modified by the introduction of a heterologous nucleic acid or protein or the alteration of a native nucleic acid or protein, or that the cell is derived from a cell so modified. Thus, for example, recombinant cells express genes that are not found within the native (non-recombinant) form of the cell or express genes otherwise modified from those found in the native form of a cell (e.g. genes encoding a mutation in a native or non-native transporter protein, such as a transporter motif sequence as described herein). For example, a recombinant protein may be a protein that is expressed by a cell or organism that has been modified by the introduction of a heterologous nucleic acid (e.g. encoding the recombinant protein).

The word "expression" or "expressed" as used herein in reference to a DNA nucleic acid sequence (e.g. a gene) means the transcriptional and/or translational product of that sequence. The level of expression of a DNA molecule in a cell may be determined on the basis of either the amount of corresponding mRNA that is present within the cell or the amount of protein encoded by that DNA produced by the cell (Sambrook et al., 1989 *Molecular Cloning: A Laboratory Manual,* 18.1-18.88).

The term "gene" means the segment of DNA involved in producing a protein; it includes regions preceding and following the coding region (leader and trailer) as well as intervening sequences (introns) between individual coding segments (exons). The leader, the trailer as well as the introns include regulatory elements that are necessary during the transcription and the translation of a gene. Further, a "protein gene product" is a protein expressed from a particular gene.

The term "isolated" refers to a nucleic acid, polynucleotide, polypeptide, protein, or other component that is partially or completely separated from components with which it is normally associated (other proteins, nucleic acids, cells, etc.). In embodiments, an isolated polypeptide or protein is a recombinant polypeptide or protein.

A "yeast cell" as used herein, refers to a eukaryotic unicellular microorganism carrying out metabolic or other function sufficient to preserve or replicate its genomic DNA. Yeast cells may carry out fermentation of sugars described herein. In embodiments, fermentation may convert the sugar to a biofuel or biochemical as set forth herein. Yeast cells referenced herein include, for example, the following species: *Candida intermedia, Cryptococcos neoformans, Debaryomyces hansenii, Saccharomyces cerevisiae, Schefersomyces stipitis*, or *Yarrowia lipolytica*. A "recombinant yeast cell" is a yeast cell which expresses a recombinant transporter protein.

The term "biofuel" as used herein refers to a convenient energy containing substance produced from living organisms (e.g. biomass conversion to a fuel). Thus, biofuels may be produced through, for example, fermentation of carbohydrates (e.g. sugars) found in biomass (e.g. lignocellulosic biomass). Biofuels may be solid, liquid, or gas forms. Biofuels include, for example, ethanol, biodiesel, vegetable oil, ether (oxygenated fuels), or gas (e.g. methane).

The term "biochemical" as used herein refers to production of chemicals by living organisms. Biochemicals herein include production of alcohols (e.g. methanol, butanol, ethanol, isobutanol, 2,3-butanediol, propanol); sugars (e.g. erythritol, mannitol, riboflavin); carotenoids (e.g. β-carotene, lycopene, astaxanthin); fatty acids (e.g. ricinoleic acid, linolenic acid, tetracetyl phytosphingosine); amino acids (e.g. valine, lysine, threonine); aromatics (e.g. indigo, vanillin, sytrene, p-hydroxystyrene); flavonoids (e.g. naringenin, genistein, kaempferol, quercetin, chrysin, apigenin, luteolin); stillbenoids (e.g. resveratrol); terpenoids (e.g. β-amyrin, taxadiene, miltiradiene, paclitaxel, artemisinin, bisabolane); polyketides (e.g. aureothin, spectinabilin, lovastatin, geodin); acetone; or organic acids (e.g. citric acid, succinic acid, malic acid, lactic acid, polylactic acid, adipic acid, glucaric acid). See e.g. Curran K. A., Alper H. S., Metabolic Engineering 14:289-297 (2012).

A "transporter motif sequence" as used herein refers to an amino acid sequence that, when present in a protein (e.g. a sugar transporter protein such as a MFS transporter protein), increases the ability of the protein to transport a sugar or sugar-containing compound into a yeast cell. In embodiments, the transporter motif sequence imparts a hexose sugar transport preference or pentose sugar transport preference to the protein. Correspondingly, a transporter motif may refer to the specific sugar it transports into a yeast cell. For example, the transporter motif sequence may impart preference to hexose sugars to a transporter protein, thereby allowing the recombinant transporter protein to preferentially transport hexoses into a yeast cell. Such transporter motif sequences may be referred to herein as a "hexose transporter motif sequence." In embodiments the transporter motif sequence imparts preference to a single hexose. The hexose may be galactose or mannose. Such transporter motif sequences may be referred to herein as a "galactose transporter motif sequence" and a "mannose transporter motif sequence" respectively. In embodiments, the transporter motif sequence imparts preference to more than one hexose sugar.

The transporter motif sequence may impart preference to pentose sugars to a transporter protein, thereby allowing the recombinant transporter protein to preferentially transport pentose into a yeast cell. In embodiments the transporter motif sequence imparts preference to a single pentose (e.g. xylose). The pentose may be xylose or arabinose. Such

transporter motif sequences may be referred to herein as a "xylose transporter motif sequence" and an "arabinose transporter motif sequence" respectively. In embodiments the transporter motif sequence imparts preference to more than one pentose sugar (e.g. xylose and arabinose). Such transporter motif sequences may be referred to as a "xylose/arabinose transporter motif sequence."

In embodiments, the transporter motif sequence imparts preference to a hexose and a pentose. That is, in embodiments, the recombinant transporter protein having such a transporter motif sequence preferentially transports one hexose and/or one pentose. Such transporter motif sequences may be referred to by the sugars which are transported (e.g. galactose and arabinose). Accordingly, in embodiments, the transporter motif sequence imparts preference to galactose and arabinose. Such a transporter motif is herein referred to as a "galactose-arabinose transporter motif sequence" (i.e. a recombinant transporter protein that transports both galactose and arabinose, or transports galactose or arabinose).

The transporter motif sequence as described herein corresponds to residues corresponding to positions 36-41 of the *Candida intermedia* GXS1 protein ("GXS1 motif sequence"). One skilled in the art will immediately recognize the identity and location of residues corresponding to positions 36-41 of the *Candida intermedia* GXS1 protein in other transporter proteins with different numbering systems. For example, by performing a simple sequence alignment with *Candida intermedia* GXS1 protein the identity and location of residues corresponding to positions 36-41 of the *Candida intermedia* GXS1 protein are identified in other yeast transport proteins as illustrated in Table 1. Insertion (e.g. substitution) of a transporter motif sequence into a yeast transport protein may thereby be performed resulting in a functional yeast transporter protein with an altered sugar transport preference (e.g. changing a preference for hexoses to a preference for pentoses). For example, amino acid residue positions 75-81 of *S. cerevisiae* HXT7 protein correspond to amino acid residue positions 36-41 of the *Candida intermedia* GXS1 protein (see Table 1).

TABLE 1

Sequence alignment of 54 sequences from major facilitator superfamily sugar transporter proteins (SEQ ID NOs: 51-104, respectively in order of appearance in Table 1). Putative transporter motif sequences are illustrated in the box and corresponds as described herein to residue positions 36-41 of *C. intermedia GXS1* protein.

```
Dh2C02530p   KFRNFLDKTPNIYNVFVIASISCISGLMFGIDISSMSLFIGDDKYIKYFHK--------- 63
Dh2E01166p   KLRLFLDKLPNIYNIYVIATISCISGLMFGIDISSMSAFLSNDAYLKYFGT--------- 63
Dh2E01298p   KFRNFLDKFPNIHNVYIVVGISCISGMMFGIDISSMSLFIGDDKYLDYFNS--------- 63
SsHGT2       KFRTFLDRLPNIYNVYIIASISCISGMMFGFDISSMSAFIGEDDYKNFFNN--------- 63
Dh2A14300p   SLNKELDKFHTTYNIYVIAMITTISGMMFGFDVSSISAFISEPSYRRFFNY--------- 61
Y10B06391p   QVGALQHRFPKLHNPYLTAAVATMGGLLFGFDISSVSAFVDTKPYKEYFGY--------- 59
Y10B01342p   --------MYKVHNPYLTAAVATMGGMLFGFDISSVSAFVGEDNYMNYFGH--------- 43
BmHGT2       --------MGRITNPYVLTALACTGGLLFGFDISSMSAIISSPNYLTYFGPKDLTVECPD 52
At5g59250    LASDAPESFSWSSVILPFIFP-ALGGLLFGYDIGATSGATLSLQSP----ALSGTTWFNF 139
At5g17010    ---HVPENYSVVAAILPFLFP-ALGGLLYGYEIGATSCATISLQEPMTLLSYYAVPFSAV 89
SsAUT1       LNAEATNKWHIPPRLIGVIALGSMAAAVQGMDESVINGANLFYPKAFGVD----TMHNSD 161
Y10D00132    LNREITNKWDHPMKVYYLVVCCSLAAAVQGMDETVINGANIIFPAQFGIKEDSGVVSRKS 180
BmSTL1       -----FLGMRGIKLNWAIGFAASAGFLLFGYDQGVLGSLYTLPSWNAQFPEINTAAVGDS 73
SsXUT6       AKTNSYLGLRGHKLNFAVSCFAGVGFLLFGYDQGVMGSLLTLPSFENTFPAMK------- 75
Dh2E01386p   --KTNTMGLRGKPLRVAITICCTIGFSLFGYDQGLMSGIITGKQFNEEPPTHGT------ 59
Dh2B05060p   --RTNTMGLRGKRLRVMFTVVATLGFSLFGYDQGLMSGLITGEQFNAEFPPTAGK----- 60
SsSTL1       --RRNRMGLRGKRLRVMFTVVATLGFSLFGYDQGLMSGLITGEQFNAEFPPTAGK----- 60
ScSTL1       --RTSHWGLTGKKLRYFITIASMTGFSLFGYDQGLMASLITGKQFNYEFPATKENG---D 70
BmHXT10      ----IDVGLRGNWLLTVITASCAAGFLLVGYDNGVMGGVVGLGEFNKTFNNPD------- 66
SsXUT2       ----------GKQVSYAVTFTCELAFILFGIEQGIIGNLINNQDFLNTFGNPTG------ 53
CnBC3990p    --HKTQRRLVGHNLLYSVSVFLSIGVWLFGYDQGVMSGIITGPYFKAYFNQPTS------ 62
Y10F06776p   -----MFSLTGKPLLYFTSVFVSLGVFLFGYDQGVMSGIITGFYFKEYPHEPTR------ 49
BmXUT3       VGATGAKGLIKNARTFAIAVFASMGGLIYGYNQGMFGQILSMHSFQEASGVKGIT----- 78
SsXUT1       AGKSGVAGLVANSRSFFIAVFASLGGLVYGYNQGMFGQISGMYSFSKAIGVEKIQD---- 77
SsXUT3       AHGNVVTIMMKDPVVFLVILFASLGGLLFGYDQGVISGIVTMESF--GAKFPRIFM---- 63

SsXUT3-A     AHGNVVTIMMKDPVVFLVILFASLGGLLFGYDQGVISGIVTMESF--GAKFPRIFM---- 63
SsXUT3-B     AHGNVVTIMMKDPVVFLVILFASLGGLLFGYDQGVISGIVTMESF--GAKFPRIFM---- 63
DhXy1HP      SKGNIITVMSKDPLVFCIIAFASIGGLLFGYDQGVISGIVTMESF--AAKFPRIFS---- 64
ScGAL2       PIEIPKKPMSEYVTVSLLCLCVAFGGFMFGWDTGTISGFVVQTDFLRRFG-MKHKDGT-- 113
ScHXT8       EVVVPEKPASAYATVSIMCLCMAFGGFMSGWDTGTISGFVNQTDFLRRFGNYSHSKNT-- 109
ScHXT1       AVAPPNTGKGVYVTVSICCVMVAFGGFIFGWDTGTISGFVAQTDFLRRFG-MKHHDGS-- 107
ScHXT3       VLTNPNTGKGAYVTVSICCVMVAFGGFVFGWDTGTISGFVAQTDFLRRFG-MKHKDGS-- 104
ScHXT7       VVEIPKRPASAYVTVSIMCIMIAFGGFVFGWDTGTISGFINQTDFIRRFG-MKHKDGT-- 107
ScHXT9       PIDLPQKPLSAYTTVAILCLMIAFGGFIFGWDTGTISGFVNLSDFIRRFG-QKNDKGT-- 103
ScHXT2       NAELPAKPIAAYWTVICLCLMIAFGGFVFGWDTGTISGFVNQTDFKRRFG-QMKSDGT-- 98
ScHXT10      SLDIPYKPIIAYWTVMGLCLMIAFGGFIFGWDTGTISGFINQTDFKRRFG-ELQRDGS-- 91
CiGXF1       QVDAPQKGFKDYIVISIFCFMVAFGGFVFGFDTGTISGFVNMSDFKDRFG-QHHADGT-- 86
ScHXT13      NVEPPKRGLIGYLVIYLLCYPISFGGFLPGWDSGITAGFINMDNFKMNFGSYKHSTGE-- 100
BmGXF1       -MVFQVRGTPIGALTLFIAMLASMGGFLFGWDTGQISGLTQMADFRQRFATVDNPDAIG- 58
```

TABLE 1-continued

Sequence alignment of 54 sequences from major facilitator superfamily sugar transporter proteins (SEQ ID NOs: 51-104, respectively in order of appearance in Table 1). Putative transporter motif sequences are illustrated in the box and corresponds as described herein to residue positions 36-41 of *C. intermedia GXS1* protein.

```
ScHXT14     GQAAKISHNASLHIPVLLCLVISLGGFIFGWDIGTIGGMTNMVSFQEKFGTTNIIHDDET 105
BmGXS1      GPVARPASVKQSLPAILVAAASAFGGVLFGYDTGTISGLIVMPNFQETFGKPVPGSTTGA  74
BmRGT2      GPVARPASVKQSLPAILVAAASAFGGVLFGYDTGTISGLIVMPNFQETFGKPVPGSTTGA  74
CiGXS1      FVNVGEKKAGSTAMAIIVGLFAASGGVLFGYDTGTISGVMTMDYVLARY------PSNK-  64
CiGXS1-A    FVNVGEKKAGSTAMAIIVGLFAASGGVLVGYDTGTISGVMTMDYVLARY------PSNK-  64
CiGXS1-B    FVNVGEKKAGSTAMAIIVGLFAAFGGVLSGYDTGTISGVMTMDYVLARY------PSNK-  64
Dh2D01474   YVNVGEKRAGSASMGIFVGAFAAFGGVLFGYDTGTISGIMAMNYVKGEF------PANK-  64
Dh0D02167p  YVNVGEKRAGSASMGIFVGAFAAFGGVLFGYDTGTISGIMAMNYVKGEF------PANK-  64
SsRGT2      YINFGEKKAGSTTMGICVGLFAAFGGILFGYDTGTISGIMAMDYVTARF------PSNH-  64
Y10C06424p  IINRGEKPEGSAFMAAFVAVFVAFGGILFGYDTGTISGVMAMPFVKKTF------TDDG-  58
Y10C08943p  -------------MAIIVAVFVAFGGLLYGYDTGTIAGIMTMGYVKEHF------TDFGK  41
Dh2B14278p  YYKKMQQKS-SSSSAITVGLVAAVGGFLYGYDTGLINDIMEMTYVKDNF------PANG-  69
EcXy1E      -----MNTQYNSSYIFSITLVATLGGLLFGYDTAVISGTVESLHTVFVAPQNLSESAAN-  54
SsXUT5      RSIGPLIPRNKHLFYGSVLLMSIVHPTIMGYDSMMVGSILNLDAYVNYFH----------  53
ScMAL11     KSMTLKQALLKYPKAALWSILVSTTLVMEGYDTALLSALYALPVFQRKFGTLNGEGS---  148
```

A "glucose mitigation mutation" as used herein refers to an amino acid mutation that, when present in a recombinant transporter protein, reduces, minimizes, diminishes, or in certain embodiments, eliminates the inhibitory effect of glucose on the recombinant transporter when transporting a sugar other than glucose (e.g. xylose) into a yeast cell. A glucose mitigation mutation may, in embodiments, increase the ability of a recombinant transporter protein to transport a preferred sugar or sugar-containing compound into a yeast cell. Thus, in embodiments, a glucose mitigation mutation may increase the ability of a recombinant transporter protein to transport xylose into a yeast cell. A glucose mitigation mutation may include a single amino acid residue mutation (e.g. a "point mutation") in a recombinant transporter protein. A glucose mitigation mutation may include two or more mutations (e.g. a "substitution set") in a recombinant transporter protein. The glucose mitigation mutation may be in a transmembrane domain, an extracellular loop, or cytoplasmic loop of a recombinant transporter protein. In embodiments, the glucose mitigation mutation may be localized (i.e. glucose mitigation mutations located within a specified domain or region of a recombinant transporter protein) or distributed (i.e. glucose mitigation mutations located throughout the sequence of the recombinant transporter protein).

A "recombinant transporter protein" as used herein refers to a recombinantly expressed transmembrane protein which transports a sugar or sugar-containing compound (e.g. hexoses and pentoses) into a yeast cell. In embodiments, the recombinant transporter protein is a yeast recombinant transporter protein. In embodiments, the recombinant transporter protein is a transporter protein belonging to the major faciliator superfamily ("MFS") transporter proteins. In embodiments, a recombinant transporter protein may transport a hexose (e.g. galactose) into a yeast cell. In embodiments, a recombinant transporter protein may transport a pentose (e.g. xylose or arabinose) into a yeast cell. A recombinant transporter protein may be engineered, using the transporter motif sequences described herein, to alter its sugar preference (e.g. a transporter protein having a preference to transport a hexose compound may be converted to a transporter protein having a preference to transport a pentose compound). A recombinant transporter protein may be characterized by the sugar it transports. Thus, a recombinant transporter protein transporting xylose is herein referred to a "recombinant xylose transporter protein." Likewise, recombinant transporter proteins transporting arabinose or galactose are herein referred to as a "recombinant arabinose transporter protein" and a "recombinant galactose transporter protein" respectively.

A recombinant transporter protein may be characterized as a transporter protein derived from a particular organism. Where a recombinant transporter protein is derived from a particular organism, the endogenous sequence of the recombinant transporter protein may be maintained and residues corresponding to positions 36-41 of the *Candida intermedia* GXS1 protein may be replaced with a transporter motif sequence. As an example, a *C. intermedia* gxs1 transporter protein is a gxs1 transporter protein, a homolog thereof, or a functional fragment thereof, found in *C. intermedia*. Amino acids 75-81 of *S. cerevisiae* hxt7 transporter protein may be replace with a transporter motif sequence thereby forming a recombinant transporter protein with desired sugar transport characteristics as described herein. In embodiments, the recombinant transporter protein is a protein, functional fragment, or homolog thereof, identified by the following NCBI gene ID or NCBI accession numbers: 836043, 831564, AJ937350.1, AJ875406.1, 2901237, 2913528, 8998057, 8999011, 50419288, 948529, 4839826, 4852047, 4851844, 4840896, 4840252, 4841106, 4851701, 2907283, 2906708, 2908504, 2909312, 2909701, 4935064, 851943, 856640, 851946, 856494, 8998297, 2902950, 2902912, 853207, 852149, 855023, 853216, 853236, 850536, 855398, 4836720, 4836632, 4840859, 2913215, 2902914, 2910370, and 4838168 (SEQ ID NOs:7-50, respectively in order of appearance). Such recombinant transporter proteins may further be characterized by the sugar preference conferred (e.g. a *Candida intermedia* GXS1 recombinant xylose transporter protein).

A "pentose compound" or "pentose" is a monosaccharide-containing compound having 5 carbon atoms. Pentose compounds include aldopentoses (e.g. pentose compounds having an aldehyde moiety at carbon 1) and ketopentoses (e.g. pentose compounds having a ketone moiety at carbon 2 or carbon 3). Pentose compounds include, for example, D/L-arabinose, D/L-lyxose, D/L-ribose, D/L-xylose, D/L-ribulose, and D/L-xylulose. The term "monosaccharide-containing" refers to a compound that includes at least one monosaccharide.

A "hexose compound" "or "hexose" is a monosaccharide-containing compound having 6 carbon atoms. Hexose compounds include aldohexoses (e.g. hexose compounds having an aldehyde moiety at carbon 1) and ketohexoses (e.g. hexose compounds having a ketone moiety at carbon 2). Hexose compounds include, for example, D/L-allose, D/L-altrose, D/L-glucose, D/L-mannose, D/L-glucose, D/L-idose, D/L-galactose, and D/L-talose.

A "xylose compound" is xylose or a xylose-containing compound including at least one xylose moiety. Thus as used herein, the term xylose compound represents a single xylose, a chain including one or more xylose moieties, or a xylose moiety covalently or non-covalently bound to another chemical moiety (e.g. another sugar forming a xylose containing polysaccharide or xylose bound to lignin). An "arabinose compound" is arabinose or an arabinose-containing compound including at least one arabinose moiety. Thus as used herein, the term arabinose compound represents a single arabinose, a chain including one or more arabinose moieties, or an arabinose moiety covalently or non-covalently bound to another chemical moiety (e.g. another sugar forming an arabinose containing polysaccharide or arabinose bound to lignin). A "galactose compound" is galactose or a galactose-containing compound including at least one galactose moiety. Thus as used herein, the term galactose compound represents a single galactose, a chain including one or more galactose moieties, or a galactose moiety covalently or non-covalently bound to another chemical moiety (e.g. another sugar forming a galactose containing polysaccharide or bound to lignin).

A "sugar" as set forth herein, refers to monosaccharide and polysaccharide compounds metabolized by a yeast cell. In embodiments, a sugar may be a hexose sugar as described herein or a pentose sugar as described herein.

Polysaccharides herein include hexose-only polysaccharides, pentose-only polysaccharides, and hexose-pentose mixture polysaccharides. In embodiments, the xylose compound, the arabinose compound, or the galactose compound may be derived from or form part of a lignocellulosic biomass (e.g. plant dry matter that may used in as a source for pentose compounds or hexose compounds and for production of biofuels or biochemicals), hemicellulose, marine biomass (e.g. seaweeds or algae that may used in as a source for pentose compounds or hexose compounds and for production of biofuels or biochemicals) or other natural or synthetic sources for xylose, arabinose, or galactose, including but not limited to xylan or pectin. "Derived from" refers to extraction, removal, purification, or otherwise freeing a xylose compound, arabinose compound, or galactose compound from a source (e.g. lignocellulosic biomass) by either chemical processes (e.g. acid hydrolysis, ammonium explosion, or ionic liquids extraction) or through natural biological processes by organisms capable of using such sources for energy.

A "xylose growth media" refers to a yeast cell media containing a xylose compound in amounts sufficient to serve as a nutrient for growing or culturing recombinant yeast cells. The term refers to a media substantially free of glucose, and, in embodiments, is "glucose free" (i.e. the media contains no glucose). In embodiments, a xylose growth media includes trace amounts of glucose which are undetectable using known methods and which are insufficient to support significant growth of yeast cells. In embodiments, a xylose growth media includes trace amounts of glucose which are insufficient to cause inhibition of activity of a recombinant transporter protein (e.g. a recombinant xylose transporter protein) as described herein.

A "xylose-glucose growth media" refers to a yeast cell media containing a xylose compound in an amount sufficient to serve as a nutrient for growing or culturing recombinant yeast cells and a glucose compound. The term refers to a media that includes glucose in an amount sufficient to serve as a nutrient for growth or culturing recombinant yeast cells or in an amount sufficient to cause inhibition of activity of a recombinant transporter protein as described herein. The glucose may be present in the xylose-glucose growth media at a pre-determined concentration as described herein.

Xylose growth media and xylose-glucose growth media may be supplemented with other hexoses or pentoses described herein (e.g. mannose, galactose, or arabinose). Growth of a recombinant yeast cell in a xylose growth media may be compared to growth of a recombinant yeast cell in a xylose-glucose growth media. Thus, in embodiments, a recombinant xylose transporter protein may be selected for its xylose selectivity and/or its rate of transfer of a xylose compound into a yeast cell by comparing its growth in xylose growth media to its growth in xylose-glucose growth media. In embodiments, recombinant yeast cells having impaired growth in xylose-glucose growth media may indicate that the recombinant xylose transporter protein in the recombinant yeast is inhibited, at least in part, by glucose.

An "arabinose growth media" refers to a yeast cell media containing an arabinose compound in amounts sufficient to serve as a nutrient for growing or culturing recombinant yeast cells. The term refers to a media substantially free of glucose, and, in embodiments, is "glucose free" (i.e. the media contains no glucose). In embodiments, an arabinose growth media includes trace amounts of glucose which are undetectable using known methods and which are insufficient to support significant growth of yeast cells. In embodiments, an arabinose growth media includes trace amounts of glucose which are insufficient to cause inhibition of activity of a recombinant transporter protein (e.g. a recombinant arabinose transporter protein) as described herein.

An "arabinose-glucose growth media" refers to a yeast cell media containing an arabinose compound in an amount sufficient to serve as a nutrient for growing or culturing recombinant yeast cells and a glucose compound. The term refers to a media that includes glucose in an amount sufficient to serve as a nutrient for growth or culturing recombinant yeast cells or in an amount sufficient to cause inhibition of activity of a recombinant transporter protein as described herein. The glucose may be present in the arabinose-glucose growth media at a pre-determined concentration as described herein.

Arabinose growth media and arabinose-glucose growth media may be supplemented with other hexoses or pentoses described herein (e.g. mannose, galactose, or xylose). Growth of a recombinant yeast cell in an arabinose growth media may be compared to growth of a recombinant yeast cell in an arabinose-glucose growth media. Thus, in embodiments, a recombinant arabinose transporter may be selected for its arabinose selectivity and/or its rate of transfer of an arabinose compound into a yeast cell by comparing its growth in arabinose growth media to its growth in arabinose-glucose growth media. In embodiments, recombinant yeast cells having impaired growth in arabinose-glucose growth media may indicate that the recombinant arabinose transporter protein in the recombinant yeast is inhibited, at least in part, by glucose.

A "galactose growth media" refers to a yeast cell media containing a galactose compound in amounts sufficient to serve as a nutrient for growing or culturing recombinant yeast cells. The term refers to a media substantially free of

glucose, and, in embodiments, is "glucose free" (i.e. the media contains no glucose). In embodiments, a galactose growth media includes trace amounts of glucose which are undetectable using known methods and which are insufficient to support significant growth of yeast cells. In embodiments, a galactose growth media includes trace amounts of glucose which are insufficient to cause inhibition of activity of a recombinant transporter protein (e.g. a recombinant galactose transporter protein) as described herein.

A "galactose-glucose growth media" refers to a yeast cell media containing a galactose compound in an amount sufficient to serve as a nutrient for growing or culturing recombinant yeast cells and a glucose compound. The term refers to a media that includes glucose in an amount sufficient to serve as a nutrient for growth or culturing recombinant yeast cells or in an amount sufficient to cause inhibition of activity of a recombinant transporter protein as described herein. The glucose may be present in the galactose-glucose growth media at a pre-determined concentration as described herein.

Galactose growth media and galactose-glucose growth media may be supplemented with other hexoses or pentoses described herein (e.g. mannose, arabinose, or xylose). Growth of a recombinant yeast cell in a galactose growth media may be compared to growth of a recombinant yeast cell in a galactose-glucose growth media. Thus, in embodiments, a recombinant galactose transporter may be selected for its galactose selectivity and/or its rate of transfer of a galactose compound into a yeast cell by comparing its growth in galactose growth media to its growth in galactose-glucose growth media. In embodiments, recombinant yeast cells having impaired growth in galactose-glucose growth media may indicate that the recombinant galactose transporter protein in the recombinant yeast is inhibited, at least in part, by glucose.

As defined herein, the term "inhibition", "inhibit", "inhibiting" and the like refers to negatively affecting (e.g. decreasing) the activity or function of a recombinant transporter protein (e.g. recombinant xylose transporter protein) relative to the activity or function of the protein in the absence of the inhibitor (e.g. glucose). In embodiments, inhibition refers to a reduction in the growth rate of a recombinant yeast cell.

"Contacting" is used in accordance with its plain ordinary meaning and refers to the process of allowing at least two distinct species (e.g. chemical compounds including sugars, biomolecules or cells) to become sufficiently proximal to react, interact or physically touch. The term "contacting" includes allowing two species to react, interact, or physically touch, where the two species may be a sugar as described herein and a recombinant transporter protein as described herein. In embodiments contacting includes allowing a sugar described herein to interact with a recombinant transporter protein that is involved in transporting hexose or pentose compounds into a yeast cell.

I. Compositions

Provided herein are recombinant transporter proteins that include a transporter motif sequence and a glucose mitigation mutation. In one aspect, the recombinant transporter protein is a recombinant xylose transporter protein that includes a xylose transporter motif sequence and a glucose mitigation mutation.

1. Recombinant Xylose Transporter Protein

The xylose transporter motif sequence may correspond to amino acid residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein (SEQ ID NO: 1). In embodiments, the xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of SEQ ID NO:1. The transporter motif sequence may have the sequence -G-G/F-X^1-X^2-X^3-G-. X^1 is D, C, G, H, I, L, or F. X^2 is A, D, C, E, G, H, or I. X^3 is N, C, Q, F, G, L, M, S, T, or P. In embodiments, the transporter motif sequence is not -G-G-L-I-F-G- (SEQ ID NO:105) or -G-G-F-I-F-G- (SEQ ID NO:106).

X^1 may be D, C, G, I, L, or F. X^1 may be D, C, G, H, or F. X^1 may be D. X^1 may be C. X^1 may be G. X^1 may be I. X^1 may be L. X^1 may be H. X^1 may be F. X^2 may be D, C, E, G, H, or I. X^2 may be E, G, H, or I. X^2 may be H or I. X^2 may be H. X^2 may be I. X^3 may be N, Q, F, M, S, T, or P. X^3 may be F, M, S, or T. X^3 may be S, T, or M. X^3 may be T. X^3 may be S. X^3 may be M. In embodiments, when X^1 is F, X^2 may be I and X^3 may be M or S.

The xylose transporter motif sequence may be -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), -G-F-F-I-T-G- (SEQ ID NO:112), -G-G-F-L-M-G- (SEQ ID NO:113), -G-F-F-L-M-G- (SEQ ID NO:114), -G-G-F-L-S-G- (SEQ ID NO:115), -G-F-F-L-S-G- (SEQ ID NO:116), -G-G-F-L-T-G- (SEQ ID NO:117), -G-F-F-L-T-G- (SEQ ID NO:118), -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-F-H-S-G- (SEQ ID NO:121), -G-F-F-H-S-G- (SEQ ID NO:122), -G-G-F-H-T-G- (SEQ ID NO:123) or -G-F-F-H-T-G- (SEQ ID NO:124). In embodiments, the xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), or -G-F-F-I-T-G- (SEQ ID NO:112). In embodiments, the xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO:110). In embodiments, the xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), or -G-F-F-I-M-G- (SEQ ID NO:108). The xylose transporter motif sequence may be -G-G-F-I-M-G- (SEQ ID NO:107). The xylose transporter motif sequence may be -G-F-F-I-M-G- (SEQ ID NO:108). The xylose transporter motif sequence may be -G-G-F-I-S-G- (SEQ ID NO:109). The xylose transporter motif sequence may be -G-F-F-I-S-G- (SEQ ID NO:110). The xylose transporter motif sequence may be -G-G-F-I-T-G- (SEQ ID NO:111). The xylose transporter motif sequence may be -G-F-F-I-T-G- (SEQ ID NO:112). The xylose transporter motif sequence may be -G-G-F-L-M-G- (SEQ ID NO:113). The xylose transporter motif sequence may be -G-F-F-L-M-G- (SEQ ID NO:114). The xylose transporter motif sequence may be -G-G-F-L-S-G- (SEQ ID NO:115). The xylose transporter motif sequence may be -G-F-F-L-S-G- (SEQ ID NO:116). The xylose transporter motif sequence may be -G-G-F-L-T-G- (SEQ ID NO:117). The xylose transporter motif sequence may be -G-F-F-L-T-G- (SEQ ID NO:118). The xylose transporter motif sequence may be -G-G-F-H-M-G- (SEQ ID NO:119). The xylose transporter motif sequence may be -G-F-F-H-M-G- (SEQ ID NO:120). The xylose transporter motif sequence may be -G-G-F-H-S-G- (SEQ ID NO:121). The xylose transporter motif sequence may be -G-F-F-H-S-G- (SEQ ID NO:122). The xylose transporter motif sequence may be -G-G-F-H-T-G- (SEQ ID NO:123). The xylose transporter motif sequence may be -G-F-F-H-T-G- (SEQ ID NO:124).

The glucose mitigation mutation may be within a protein domain corresponding to a transmembrane of a recombinant

transporter protein (e.g. one or more of transmembrane domains 1-12). The glucose mitigation mutation may be within two or more protein domains corresponding to transmembranes of a recombinant transporter protein. The glucose mitigation mutation may be within a protein domain corresponding to a transmembrane of *Candida intermedia* GXS1 protein. The transmembrane may be a protein domain corresponding to transmembrane 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 of *Candida intermedia* GXS1 protein. The transmembrane may be a protein domain corresponding to a transmembrane a protein of SEQ ID NO:51-104. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 1 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 2 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 3 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 4 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 5 of *Candida intermedia* GXS1 protein.

In embodiments, the glucose mitigation mutation is within a protein domain corresponding to transmembrane 5 of SEQ ID NO:1. In embodiments, the glucose mitigation mutation is within a protein domain corresponding to residue 160-179 of SEQ ID NO:1. In embodiments, the glucose mitigation mutation is at a position corresponding to T170 or I171 of SEQ ID NO:1. In embodiments, the glucose mitigation mutation is a T170N mutation. In embodiments, the glucose mitigation mutation is a I171F mutation.

The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 6 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 7 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 8 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 8 or 9 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 8 and 9 of *Candida intermedia* GXS1 protein (e.g. amino acid residues about 347 to about 366 of *Candida intermedia* GXS1 amino acid sequence (SEQ ID NO: 1)). The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 10 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 11 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 12 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1.

In embodiments, the glucose mitigation mutation is within a protein domain corresponding to an extracellular domain of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be in a protein domain corresponding to the 11-12 extracellular domain of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be within a protein domain corresponding to a cytoplasmic domain (i.e. intracellular) of *Candida intermedia* GXS1 protein. In embodiments, the glucose mitigation mutation is in a protein domain corresponding to the 4-5 cytoplasmic domain (i.e. an intracellular domain between protein domains corresponding to transmembranes 4 and 5 of *Candida intermedia* GXS1 protein); the central cytoplasmic domain (i.e. an intracellular domain between protein domains corresponding to transmembranes 6 and 7 of *Candida intermedia* GXS1 protein); or the 10-11 cytoplasmic domain (i.e. an intracellular domain between protein domains corresponding to transmembranes 10 and 11 of *Candida intermedia* GXS1 protein) of *Candida intermedia* GXS1 protein.

The glucose mitigation mutation may be at a position corresponding to K155, T170, I171, N225, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be at a position corresponding to T170 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be at a position corresponding to I171 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be at a position corresponding to K155 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 155 as described herein. In embodiments, the glucose mitigation mutation is a K155E mutation. The glucose mitigation mutation may be at a position corresponding to N225 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 225 as described herein. In embodiments, the glucose mitigation mutation is a N225D mutation. The glucose mitigation mutation may be at a position corresponding to S354 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 354 as described herein. In embodiments, the glucose mitigation mutation is a S354T mutation. The glucose mitigation mutation may be at a position corresponding to A361 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 361 as described herein. In embodiments, the glucose mitigation mutation is a A361T mutation. The glucose mitigation mutation may be at a position corresponding to L407 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 407 as described herein. In embodiments, the glucose mitigation mutation is a L407M mutation. The glucose mitigation mutation may be at a position corresponding to N446 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 446 as described herein. In embodiments, the glucose mitigation mutation is a N446S mutation. The glucose mitigation mutation may be at a position corresponding to N326 of *Candida intermedia* GXS1 protein. The glucose mitigation mutation may be a conservative mutation at position 326 as described herein. In embodiments, the glucose mitigation mutation is a N326S mutation. In embodiments, the glucose mitigation mutation is a N326H mutation.

The glucose mitigation mutation may include two or more positions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include three or more positions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include four or more positions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include five or more posi-

tions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include six or more positions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include mutation at positions corresponding to K155, T170, I171, N225, N326, S354, A361, L407, and N446 of *Candida intermedia* GXS1 protein as described hereinabove. The glucose mitigation mutation may include mutation at positions corresponding to K155, T170, I171, N225, S354, A361, L407, and N446 of *Candida intermedia* GXS1 protein as described hereinabove.

The recombinant xylose transporter protein provided herein including embodiments thereof may further include an amino acid deletion. An amino acid deletion as provided herein is a deletion of at least one amino acid residue of a *Candida intermedia* GXS1 protein as described hereinabove. Thus, the sequence of a *Candida intermedia* GXS1 protein including an amino acid deletion includes at least one amino acid residue less relative to the sequence of a *Candida intermedia* GXS1 protein lacking said deletion. In embodiments, the deletion is at least 5 amino acids in length. In embodiments, the deletion is at least 10 amino acids in length. In embodiments, the deletion is at least 15 amino acids in length. In embodiments, the deletion is at least 20 amino acids in length. In embodiments, the deletion is at least 25 amino acids in length. In embodiments, the deletion is at least 30 amino acids in length. In embodiments, the deletion is at least 35 amino acids in length. In embodiments, the deletion is at least 40 amino acids in length. In embodiments, the deletion is at least 45 amino acids in length. In embodiments, the deletion is at least 50 amino acids in length. In embodiments, the deletion is at least 55 amino acids in length. In embodiments, the deletion is at least 60 amino acids in length. In embodiments, the deletion is at least 65 amino acids in length. In embodiments, the deletion is at least 70 amino acids in length. In embodiments, the deletion is at least 75 amino acids in length. In embodiments, the deletion is at least 80 amino acids in length. In embodiments, the deletion is at least 85 amino acids in length. In embodiments, the deletion is at least 90 amino acids in length. In embodiments, the deletion is at least 95 amino acids in length. In embodiments, the deletion is at least 100 amino acids in length.

In embodiments, the deletion is less than 50 amino acids in length. In embodiments, the deletion is less than 45 amino acids in length. In embodiments, the deletion is less than 40 amino acids in length. In embodiments, the deletion is less than 35 amino acids in length. In embodiments, the deletion is less than 30 amino acids in length. In embodiments, the deletion is less than 25 amino acids in length. In embodiments, the deletion is less than 20 amino acids in length. In embodiments, the deletion is less than 15 amino acids in length. In embodiments, the deletion is less than 10 amino acids in length. In embodiments, the deletion is within a protein domain corresponding to residue 497-522 of SEQ ID NO:1. In embodiments, the deletion is within a protein domain corresponding to residue 497-522 of a *Candida intermedia* GXS1 protein as described hereinabove.

2. Recombinant Arabinose Transporter Protein

Also provided herein is a recombinant arabinose transporter protein that includes an arabinose transporter motif sequence and a glucose mitigation mutation.

The arabinose transporter motif sequence may correspond to residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein. The arabinose transporter motif sequence may have the sequence -G-G/F-X^4-X^5-X^6-G-. X^4 is D, C, F, G, H, L, R, T, or P. X^5 is A, C, E, F, H, K, S, P, or V. X^6 is R, D, E, F, H, I, M, T, or Y. In embodiments, the arabinose transporter is not -G-G-L-V-Y-G- (SEQ ID NO:125), or -G-G-F-V-F-G- (SEQ ID NO:126).

X^4 may be D, F, G, L, R, or T. X^4 may be R, T, H, or F. X^4 may be R. X^4 may be T. X^4 may be H. X^4 may be F. X^5 may be A, E, F, P, H, or V. X^5 may be P, H, or V. X^5 may be P. X^5 may be H. X^5 may be V. X^6 may be T, H, F, M, or Y. X^6 may be F or Y. X^6 may be T or M. X^6 may be T. X^6 may be H. X^6 may be F. X^6 may be M. X^6 may be Y. In embodiments, X^4 is F or T, X^5 is P or I, and X^6 is M or T.

The arabinose transporter motif sequence may be -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-R-P-T-G- (SEQ ID NO:127), -G-F-R-P-T-G- (SEQ ID NO:128), -G-G-T-P-T-G- (SEQ ID NO:129), or -G-F-T-P-T-G- (SEQ ID NO:130). The arabinose transporter motif sequence may be -G-G-F-H-M-G- (SEQ ID NO:119), or -G-F-F-H-M-G- (SEQ ID NO:120). The arabinose transporter motif sequence may be -G-G-R-P-T-G- (SEQ ID NO:127), -G-F-R-P-T-G- (SEQ ID NO:128). The arabinose transporter motif sequence may be -G-G-T-P-T-G- (SEQ ID NO:129) or -G-F-T-P-T-G- (SEQ ID NO:130). The arabinose transporter motif sequence may be -G-G-F-H-M-G- (SEQ ID NO:119). The arabinose transporter motif sequence may be -G-F-F-H-M-G- (SEQ ID NO:120). The arabinose transporter motif sequence may be -G-G-R-P-T-G- (SEQ ID NO:127). The arabinose transporter motif sequence may be -G-F-R-P-T-G- (SEQ ID NO:128). The arabinose transporter motif sequence may be -G-G-T-P-T-G- (SEQ ID NO:129). The arabinose transporter motif sequence may be -G-F-T-P-T-G- (SEQ ID NO:130).

The glucose mitigation mutation of the recombinant arabinose transporter protein is as described hereinabove for the "recombinant xylose transporter protein" and includes embodiments thereof.

3. Recombinant Galactose Transporter Protein

Provided herein is a recombinant galactose transporter protein that includes an galactose transporter motif sequence and a glucose mitigation mutation.

The galactose transporter motif sequence is as described hereinabove for the "arabinose transporter motif sequence" and includes embodiments thereof. The glucose mitigation mutation of the recombinant arabinose transporter protein is as described hereinabove for the "recombinant xylose transporter protein" and includes embodiments thereof.

Also provided herein is a recombinant galactose-arabinose transporter protein that includes a galactose-arabinose transporter motif sequence and a glucose mitigation mutation. The galactose-arabinose transporter motif sequence may be as described hereinabove for the "arabinose transporter motif sequence" and includes embodiments thereof. The glucose mitigation mutation of the recombinant galactose-arabinose transporter protein is as described hereinabove for the "recombinant xylose transporter protein" and includes embodiments thereof.

II. Nucleic Acids

In another aspect is a nucleic acid encoding a recombinant xylose transporter protein described herein, including embodiments thereof. In yet another aspect is a nucleic acid encoding a recombinant arabinose transporter protein described herein, including embodiments thereof. In still another aspect is a nucleic acid encoding a recombinant galactose transporter protein described herein, including

embodiments thereof. In another aspect is a nucleic acid encoding a recombinant galactose-arabinose transporter protein described herein, including embodiments thereof. The nucleic acids may be RNA or DNA. The nucleic acids may be cDNA. The nucleic acids may be single- or double-stranded RNA or single- or double-stranded DNA. The nucleic acids may be located on a plasmid or other vector. The nucleic acids may be introduced and expressed by a yeast cell using conventional techniques known to those in the art.

III. Recombinant Yeast Cells

Provided herein are recombinant yeast cells that include a recombinant transporter protein as described herein, including embodiments thereof. Also provided herein are recombinant yeast cells that include a nucleic acid encoding a recombinant xylose transporter protein described herein, including embodiments thereof.

1. Recombinant Yeast Cell Including a Recombinant Xylose Transporter Protein

In one aspect is a recombinant yeast cell that includes a recombinant xylose transporter protein as described herein, including embodiments thereof. In embodiments, the growth rate of the recombinant yeast cell including a recombinant transporter protein as described herein can be measured. The growth rate may be determined in xylose growth media (i.e. in the absence of glucose). The growth rate may be determined in xylose-glucose growth media. In embodiments, the growth rates (i.e. growth rate in the absence and presence of glucose) are compared to determine the differential growth rate of the recombinant yeast cells. If the growth rate of recombinant yeast cells grown in xylose-glucose growth media is less than the growth rate of recombinant yeast cells grown in xylose growth media, the differential growth rate may indicate the presence of glucose inhibition of the recombinant transporter protein. As described herein, inclusion of a glucose mitigating mutation decreases, minimizes, or may eliminate glucose inhibition of a recombinant xylose transporter protein.

In embodiments, the growth rate of the recombinant yeast cell in a xylose-glucose growth media is about 5% to about 150% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 140% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 130% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 120% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 110% of the growth rate of the recombinant yeast cell in xylose growth media.

The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 100% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 90% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 80% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 70% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 60% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 50% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 40% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 30% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 20% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% to about 10% of the growth rate of the recombinant yeast cell in xylose growth media.

The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 150% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 140% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 130% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 120% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 110% of the growth rate of the recombinant yeast cell in xylose growth media.

The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 100% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 90% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 80% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 70% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 60% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 50% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 40% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 30% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% to about 20% of the growth rate of the recombinant yeast cell in xylose growth media.

The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 5% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 10% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 20% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 30% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 40% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 50% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 60% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 70% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 80% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 90% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 100% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about equal to the growth rate of the recombinant yeast cell in xylose growth media. Thus, in embodiments, the growth rate of the recombinant yeast cell is not inhibited in the presence of glucose. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be greater than the growth rate of the recombinant yeast cell in xylose growth media.

The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 110% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 120% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 130% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 140% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 150% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 160% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 170% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 180% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 190% of the growth rate of the recombinant yeast cell in xylose growth media. The growth rate of the recombinant yeast cell in a xylose-glucose growth media may be about 200% of the growth rate of the recombinant yeast cell in xylose growth media.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} to about 0.05 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.04 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.03 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.025 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.0225 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.02 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.0175 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.015 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.0125 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.01 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} to about 0.0075 hr^{-1}. In embodiments, the recombinant yeast cells are cultured in a xylose growth media and the growth rate is measured in the xylose growth media. In embodiments, the recombinant yeast cells are cultured in lignocellulosic biomass, hemicellulose, or xylan and the growth rate is measured in the lignocellulosic biomass, hemicellulose, or xylan respectively.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1}. In embodiments, the recombinant yeast cells are cultured in a xylose growth media and the growth rate is measured in the xylose growth media. In embodiments, the recombinant yeast cells are cultured in lignocellulosic biomass, hemicellulose, or xylan and the growth rate is measured in the lignocellulosic biomass, hemicellulose, or xylan respectively.

In embodiments, the recombinant yeast cells have a growth rate of about 0.05 hr^{-1} to about 0.1 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.125 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.15 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.175 hr^{-1}. The recombinant yeast cells

may have a growth rate of about 0.05 hr^{-1} to about 0.2 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.225 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.25 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.275 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.3 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.325 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.35 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.375 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.4 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.425 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.45 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.475 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.5 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.525 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.5 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.575 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.6 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.65 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.7 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.75 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.8 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.85 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.9 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 0.95 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} to about 1 hr^{-1}. In embodiments, the recombinant yeast cells are cultured in a xylose growth media and the growth rate is measured in the xylose growth media. In embodiments, the recombinant yeast cells are cultured in lignocellulosic biomass, hemicellulose, or xylan and the growth rate is measured in the lignocellulosic biomass, hemicellulose, or xylan respectively.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1}. The recombinant yeast cells may have a growth rate of about 1 hr^{-1}. In embodiments, the recombinant yeast cells are cultured in a xylose growth media and the growth rate is measured in the xylose growth media. In embodiments, the recombinant yeast cells are cultured in lignocellulosic biomass, hemicellulose, or xylan and the growth rate is measured in the lignocellulosic biomass, hemicellulose, or xylan respectively.

The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast

cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 2.5 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may

have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 5 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate

of about 0.75 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 10 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 20 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The

recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 30 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant

yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 50 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may

have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 75 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in xylose-glucose growth media that

includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in xylose-glucose growth media that includes 100 g/L glucose.

In embodiments, the growth rate of the recombinant yeast cell in xylose-glucose growth media is about 0.1× fold greater than a wildtype yeast cell (i.e. a yeast cell without a recombinant transporter protein described herein) in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.2× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.3× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.4× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.5× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.6× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.7× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.8× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 0.9× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 1× fold greater than a wildtype yeast cell in xylose-glucose growth media.

The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 2× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 3× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 4× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 5× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 6× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 7× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 8× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 9× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 10× fold greater than a wildtype yeast cell in xylose-glucose growth media.

The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 11× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 12× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 13× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 14× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 15× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 16× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 17× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 18× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 19× fold greater than a wildtype yeast cell in xylose-glucose growth media. The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 20× fold greater than a wildtype yeast cell in xylose-glucose growth media.

In embodiments, the recombinant xylose transporter transports a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 150% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 140% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 130% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 120% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5%

to about 110% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 100% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 90% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 80% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 70% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 60% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 50% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 40% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 30% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 20% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% to about 10% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 5% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 10% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 20% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 30% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 40% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 50% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 60% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 70% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 80% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 90% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 100% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. In embodiments, a recombinant xylose transporter transports a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate about equal to the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. In embodiments, a recombinant xylose transporter transports a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate greater to the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 110% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 120% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 130% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 140% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 150% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 160% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 170% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 180% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate of about 190% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast in a xylose-glucose growth media at a rate about 200% of the rate the recombinant xylose transporter transports the xylose compound into the recombinant yeast in a xylose growth media.

In embodiments, the xylose growth media includes xylose at a concentration of about 0.05 g/L to about 100 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 90 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 80 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 70 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 60 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 50 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 40 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 30 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 25 g/L.

In embodiments, the xylose growth media includes xylose at a concentration of about 0.05 g/L to about 20 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 15 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 10 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 5 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 4 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 3 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 2 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 1 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 0.5 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 0.1 g/L.

The xylose growth media may include xylose at a concentration of about 0.05 g/L. The xylose growth media may include xylose at a concentration of about 0.1 g/L. The xylose growth media may include xylose at a concentration of about 0.5 g/L. The xylose growth media may include xylose at a concentration of about 1 g/L. The xylose growth media may include xylose at a concentration of about 2 g/L. The xylose growth media may include xylose at a concentration of about 3 g/L. The xylose growth media may include xylose at a concentration of about 4 g/L. The xylose growth media may include xylose at a concentration of about 5 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L. The xylose growth media may include xylose at a concentration of about 15 g/L. The xylose growth media may include xylose at a concentration of about 20 g/L. The xylose growth media may include xylose at a concentration of about 25 g/L. The xylose growth media may include xylose at a concentration of about 30 g/L. The xylose growth media may include xylose at a concentration of about 40 g/L. The xylose growth media may include xylose at a concentration of about 50 g/L. The xylose growth media may include xylose at a concentration of about 60 g/L. The xylose growth media may include xylose at a concentration of about 70 g/L. The xylose growth media may include xylose at a concentration of about 80 g/L. The xylose growth media may include xylose at a concentration of about 90 g/L. The xylose growth media may include xylose at a concentration of about 100 g/L.

In embodiments, the xylose growth media includes xylose at a concentration of about 0.05 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 250 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 200 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 150 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 100 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 50 g/L. The xylose growth media may include xylose at a concentration of about 0.05 g/L to about 25 g/L. The xylose growth media may include xylose at a concentration of about 1 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 20 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 30 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 40 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 50 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 75 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 100 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 125 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 150 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 175 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 200 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 225 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 250 g/L to about 300 g/L. The xylose growth media may include xylose at a concentration of about 275 g/L to about 300 g/L.

In embodiments, the xylose growth media includes xylose at a concentration of about 10 g/L to about 275 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 250 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 225 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 200 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 175 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 150 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 125 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 100 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 75 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 50 g/L. The xylose growth media may include xylose at a concentration of about 10 g/L to about 25 g/L.

The xylose growth media may include xylose at a concentration of about 125 g/L. The xylose growth media may include xylose at a concentration of about 150 g/L. The xylose growth media may include xylose at a concentration of about 175 g/L. The xylose growth media may include xylose at a concentration of about 200 g/L. The xylose growth media may include xylose at a concentration of about 225 g/L. The xylose growth media may include xylose at a concentration of about 250 g/L. The xylose growth media may include xylose at a concentration of about 275 g/L. The xylose growth media may include xylose at a concentration of about 300 g/L.

In embodiments, the xylose-glucose growth media includes xylose at a concentration as described herein for xylose growth media. In embodiments, the xylose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 20 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 15 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 10 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 5 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 4 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 3 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 2 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 1 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.5 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.1 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.1 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.5 g/L. The xylose-glucose growth media may include glucose at a concentration of about 1 g/L. The xylose-glucose growth media may include glucose at a concentration of about 2 g/L. The xylose-glucose growth media may include glucose at a concentration of about 3 g/L. The xylose-glucose growth media may include glucose at a concentration of about 4 g/L. The xylose-glucose growth media may include glucose at a concentration of about 5 g/L. The xylose-glucose growth media may include glucose at a concentration of about 10 g/L. The xylose-glucose growth media may include glucose at a concentration of about 15 g/L. The xylose-glucose growth media may include glucose at a concentration of about 20 g/L.

In embodiments, the xylose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 100 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 90 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 80 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 70 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 60 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 50 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 40 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 30 g/L. The xylose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 25 g/L.

The xylose-glucose growth media may include glucose at a concentration of about 25 g/L. The xylose-glucose growth media may include glucose at a concentration of about 30 g/L. The xylose-glucose growth media may include glucose at a concentration of about 40 g/L. The xylose-glucose growth media may include glucose at a concentration of about 50 g/L. The xylose-glucose growth media may include glucose at a concentration of about 60 g/L. The xylose-glucose growth media may include glucose at a concentration of about 70 g/L. The xylose-glucose growth media may include glucose at a concentration of about 80 g/L. The xylose-glucose growth media may include glucose at a concentration of about 90 g/L. The xylose-glucose growth media may include glucose at a concentration of about 100 g/L.

2. Recombinant Yeast Cell Including a Recombinant Arabinose Transporter Protein

In another aspect is a recombinant yeast cell that includes a recombinant arabinose transporter protein as described herein, including embodiments thereof. In embodiments, the growth rate of the recombinant yeast cell including a recombinant arabinose transporter protein as described herein can be measured. The growth rate may be determined in arabinose growth media (i.e. in the absence of glucose). The growth rate may be determined in arabinose-glucose growth media. In embodiments, the growth rates (i.e. growth rate in the absence and presence of glucose) are compared to determine the differential growth rate of the recombinant yeast cells. If the growth rate of recombinant yeast cells grown in arabinose-glucose growth media is less than the growth rate of recombinant yeast cells grown in arabinose growth media, the differential growth rate may indicate glucose inhibits the activity of the recombinant arabinose transporter protein. As described herein, inclusion of a glucose mitigating mutation decreases, minimizes, or may eliminate glucose inhibition of the recombinant arabinose transporter protein.

In embodiments, the growth rate of the recombinant yeast cell in an arabinose-glucose growth media is about 5% to about 150% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 140% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 130% of

the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 120% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 110% of the growth rate of the recombinant yeast cell in arabinose growth media.

The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 100% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 90% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 80% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 70% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 60% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 50% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 40% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 30% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 20% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% to about 10% of the growth rate of the recombinant yeast cell in arabinose growth media.

The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 150% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 140% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 130% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 120% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 110% of the growth rate of the recombinant yeast cell in arabinose growth media.

The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 100% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 90% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 80% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 70% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 60% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 50% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 40% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 30% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% to about 20% of the growth rate of the recombinant yeast cell in arabinose growth media.

The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 5% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 10% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 20% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 30% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 40% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 50% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 60% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 70% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 80% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 90% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 100% of the growth rate of the recombinant yeast cell in arabinose growth media.

The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 110% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 120% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 130% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 140%

of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 150% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 160% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 170% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 180% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 190% of the growth rate of the recombinant yeast cell in arabinose growth media. The growth rate of the recombinant yeast cell in an arabinose-glucose growth media may be about 200% of the growth rate of the recombinant yeast cell in arabinose growth media.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The

recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in arabinose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose.

The recombinant yeast cells may have a growth rate of about 0.005 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may

have a growth rate of about 0.9 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in arabinose-glucose growth media that includes about 25 to about 100 g/L glucose.

In embodiments, the growth rate of the recombinant yeast cell in arabinose-glucose growth media is about 0.1× fold greater than a wildtype yeast cell (i.e. a yeast cell without a recombinant transporter protein described herein) in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.2× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.3× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.4× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.5× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.6× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.7× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.8× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 0.9× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 1× fold greater than a wildtype yeast cell in arabinose-glucose growth media.

The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 2× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 3× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 4× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 5× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 6× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 7× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 8× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 9× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 10× fold greater than a wildtype yeast cell in arabinose-glucose growth media.

The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 11× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 12× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 13× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 14× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 15× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 16× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 17× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 18× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 19× fold greater than a wildtype yeast cell in arabinose-glucose growth media. The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 20× fold greater than a wildtype yeast cell in arabinose-glucose growth media.

In embodiments, the recombinant arabinose transporter transports an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 150% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 140% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 130% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 120% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 110% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 100% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant

yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 90% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 80% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 70% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 60% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 50% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 40% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 30% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 20% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% to about 10% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 5% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 10% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 20% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 30% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 40% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 50% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 60% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 70% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 80% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 90% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 100% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 110% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 120% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 130% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 140% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate

of about 150% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 160% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 170% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 180% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate of about 190% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast in an arabinose-glucose growth media at a rate about 200% of the rate the recombinant arabinose transporter transports the arabinose compound into the recombinant yeast in an arabinose growth media.

In embodiments, the arabinose growth media includes arabinose at a concentration of about 0.05 g/L to about 20 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 15 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 10 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 5 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 4 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 3 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 2 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 1 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 0.5 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 0.1 g/L.

The arabinose growth media may include arabinose at a concentration of about 0.05 g/L. The arabinose growth media may include arabinose at a concentration of about 0.1 g/L. The arabinose growth media may include arabinose at a concentration of about 0.5 g/L. The arabinose growth media may include arabinose at a concentration of about 1 g/L. The arabinose growth media may include arabinose at a concentration of about 2 g/L. The arabinose growth media may include arabinose at a concentration of about 3 g/L. The arabinose growth media may include arabinose at a concentration of about 4 g/L. The arabinose growth media may include arabinose at a concentration of about 5 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L. The arabinose growth media may include arabinose at a concentration of about 15 g/L. The arabinose growth media may include arabinose at a concentration of about 20 g/L.

In embodiments, the arabinose growth media includes arabinose at a concentration of about 0.05 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 250 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 200 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 150 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 100 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 50 g/L. The arabinose growth media may include arabinose at a concentration of about 0.05 g/L to about 25 g/L. The arabinose growth media may include arabinose at a concentration of about 1 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 20 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 30 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 40 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 50 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 75 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 100 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 125 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 150 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 175 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 200 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 225 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 250 g/L to about 300 g/L. The arabinose growth media may include arabinose at a concentration of about 275 g/L to about 300 g/L.

In embodiments, the arabinose growth media includes arabinose at a concentration of about 10 g/L to about 275 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 250 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 225 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 200 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 175 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 150 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 125 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 100 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 75 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 50 g/L. The arabinose growth media may include arabinose at a concentration of about 10 g/L to about 25 g/L.

The arabinose growth media may include arabinose at a concentration of about 25 g/L. The arabinose growth media may include arabinose at a concentration of about 50 g/L. The arabinose growth media may include arabinose at a concentration of about 75 g/L. The arabinose growth media may include arabinose at a concentration of about 100 g/L.

The arabinose growth media may include arabinose at a concentration of about 125 g/L. The arabinose growth media may include arabinose at a concentration of about 150 g/L. The arabinose growth media may include arabinose at a concentration of about 175 g/L. The arabinose growth media may include arabinose at a concentration of about 200 g/L. The arabinose growth media may include arabinose at a concentration of about 225 g/L. The arabinose growth media may include arabinose at a concentration of about 250 g/L. The arabinose growth media may include arabinose at a concentration of about 275 g/L. The arabinose growth media may include arabinose at a concentration of about 300 g/L.

In embodiments, the arabinose-glucose growth media includes arabinose at a concentration described herein for an arabinose growth media. In embodiments, the arabinose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 100 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 90 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 80 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 70 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 60 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 50 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 40 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 30 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 25 g/L.

The arabinose-glucose growth media may include glucose at a concentration of about 25 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 30 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 40 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 50 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 60 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 70 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 80 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 90 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 100 g/L.

In embodiments, the arabinose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 20 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 15 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 10 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 5 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 4 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 3 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 2 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 1 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.5 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.1 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 0.5 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 1 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 2 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 3 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 4 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 5 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 10 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 15 g/L. The arabinose-glucose growth media may include glucose at a concentration of about 20 g/L.

3. Recombinant Yeast Cell Including a Recombinant Galactose Transporter Protein

In another aspect is a recombinant yeast cell that includes a recombinant galactose transporter protein as described herein, including embodiments thereof. In embodiments, the growth rate of the recombinant yeast cell including a recombinant transporter protein as described herein can be measured. The growth rate may be determined in galactose growth media (i.e. in the absence of glucose). The growth rate may be determined in galactose-glucose growth media. In embodiments, the growth rates (i.e. growth rate in the absence and presence of glucose) are compared to determine the differential growth rate of the recombinant yeast cells. If the growth rate of recombinant yeast cells grown in galactose-glucose growth media is less than the growth rate of recombinant yeast cells grown in galactose growth media, the differential growth rate may indicate glucose inhibits the activity of the recombinant galactose transporter protein. As described herein, inclusion of a glucose mitigating mutation decreases, minimizes, or may eliminate glucose inhibition experienced by the recombinant galactose transporter protein.

In embodiments, the growth rate of the recombinant yeast cell in a galactose-glucose growth media is about 5% to about 150% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 140% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 130% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 120% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 110% of the growth rate of the recombinant yeast cell in galactose growth media.

The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 100% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 90% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 80% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 70% of the

growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 60% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 50% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 40% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 30% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 20% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% to about 10% of the growth rate of the recombinant yeast cell in galactose growth media.

The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 150% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 140% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 130% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 120% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 110% of the growth rate of the recombinant yeast cell in galactose growth media.

The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 100% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 90% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 80% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 70% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 60% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 50% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 40% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 30% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% to about 20% of the growth rate of the recombinant yeast cell in galactose growth media.

The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 5% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 10% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 20% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 30% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 40% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 50% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 60% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 70% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 80% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 90% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 100% of the growth rate of the recombinant yeast cell in galactose growth media.

The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 110% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 120% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 130% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 140% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 150% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 160% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 170% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 180% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 190% of the growth rate of the recombinant yeast cell in galactose growth media. The growth rate of the recombinant yeast cell in a galactose-glucose growth media may be about 200% of the growth rate of the recombinant yeast cell in galactose growth media.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.01 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in galactose-glucose growth media that includes about 2.5, 5, 10, or 20 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.005 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0075 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast

cells may have a growth rate of about 0.01 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0125 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.015 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0175 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.02 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0225 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.025 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0275 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.03 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0325 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.035 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0375 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.04 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.0425 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.045 hr^{-1}. The recombinant yeast cells may have a growth rate of about 0.0475 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.05 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose.

In embodiments, the recombinant yeast cells have a growth rate of about 0.1 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.125 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.15 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.175 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.2 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.225 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.25 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.275 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.3 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.325 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.35 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.375 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.4 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.425 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.45 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.475 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.525 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.5 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.575 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.6 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.65 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.7 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.75 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.8 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.85 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.9 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 0.95 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose. The recombinant yeast cells may have a growth rate of about 1 hr^{-1} in galactose-glucose growth media that includes about 25 to about 100 g/L glucose.

In embodiments, the growth rate of the recombinant yeast cell in galactose-glucose growth media is about 0.1× fold greater than a wildtype yeast cell (i.e. a yeast cell without a recombinant transporter protein described herein) in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.2× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.3× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be

about 0.4× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.5× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.6× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.7× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.8× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 0.9× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 1× fold greater than a wildtype yeast cell in galactose-glucose growth media.

The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 2× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 3× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 4× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 5× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 6× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 7× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 8× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 9× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 10× fold greater than a wildtype yeast cell in galactose-glucose growth media.

The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 11× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 12× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 13× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 14× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 15× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 16× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 17× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 18× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 19× fold greater than a wildtype yeast cell in galactose-glucose growth media. The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 20× fold greater than a wildtype yeast cell in galactose-glucose growth media.

In embodiments, the recombinant galactose transporter transports an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 150% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 140% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 130% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 120% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 110% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media.

The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 100% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 90% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 80% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 70% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 60% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The

recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 50% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 40% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 30% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 20% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% to about 10% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media.

The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 5% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 10% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 20% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 30% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 40% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 50% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 60% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 70% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 80% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 90% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 100% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media.

The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 110% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 120% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 130% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 140% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 150% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 160% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 170% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 180% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate of about 190% of the rate the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media. The recombinant galactose transporter may transport an galactose compound into a recombinant yeast in a galactose-glucose growth media at a rate about 200% of the rate

the recombinant galactose transporter transports the galactose compound into the recombinant yeast in a galactose growth media.

In embodiments, the galactose growth media includes galactose a concentration of about 0.05 g/L to about 20 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 15 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 10 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 5 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 4 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 3 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 2 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 1 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 0.5 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 0.1 g/L.

The galactose growth media may include galactose a concentration of about 0.05 g/L. The galactose growth media may include galactose a concentration of about 0.1 g/L. The galactose growth media may include galactose a concentration of about 0.5 g/L. The galactose growth media may include galactose a concentration of about 1 g/L. The galactose growth media may include galactose a concentration of about 2 g/L. The galactose growth media may include galactose a concentration of about 3 g/L. The galactose growth media may include galactose a concentration of about 4 g/L. The galactose growth media may include galactose a concentration of about 5 g/L. The galactose growth media may include galactose a concentration of about 10 g/L. The galactose growth media may include galactose a concentration of about 15 g/L. The galactose growth media may include galactose a concentration of about 20 g/L.

In embodiments, the galactose growth media includes galactose a concentration of about 0.05 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 250 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 200 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 150 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 100 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 50 g/L. The galactose growth media may include galactose a concentration of about 0.05 g/L to about 25 g/L. The galactose growth media may include galactose a concentration of about 1 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 20 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 30 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 40 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 50 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 75 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 100 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 125 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 150 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 175 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 200 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 225 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 250 g/L to about 300 g/L. The galactose growth media may include galactose a concentration of about 275 g/L to about 300 g/L.

In embodiments, the galactose growth media includes galactose a concentration of about 10 g/L to about 275 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 250 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 225 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 200 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 175 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 150 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 125 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 100 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 75 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 50 g/L. The galactose growth media may include galactose a concentration of about 10 g/L to about 25 g/L.

The galactose growth media may include galactose a concentration of about 25 g/L. The galactose growth media may include galactose a concentration of about 50 g/L. The galactose growth media may include galactose a concentration of about 75 g/L. The galactose growth media may include galactose a concentration of about 100 g/L. The galactose growth media may include galactose a concentration of about 125 g/L. The galactose growth media may include galactose a concentration of about 150 g/L. The galactose growth media may include galactose a concentration of about 175 g/L. The galactose growth media may include galactose a concentration of about 200 g/L. The galactose growth media may include galactose a concentration of about 225 g/L. The galactose growth media may include galactose a concentration of about 250 g/L. The galactose growth media may include galactose a concentration of about 275 g/L. The galactose growth media may include galactose a concentration of about 300 g/L.

In embodiments, the galactose-glucose growth media includes galactose at a concentration as described herein for a galactose growth media. In embodiments, the galactose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 100 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 90 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 80 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 70 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 60 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 50 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 40 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 30 g/L. The galactose-glucose

growth media may include glucose at a concentration of about 0.05 g/L to about 25 g/L.

The galactose-glucose growth media may include glucose at a concentration of about 25 g/L. The galactose-glucose growth media may include glucose at a concentration of about 30 g/L. The galactose-glucose growth media may include glucose at a concentration of about 40 g/L. The galactose-glucose growth media may include glucose at a concentration of about 50 g/L. The galactose-glucose growth media may include glucose at a concentration of about 60 g/L. The galactose-glucose growth media may include glucose at a concentration of about 70 g/L. The galactose-glucose growth media may include glucose at a concentration of about 80 g/L. The galactose-glucose growth media may include glucose at a concentration of about 90 g/L. The galactose-glucose growth media may include glucose at a concentration of about 100 g/L.

In embodiments, the galactose-glucose growth media includes glucose at a concentration of about 0.05 g/L to about 20 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 15 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 10 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 5 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 4 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 3 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 2 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 1 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.5 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L to about 0.1 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.05 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.1 g/L. The galactose-glucose growth media may include glucose at a concentration of about 0.5 g/L. The galactose-glucose growth media may include glucose at a concentration of about 1 g/L. The galactose-glucose growth media may include glucose at a concentration of about 2 g/L. The galactose-glucose growth media may include glucose at a concentration of about 3 g/L. The galactose-glucose growth media may include glucose at a concentration of about 4 g/L. The galactose-glucose growth media may include glucose at a concentration of about 5 g/L. The galactose-glucose growth media may include glucose at a concentration of about 10 g/L. The galactose-glucose growth media may include glucose at a concentration of about 15 g/L. The galactose-glucose growth media may include glucose at a concentration of about 20 g/L.

IV. Methods

Also provided herein are methods of transporting xylose into a recombinant yeast cell. In one aspect, the method includes contacting a recombinant yeast cell with a xylose compound described herein, where the recombinant yeast cell includes a recombinant xylose transporter protein as described herein, including embodiments thereof. The recombinant xylose transporter protein transports the xylose compound into the recombinant yeast cell. In embodiments, the only sugar (i.e. carbon source) present is a xylose compound. The recombinant xylose transporter protein is as described herein, including embodiments thereof. By extension, the xylose transporter motif sequence and the glucose mitigation mutation are as described herein, including embodiments thereof.

In another aspect, the method includes contacting a recombinant yeast cell with a xylose compound, where the xylose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant xylose transporter protein as described herein, including embodiments thereof.

1. Transporting Xylose into a Recombinant Yeast Cell

The xylose compound may be derived from lignocellulosic biomass, hemicellulose, or xylan. Thus, in embodiments, the xylose compound is not the only sugar (i.e. carbon source) present. The xylose compound may be derived from lignocellulosic biomass. The xylose compound may be derived from hemicellulose. The xylose compound may be derived from xylan. In embodiments, the recombinant yeast cell metabolizes the xylose compound. The xylose compound may be present at a concentration as described hereinabove for the "xylose growth media". In embodiments, the recombinant yeast cell converts the xylose compound to a biofuel as described herein (e.g. ethanol) or to a biochemical as described herein. The recombinant yeast cell may convert the xylose compound to a biofuel as described herein (e.g. ethanol). The recombinant yeast cell may convert the xylose compound to a biochemical as described herein. In embodiments, the only sugar (i.e. carbon source) available is the xylose compound.

In embodiments, the recombinant xylose transporter transports a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The term "gDCW" provided herein is well known in the art and refers to gram dry cell weight. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 2 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 3 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 4 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 6 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 7 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 8 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 9 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 11 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 13 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 14 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 2 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 3 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 4 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 6 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 7 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 8 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 9 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 11 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 13 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 14 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 15 nmol min^{-1} $gDCW^{-1}$.

In embodiments, the recombinant xylose transporter transports a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 2.5 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 15 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 25 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 35 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 2.5 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 17 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 18 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 19 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 22 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 25 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 35 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may

transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$.

In embodiments, the recombinant xylose transporter transports a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$.

The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$. The recombinant xylose transporter may transport a xylose compound into a recombinant yeast cell in a xylose-glucose growth media at a rate of at least 150 nmol min^{-1} $gDCW^{-1}$.

2. Transporting Arabinose into a Recombinant Yeast Cell

Also provided herein are methods of transporting arabinose into a recombinant yeast cell. In one aspect, the method includes contacting a recombinant yeast cell with an arabinose compound described herein, where the recombinant yeast cell includes a recombinant arabinose transporter protein as described herein, including embodiments thereof. The recombinant arabinose transporter protein transports the arabinose compound into the recombinant yeast cell. In embodiments, the only sugar (i.e. carbon source) present is an arabinose compound. The recombinant arabinose transporter protein is as described herein, including embodiments thereof. By extension, the arabinose transporter motif sequence and the glucose mitigation mutation are as described herein, including embodiments thereof.

In another aspect, the method includes contacting a recombinant yeast cell with an arabinose compound, where the arabinose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant arabinose transporter protein as described herein, including embodiments thereof.

The arabinose compound may be derived from lignocellulosic biomass, hemicellulose, pectin, or xylan. Thus, in embodiments, the arabinose compound is not the only sugar (i.e. carbon source) present. The arabinose compound may be derived from lignocellulosic biomass. The arabinose compound may be derived from hemicellulose. The arabinose compound may be derived from pectin. The arabinose compound may be derived from xylan. In embodiments, the recombinant yeast cell metabolizes the arabinose compound. The arabinose compound may be present at a concentration as described hereinabove for the "arabinose growth media". In embodiments, the recombinant yeast cell converts the arabinose compound to a biofuel (e.g. ethanol) or to a biochemical as described herein, including embodiments thereof. The recombinant yeast cell may convert the arabinose compound to a biofuel (e.g. ethanol). The recombinant yeast cell may convert the arabinose compound to a biochemical as described herein, including embodiments thereof.

In embodiments, the recombinant arabinose transporter transports an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$ to 15 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 2 nmol min^{-1}

gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 3 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 4 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 5 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 6 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 7 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 8 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 9 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 10 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 11 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 12 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 13 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 14 nmol min^{-1} gDCW^{-1} to 15 nmol min^{-1} gDCW^{-1}.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 1 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 2 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 3 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 4 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 5 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 6 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 7 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 8 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 9 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 10 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 11 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 12 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 13 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 14 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 15 nmol min^{-1} gDCW^{-1}.

In embodiments, the recombinant arabinose transporter transports an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 1 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 2.5 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 5 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 10 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 12 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 15 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 20 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 25 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 30 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 35 nmol min^{-1} gDCW^{-1} to 50 nmol min^{-1} gDCW^{-1}. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose

growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 2.5 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 17 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 18 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 19 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 22 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 25 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 35 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$.

In embodiments, the recombinant arabinose transporter transports an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$.

The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$. The recombinant arabinose transporter may transport an arabinose compound into a recombinant yeast cell in an arabinose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$.

3. Transporting Galactose into a Recombinant Yeast Cell

Also provided herein are methods of transporting galactose into a recombinant yeast cell. In one aspect, the method

includes contacting a recombinant yeast cell with a galactose compound described herein, where the recombinant yeast cell includes a recombinant galactose transporter protein as described herein, including embodiments thereof. The recombinant galactose transporter protein transports the galactose compound into the recombinant yeast cell. In embodiments, the only sugar (i.e. carbon source) present is a galactose compound. The recombinant galactose transporter protein is as described herein, including embodiments thereof. By extension, the galactose transporter motif sequence and the glucose mitigation mutation are as described herein, including embodiments thereof.

In another aspect, the method includes contacting a recombinant yeast cell with a galactose compound, where the galactose compound is the only sugar (i.e. carbon source) in the media, and where the recombinant yeast cell includes a recombinant galactose transporter protein as described herein, including embodiments thereof.

The galactose compound may be derived from lignocellulosic biomass, hemicellulose, or marine biomass. Thus, in embodiments, the galactose compound is not the only sugar (i.e. carbon source) present. The galactose compound may be derived from lignocellulosic biomass. The galactose compound may be derived from hemicellulose. The galactose compound may be derived from marine biomass. In embodiments, the recombinant yeast cell metabolizes the galactose compound. The galactose compound may be present at a concentration as described hereinabove for the "galactose growth media". In embodiments, the recombinant yeast cell converts the galactose compound to a biofuel (e.g. ethanol) or to a biochemical as described herein, including embodiments thereof. The recombinant yeast cell may convert the galactose compound to a biofuel (e.g. ethanol). The recombinant yeast cell may convert the galactose compound to a biochemical as described herein, including embodiments thereof.

In embodiments, the recombinant galactose transporter transports a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 2 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 3 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 4 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 6 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 7 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 8 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 9 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 11 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 13 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 14 nmol min^{-1} $gDCW^{-1}$ to about 15 nmol min^{-1} $gDCW^{-1}$.

The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 2 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 3 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 4 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 6 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 7 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 8 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 9 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 11 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 13 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate

of at least 14 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 15 nmol min^{-1} $gDCW^{-1}$.

In embodiments, the recombinant galactose transporter transports a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 1 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 2.5 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 12 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 15 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 25 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 35 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$ to 50 nmol min^{-1} $gDCW^{-1}$.

The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 2.5 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 17 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 18 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 19 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 22 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 25 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 35 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 45 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$.

In embodiments, the recombinant galactose transporter transports a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 10 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 20 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 30 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 40 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 50 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may trans-

port a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$ to 150 nmol min^{-1} $gDCW^{-1}$.

The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 60 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 70 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 80 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 90 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 100 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 110 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 120 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 130 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 140 nmol min^{-1} $gDCW^{-1}$. The recombinant galactose transporter may transport a galactose compound into a recombinant yeast cell in a galactose-glucose growth media at a rate of at least 150 nmol min^{-1} $gDCW^{-1}$.

V. Examples

In previous research, was developed a xylose specific transporter hereafter termed "CiGXS1-FIM" ("FIM"), based on a hexose transporter from *C. intermedia*, GXS1. The FIM mutation imparted specificity in transporting xylose over glucose. (11) The presence of glucose, however, inhibited the performance of FIM in transporting xylose. Herein directed evolution was conducted to reduce the observed glucose inhibition.

A library of randomly mutated FIM was generated by error-prone PCR with a library size of over 1×10^5 mutants (as measured by independent *E. coli* colonies post-transformation). The mutant FIM was then transformed into *S. cerevisiae* ETKXG strain, a triple hexokinase knockout strain which is not able to grow on glucose, and screened on the xylose dependent growth based advantage on the drop-out plates with 20 g/L of xylose and 2.5 g/L of glucose. The 140 selected mutants from the plates were then tested for the growth on the medium with 20 g/L of xylose and 2.5 g/L glucose using Bioscreen C and the top 6 mutants were selected for further confirmation. The growth rates of the selected mutants on xylose in the presence of various concentration of glucose were then confirmed using Bioscreen C (FIG. **1**).

The mutant 105, which has 6 mutations: K155E, N225D, S354T, A361T, L407M, N446S (FIG. **2**), showed reduced glucose inhibition. Indeed, the mutant 105 showed significantly higher growth rates in the all tested conditions compared to FIM and wild-type transporters. Mutant 105 shows nearly a 30-fold increase in the growth rate on a xylose medium with the presence of glucose. The growth rate of the mutant 105 in the xylose 20 g/L+glucose 2.5 g/L medium was slightly higher than the growth rate of the wild-type transporter in the xylose only medium. Though the mutant 105 showed the highest reduction in glucose inhibition, the growth rate on xylose only was slightly reduced compared to FIM and wild-type. See FIG. **1**

The mutant 78, which has a single mutation, N326S, showed reduced glucose inhibition without decrease in xylose transport capability. In contrast to mutant 105, mutant 78 showed no reduction in the xylose transport performance. This suggests the mutant 78 represents a promising candidate for further round of directed evolution to develop xylose transporters with reduced glucose inhibition.

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VI. P Embodiments

Embodiment P 1

A recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation.

Embodiment P 2

The recombinant xylose transporter protein of embodiment P 1, wherein said xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein, and wherein said xylose transporter motif sequence is -G-G/F-X^1-X^2-X^3-G-; wherein, X^1 is D, C, G, H, I, L, or F; X^2 is A, D, C, E, G, H, or I; and X^3 is N, C, Q, F, G, L, M, S, T, or P.

Embodiment P 3

The recombinant xylose transporter protein of embodiment P 1 or embodiment P 2, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), -G-F-F-I-T-G- (SEQ ID NO:112), -G-G-F-L-M-G- (SEQ ID NO:113), -G-F-F-L-M-G- (SEQ ID NO:114), -G-G-F-L-S-G- (SEQ ID NO:115), -G-F-F-L-S-G- (SEQ ID NO:116), -G-G-F-L-T-G- (SEQ ID NO:117), -G-F-F-L-T-G- (SEQ ID NO:118), -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-F-H-S-G- (SEQ ID NO:121), -G-F-F-H-S-G- (SEQ ID NO:122), -G-G-F-H-T-G- (SEQ ID NO:123) or -G-F-F-H-T-G- (SEQ ID NO:124).

Embodiment P 4

The recombinant xylose transporter protein of any one of embodiments P 1 to 3, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO:110).

Embodiment P 5

The recombinant xylose transporter protein of any one of embodiments P 1 to 4, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107).

Embodiment P 6

The recombinant xylose transporter protein of any one of embodiments P 1 to 5, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1 protein.

Embodiment P 7

The recombinant xylose transporter protein of any one of embodiments P 1 to 6, wherein said glucose mitigation mutation is at a position corresponding to K155, N225, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein.

Embodiment P 8

The recombinant xylose transporter protein of any one of embodiments P 1 to 5, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 8 of *Candida intermedia* GXS1 protein.

Embodiment P 9

The recombinant xylose transporter protein of any one of embodiments P 1 to 5, or embodiment P 8, wherein said glucose mitigation mutation is at a position corresponding N326 of *Candida intermedia* GXS1 protein.

Embodiment P 10

The recombinant xylose transporter protein of embodiment P 9, wherein said glucose mitigation mutation is a N326S mutation.

Embodiment P 11

A recombinant yeast cell comprising a recombinant xylose transporter protein of any one of embodiments P 1 to 10.

Embodiment P 12

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 10% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 13

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 20% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 14

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 30% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 15

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 40% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 16

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 50% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 17

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 60% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 18

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-

glucose growth media is at least about 70% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 19

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 80% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 20

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 90% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 21

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 100% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 22

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 110% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 23

The recombinant yeast cell of embodiment P 11, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 120% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment P 24

The recombinant yeast cell of any one of embodiments P 11 to 23, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 20 g/L glucose.

Embodiment P 25

The recombinant yeast cell of any one of embodiments P 11 to 24, wherein said xylose-glucose growth media comprises about 2.5 g/L glucose.

Embodiment P 26

The recombinant yeast cell of any one of embodiments P 11 to 25, wherein said xylose-glucose growth media comprises about 5 g/L glucose.

Embodiment P 27

The recombinant yeast cell of any one of embodiments P 11 to 26, wherein said xylose-glucose growth media comprises about 10 g/L glucose.

Embodiment P 28

The recombinant yeast cell of any one of embodiments P 11 to 27, wherein said xylose-glucose growth media comprises about 20 g/L glucose.

Embodiment P 29

The recombinant yeast cell of any one of embodiments P 11 to 28, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment P 30

The recombinant yeast cell of any one of embodiments P 11 to 29, wherein said xylose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment P 31

The recombinant yeast cell of any one of embodiments P 11 to 30, wherein said xylose growth media comprises about 20 g/L xylose.

Embodiment P 32

A method of transporting xylose into a recombinant yeast cell, said method comprising: i) contacting a recombinant yeast cell with a xylose compound, wherein said recombinant yeast cell comprises a recombinant xylose transporter protein, said recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation; and ii) allowing said recombinant xylose transporter protein to transport said xylose compound into said recombinant yeast cell.

Embodiment P 33

The method of embodiment P 32, wherein said xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein, and wherein said xylose transporter motif sequence is -G-G/F-X^1-X^2-X^3-G-; wherein, X^1 is D, C, G, H, I, L, or F; X^2 is A, D, C, E, G, H, or I; and X^3 is N, C, Q, F, G, L, M, S, T, or P.

Embodiment P 34

The method of embodiment P 32 or embodiment P 33, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), -G-F-F-I-T-G- (SEQ ID NO:112), -G-G-F-L-M-G- (SEQ ID NO:113), -G-F-F-L-M-G- (SEQ ID NO:114), -G-G-F-L-S-G- (SEQ ID NO:115), -G-F-F-L-S-G- (SEQ ID NO:116), -G-G-F-L-T-G- (SEQ ID NO:117), -G-F-F-L-T-G- (SEQ ID NO:118), -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-F-H-S-G- (SEQ ID NO:121), -G-F-F-H-S-G- (SEQ ID NO:122), -G-G-F-H-T-G- (SEQ ID NO:123) or -G-F-F-H-T-G- (SEQ ID NO:124).

Embodiment P 35

The method of any one of embodiments P 32 to 34, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO:110).

Embodiment P 36

The method of any one of embodiments P 32 to 35, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107).

Embodiment P 37

The method of any one of embodiments P 32 to 36, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1 protein.

Embodiment P 38

The method of any one of embodiments P 32 to 37, wherein said glucose mitigation mutation is at a position corresponding to K155, N225, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein.

Embodiment P 39

The method of any one of embodiments P 32 to 36, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 8 of *Candida intermedia* GXS1 protein.

Embodiment P 40

The method of any one of embodiments P 32 to 36, or embodiment P 39, wherein said glucose mitigation mutation is at a position corresponding N326 of *Candida intermedia* GXS1 protein.

Embodiment P 41

The method of embodiment P 40, wherein said glucose mitigation mutation is a N326S mutation.

Embodiment P 42

The method of any one of embodiments P 32 to 41, wherein said recombinant yeast cell metabolizes said xylose compound.

Embodiment P 43

The method of any one of embodiments P 32 to 42, wherein said recombinant yeast cell converts said xylose compound to a biofuel.

Embodiment P 44

The method of any one of embodiments P 32 to 43, wherein said xylose compound forms part of lignocellulosic biomass, hemicellulose, or xylan.

Embodiment P 45

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 10% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 46

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 20% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 47

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 30% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 48

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 40% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 49

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 50% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 50

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 60% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 51

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 70% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 52

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 80% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 53

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 90% of the rate said recom-

binant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 54

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 100% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 55

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 110% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 56

The method of any one of embodiments P 32 to 44, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 120% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment P 57

The method of any one of embodiments P 45 to 56, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 20 g/L glucose.

Embodiment P 58

The method of any one of embodiments P 45 to 57, wherein said xylose-glucose growth media comprises about 2.5 g/L glucose.

Embodiment P 59

The method of any one of embodiments P 45 to 58, wherein said xylose-glucose growth media comprises about 5 g/L glucose.

Embodiment P 60

The method of any one of embodiments P 45 to 59, wherein said xylose-glucose growth media comprises about 10 g/L glucose.

Embodiment P 61

The method of any one of embodiments P 45 to 60, wherein said xylose-glucose growth media comprises about 20 g/L glucose.

Embodiment P 62

The method of any one of embodiments P 45 to 61, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment P 63

The method of any one of embodiments P 45 to 62, wherein said xylose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment P 64

The method of any one of embodiments P 45 to 63, wherein said xylose growth media comprises about 20 g/L xylose.

Embodiment P 65

The method of any one of embodiments P 32 to 64, wherein said recombinant xylose transporter protein transports said xylose compound into said recombinant yeast cell in a xylose-glucose growth media growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$.

Embodiment P 66

A nucleic acid encoding the recombinant xylose transporter protein of one of embodiments P 1 to 10.

VII. Further Embodiments

Embodiment 1

A recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation.

Embodiment 2

The recombinant xylose transporter protein of embodiment 1, wherein said xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein.

Embodiment 3

The recombinant xylose transporter protein of embodiment 1 or embodiment 2, wherein said xylose transporter motif sequence is -G-G/F-X^1-X^2-X^3-G-; wherein, X^1 is D, C, G, H, I, L, or F; X^2 is A, D, C, E, G, H, or I; and X^3 is N, C, Q, F, G, L, M, S, T, or P.

Embodiment 4

The recombinant xylose transporter protein of one of embodiments 1-3, wherein said xylose transporter motif sequence is G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), -G-F-F-I-T-G- (SEQ ID NO:112), -G-G-F-L-M-G- (SEQ ID NO:113), -G-F-F-L-M-G- (SEQ ID NO:114), -G-G-F-L-S-G- (SEQ ID NO:115), -G-F-F-L-S-G- (SEQ ID NO:116), -G-G-F-L-T-G- (SEQ ID NO:117), -G-F-F-L-T-G- (SEQ ID NO:118), -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-F-H-S-G- (SEQ ID NO:121), -G-F-F-H-S-G- (SEQ ID NO:122), -G-G-F-H-T-G- (SEQ ID NO:123) or -G-F-F-H-T-G- (SEQ ID NO:124).

Embodiment 5

The recombinant xylose transporter protein of any one of embodiments 2 to 4, wherein said xylose transporter motif

sequence is G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO:110).

Embodiment 6

The recombinant xylose transporter protein of any one of embodiments 1 to 5, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107).

Embodiment 7

The recombinant xylose transporter protein of any one of embodiments 1 to 6, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1 protein.

Embodiment 8

The recombinant xylose transporter protein of any one of embodiments 1 to 7, wherein said glucose mitigation mutation is at a position corresponding to K155, N225, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein.

Embodiment 9

The recombinant xylose transporter protein of any one of embodiments 1 to 6, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 8 of *Candida intermedia* GXS1 protein.

Embodiment 10

The recombinant xylose transporter protein of any one of embodiments 1 to 6, or embodiment 9, wherein said glucose mitigation mutation is at a position corresponding to N326 of *Candida intermedia* GXS1 protein.

Embodiment 11

The recombinant xylose transporter protein of embodiment 10, wherein said glucose mitigation mutation is a N326H mutation.

Embodiment 12

The recombinant xylose transporter protein of embodiment 10, wherein said glucose mitigation mutation is a N326S mutation.

Embodiment 13

The recombinant xylose transporter protein of any one of embodiments 1 to 6, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 5 of *Candida intermedia* GXS1 protein.

Embodiment 14

The recombinant xylose transporter protein of any one of embodiments 1 to 6, or embodiment 13, wherein said glucose mitigation mutation is within a protein domain corresponding to residue 160-179 of *Candida intermedia* GXS1 protein.

Embodiment 15

The recombinant xylose transporter protein of any one of embodiments 1 to 6, 13 or 14, wherein said glucose mitigation mutation is at a position corresponding to T170 or I171 of *Candida intermedia* GXS1 protein.

Embodiment 16

The recombinant xylose transporter protein of embodiment 15, wherein said glucose mitigation mutation is a T170N mutation.

Embodiment 17

The recombinant xylose transporter protein of embodiment 15, wherein said glucose mitigation mutation is a I171F mutation.

Embodiment 18

The recombinant xylose transporter protein of one of embodiments 1-17 further comprising an amino acid deletion.

Embodiment 19

The recombinant xylose transporter protein of embodiment 18, wherein said deletion is within a protein domain corresponding to residue 497-522 of *Candida intermedia* GXS1 protein.

Embodiment 20

The recombinant xylose transporter protein of embodiment 18 or embodiment 19, wherein said deletion is at least 10 amino acids in length.

Embodiment 21

A recombinant yeast cell comprising a recombinant xylose transporter protein of any one of embodiments 1 to 20

Embodiment 22

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 10% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 23

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 20% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 24

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 30% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 25

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 40% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 26

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-

glucose growth media is at least about 50% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 27

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 60% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 28

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 70% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 29

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 80% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 30

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 90% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 31

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 100% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 32

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 110% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 33

The recombinant yeast cell of embodiment 21, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 120% of the growth rate of said recombinant yeast cell in a xylose growth media.

Embodiment 34

The recombinant yeast cell of any one of embodiments 21 to 33, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 20 g/L glucose.

Embodiment 35

The recombinant yeast cell of any one of embodiments 21 to 34, wherein said xylose-glucose growth media comprises about 2.5 g/L glucose.

Embodiment 36

The recombinant yeast cell of any one of embodiments 21 to 35, wherein said xylose-glucose growth media comprises about 5 g/L glucose.

Embodiment 37

The recombinant yeast cell of any one of embodiments 21 to 36, wherein said xylose-glucose growth media comprises about 10 g/L glucose.

Embodiment 38

The recombinant yeast cell of any one of embodiments 21 to 37, wherein said xylose-glucose growth media comprises about 20 g/L glucose.

Embodiment 39

The recombinant yeast cell of any one of embodiments 21 to 38, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment 40

The recombinant yeast cell of any one of embodiments 21 to 39, wherein said xylose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment 41

The recombinant yeast cell of any one of embodiments 21 to 40, wherein said xylose growth media comprises about 20 g/L xylose.

Embodiment 42

A method of transporting xylose into a recombinant yeast cell, said method comprising: i) contacting a recombinant yeast cell with a xylose compound, wherein said recombinant yeast cell comprises a recombinant xylose transporter protein, said recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation; and ii) allowing said recombinant xylose transporter protein to transport said xylose compound into said recombinant yeast cell.

Embodiment 43

The method of embodiment 42, wherein said xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of *Candida intermedia* GXS1 protein.

Embodiment 44

The method of embodiment 42 or embodiment 43, wherein said xylose transporter motif sequence is -G-G/F-X^1-X^2-X^3-G-; wherein, X^1 is D, C, G, H, I, L, or F; X^2 is A, D, C, E, G, H, or I; and X^3 is N, C, Q, F, G, L, M, S, T, or P.

Embodiment 45

The method of one of embodiments 42-44, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ

ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), -G-F-F-I-S-G- (SEQ ID NO:110), -G-G-F-I-T-G- (SEQ ID NO:111), -G-F-F-I-T-G- (SEQ ID NO:112), -G-G-F-L-M-G- (SEQ ID NO:113), -G-F-F-L-M-G- (SEQ ID NO:114), -G-G-F-L-S-G- (SEQ ID NO:115), -G-F-F-L-S-G- (SEQ ID NO:116), -G-G-F-L-T-G- (SEQ ID NO:117), -G-F-F-L-T-G- (SEQ ID NO:118), -G-G-F-H-M-G- (SEQ ID NO:119), -G-F-F-H-M-G- (SEQ ID NO:120), -G-G-F-H-S-G- (SEQ ID NO:121), -G-F-F-H-S-G- (SEQ ID NO:122), -G-G-F-H-T-G- (SEQ ID NO:123) or -G-F-F-H-T-G- (SEQ ID NO:124).

Embodiment 46

The method of any one of embodiments 42 to 45, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO:110).

Embodiment 47

The method of any one of embodiments 42 to 46, wherein said xylose transporter motif sequence is -G-G-F-I-M-G- (SEQ ID NO:107).

Embodiment 48

The method of any one of embodiments 42 to 47, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 9 of *Candida intermedia* GXS1 protein.

Embodiment 49

The method of any one of embodiments 42 to 48, wherein said glucose mitigation mutation is at a position corresponding to K155, N225, S354, A361, L407, or N446 of *Candida intermedia* GXS1 protein.

Embodiment 50

The method of any one of embodiments 42 to 47, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 8 of *Candida intermedia* GXS1 protein.

Embodiment 51

The method of any one of embodiments 42 to 47, or embodiment 50, wherein said glucose mitigation mutation is at a position corresponding N326 of *Candida intermedia* GXS1 protein.

Embodiment 52

The method of embodiment 51, wherein said glucose mitigation mutation is a N326H mutation.

Embodiment 53

The method of embodiment 51, wherein said glucose mitigation mutation is a N326S mutation.

Embodiment 54

The method of any one of embodiments 42 to 47, wherein said glucose mitigation mutation is within a protein domain corresponding to transmembrane 5 of *Candida intermedia* GXS1 protein.

Embodiment 55

The method of one of embodiments 42 to 47, or embodiment 54, wherein said glucose mitigation mutation is within a protein domain corresponding to residue 160-179 of *Candida intermedia* GXS1 protein.

Embodiment 56

The method of embodiment 54 or 55, wherein said glucose mitigation mutation is at a position corresponding to T170 or I171 of *Candida intermedia* GXS1 protein.

Embodiment 57

The method of embodiment 56, wherein said glucose mitigation mutation is a T170N mutation.

Embodiment 58

The method of embodiment 56, wherein said glucose mitigation mutation is a I171F mutation.

Embodiment 59

The method of any one of embodiments 42 to 58, further comprising an amino acid deletion.

Embodiment 60

The method of embodiment 59, wherein said deletion is within a protein domain corresponding to residue 497-522 of *Candida intermedia* GXS1 protein.

Embodiment 61

The method of any one of embodiments 42 to 53, wherein said recombinant yeast cell metabolizes said xylose compound.

Embodiment 62

The method of any one of embodiments 42 to 61, wherein said recombinant yeast cell converts said xylose compound to a biofuel.

Embodiment 63

The method of any one of embodiments 42 to 62, wherein said xylose compound forms part of lignocellulosic biomass, hemicellulose, or xylan.

Embodiment 64

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 10% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 65

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 20% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 66

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 30% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 67

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 40% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 68

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 50% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 69

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 60% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 70

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 70% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 71

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 80% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 72

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 90% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 73

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 100% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 74

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 110% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 75

The method of any one of embodiments 42 to 63, wherein said recombinant xylose transporter transports said xylose compound into said yeast in a xylose-glucose growth media at a rate at least about 120% of the rate said recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

Embodiment 76

The method of any one of embodiments 64 to 75, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 20 g/L glucose.

Embodiment 77

The method of any one of embodiments 64 to 76, wherein said xylose-glucose growth media comprises about 2.5 g/L glucose.

Embodiment 78

The method 1 of any one of embodiments 64 to 77, wherein said xylose-glucose growth media comprises about 5 g/L glucose.

Embodiment 79

The method of any one of embodiments 64 to 78, wherein said xylose-glucose growth media comprises about 10 g/L glucose.

Embodiment 80

The method of any one of embodiments 64 to 79, wherein said xylose-glucose growth media comprises about 20 g/L glucose.

Embodiment 81

The method of any one of embodiments 64 to 80, wherein said xylose-glucose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment 82

The method of any one of embodiments 64 to 81, wherein said xylose growth media comprises about 0.05 g/L to about 300 g/L xylose.

Embodiment 83

The method of any one of embodiments 64 to 82, wherein said xylose growth media comprises about 20 g/L xylose.

Embodiment 84

The method of any one of embodiments 42 to 83, wherein said recombinant xylose transporter protein transports said xylose compound into said recombinant yeast cell in a xylose-glucose growth media growth media at a rate of at least 5 nmol min^{-1} $gDCW^{-1}$

Embodiment 85

A nucleic acid encoding the recombinant xylose transporter protein of one of embodiments 1 to 21.

SEQUENCE LISTING

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<210> SEQ ID NO 1
<211> LENGTH: 522
<212> TYPE: PRT
<213> ORGANISM: Candida intermedia

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            20                  25                  30

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

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
    50                  55                  60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65                  70                  75                  80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
                85                  90                  95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
            100                 105                 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
        115                 120                 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
    130                 135                 140

Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145                 150                 155                 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Thr Ile Gly Leu Phe Leu Ala
                165                 170                 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
            180                 185                 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
        195                 200                 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
    210                 215                 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225                 230                 235                 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
                245                 250                 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
            260                 265                 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
        275                 280                 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
    290                 295                 300
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Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305                 310                 315                 320

Ala Thr Asn Ile Val Asn Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
                325                 330                 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
        355                 360                 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
    370                 375                 380

Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
                485                 490                 495

Lys His Ser Phe Arg Glu Gln Val Asp Gln Gln Met Asp Ser Lys Thr
            500                 505                 510

Glu Ala Ile Met Ser Glu Glu Ala Ser Val
        515                 520


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<211> LENGTH: 522
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

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Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile Ile Val Gly Leu Phe
            20                  25                  30

Ala Ala Ser Gly Gly Phe Ile Met Gly Tyr Asp Thr Gly Thr Ile Ser
        35                  40                  45

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
    50                  55                  60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65                  70                  75                  80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
                85                  90                  95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
            100                 105                 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
        115                 120                 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
    130                 135                 140
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Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145                 150                 155                 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Thr Ile Gly Leu Phe Leu Ala
                165                 170                 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
            180                 185                 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
        195                 200                 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
    210                 215                 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225                 230                 235                 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
                245                 250                 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
            260                 265                 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
        275                 280                 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
    290                 295                 300

Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305                 310                 315                 320

Ala Thr Asn Ile Val Asn Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
                325                 330                 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
        355                 360                 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
    370                 375                 380

Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
                485                 490                 495

Lys His Ser Phe Arg Glu Gln Val Asp Gln Gln Met Asp Ser Lys Thr
            500                 505                 510

Glu Ala Ile Met Ser Glu Glu Ala Ser Val
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<211> LENGTH: 522
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

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<400> SEQUENCE: 3

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            20                  25                  30

Ala Ala Ser Gly Gly Phe Ile Met Gly Tyr Asp Thr Gly Thr Ile Ser
        35                  40                  45

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
    50                  55                  60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65                  70                  75                  80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
                85                  90                  95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
            100                 105                 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
        115                 120                 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
    130                 135                 140

Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145                 150                 155                 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Thr Ile Gly Leu Phe Leu Ala
                165                 170                 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
            180                 185                 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
        195                 200                 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
    210                 215                 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225                 230                 235                 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
                245                 250                 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
            260                 265                 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
        275                 280                 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
    290                 295                 300

Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305                 310                 315                 320

Ala Thr Asn Ile Val His Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
                325                 330                 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
        355                 360                 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
    370                 375                 380

Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
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                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
                485                 490                 495

Lys His Ser Phe Arg Glu Gln Val Asp Gln Gln Met Asp Ser Lys Thr
            500                 505                 510

Glu Ala Ile Met Ser Glu Glu Ala Ser Val
        515                 520


<210> SEQ ID NO 4
<211> LENGTH: 522
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

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            20                  25                  30

Ala Ala Ser Gly Gly Phe Ile Met Gly Tyr Asp Thr Gly Thr Ile Ser
        35                  40                  45

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
    50                  55                  60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65                  70                  75                  80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
                85                  90                  95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
            100                 105                 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
        115                 120                 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
    130                 135                 140

Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145                 150                 155                 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Asn Ile Gly Leu Phe Leu Ala
                165                 170                 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
            180                 185                 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
        195                 200                 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
    210                 215                 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225                 230                 235                 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
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                245                 250                 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
            260                 265                 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
        275                 280                 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
    290                 295                 300

Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305                 310                 315                 320

Ala Thr Asn Ile Val Asn Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
                325                 330                 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
        355                 360                 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
    370                 375                 380

Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
                485                 490                 495

Lys His Ser Phe Arg Glu Gln Val Asp Gln Gln Met Asp Ser Lys Thr
            500                 505                 510

Glu Ala Ile Met Ser Glu Glu Ala Ser Val
        515                 520


<210> SEQ ID NO 5
<211> LENGTH: 496
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 5

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Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile Ile Val Gly Leu Phe
            20                  25                  30

Ala Ala Ser Gly Gly Phe Ile Met Gly Tyr Asp Thr Gly Thr Ile Ser
        35                  40                  45

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
    50                  55                  60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65                  70                  75                  80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
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                85                  90                  95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
            100                 105                 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
        115                 120                 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
    130                 135                 140

Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145                 150                 155                 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Thr Ile Gly Leu Phe Leu Ala
                165                 170                 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
            180                 185                 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
        195                 200                 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
    210                 215                 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225                 230                 235                 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
                245                 250                 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
            260                 265                 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
        275                 280                 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
    290                 295                 300

Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305                 310                 315                 320

Ala Thr Asn Ile Val His Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
                325                 330                 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
        355                 360                 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
    370                 375                 380

Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
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<210> SEQ ID NO 6

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<211> LENGTH: 496
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 6

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Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile Ile Val Gly Leu Phe
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Ala Ala Ser Gly Gly Phe Ile Met Gly Tyr Asp Thr Gly Thr Ile Ser
35 40 45

Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg Tyr Pro Ser Asn Lys
50 55 60

His Ser Phe Thr Ala Asp Glu Ser Ser Leu Ile Val Ser Ile Leu Ser
65 70 75 80

Val Gly Thr Phe Phe Gly Ala Leu Cys Ala Pro Phe Leu Asn Asp Thr
85 90 95

Leu Gly Arg Arg Trp Cys Leu Ile Leu Ser Ala Leu Ile Val Phe Asn
100 105 110

Ile Gly Ala Ile Leu Gln Val Ile Ser Thr Ala Ile Pro Leu Leu Cys
115 120 125

Ala Gly Arg Val Ile Ala Gly Phe Gly Val Gly Leu Ile Ser Ala Thr
130 135 140

Ile Pro Leu Tyr Gln Ser Glu Thr Ala Pro Lys Trp Ile Arg Gly Ala
145 150 155 160

Ile Val Ser Cys Tyr Gln Trp Ala Ile Thr Phe Gly Leu Phe Leu Ala
165 170 175

Ser Cys Val Asn Lys Gly Thr Glu His Met Thr Asn Ser Gly Ser Tyr
180 185 190

Arg Ile Pro Leu Ala Ile Gln Cys Leu Trp Gly Leu Ile Leu Gly Ile
195 200 205

Gly Met Ile Phe Leu Pro Glu Thr Pro Arg Phe Trp Ile Ser Lys Gly
210 215 220

Asn Gln Glu Lys Ala Ala Glu Ser Leu Ala Arg Leu Arg Lys Leu Pro
225 230 235 240

Ile Asp His Pro Asp Ser Leu Glu Glu Leu Arg Asp Ile Thr Ala Ala
245 250 255

Tyr Glu Phe Glu Thr Val Tyr Gly Lys Ser Ser Trp Ser Gln Val Phe
260 265 270

Ser His Lys Asn His Gln Leu Lys Arg Leu Phe Thr Gly Val Ala Ile
275 280 285

Gln Ala Phe Gln Gln Leu Thr Gly Val Asn Phe Ile Phe Tyr Tyr Gly
290 295 300

Thr Thr Phe Phe Lys Arg Ala Gly Val Asn Gly Phe Thr Ile Ser Leu
305 310 315 320

Ala Thr Asn Ile Val His Val Gly Ser Thr Ile Pro Gly Ile Leu Leu
325 330 335

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

Met Ser Leu Ser Gln Leu Ile Val Ala Ile Val Gly Val Ala Thr Ser
355 360 365

Glu Asn Asn Lys Ser Ser Gln Ser Val Leu Val Ala Phe Ser Cys Ile
370 375 380

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Phe Ile Ala Phe Phe Ala Ala Thr Trp Gly Pro Cys Ala Trp Val Val
385                 390                 395                 400

Val Gly Glu Leu Phe Pro Leu Arg Thr Arg Ala Lys Ser Val Ser Leu
                405                 410                 415

Cys Thr Ala Ser Asn Trp Leu Trp Asn Trp Gly Ile Ala Tyr Ala Thr
            420                 425                 430

Pro Tyr Met Val Asp Glu Asp Lys Gly Asn Leu Gly Ser Asn Val Phe
        435                 440                 445

Phe Ile Trp Gly Gly Phe Asn Leu Ala Cys Val Phe Phe Ala Trp Tyr
    450                 455                 460

Phe Ile Tyr Glu Thr Lys Gly Leu Ser Leu Glu Gln Val Asp Glu Leu
465                 470                 475                 480

Tyr Glu His Val Ser Lys Ala Trp Lys Ser Lys Gly Phe Val Pro Ser
                485                 490                 495


<210> SEQ ID NO 7
<211> LENGTH: 3086
<212> TYPE: DNA
<213> ORGANISM: Arabidopsis thaliana

<400> SEQUENCE: 7

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tcgtcttacc ttagtttaaa ggaacgtact tgcttcgttt ccaaaccggg tttagtcact    240

actagataca gacatatatt ccaggtgaaa agcaattttc tctgattttg atttcttcta    300

aaaaaaattc aaaagttttg atttttccgg ttttggttca tggttaggtc ggagctgaga    360

cgggaggaga gttcgccgac agtggagaag tagctgattc gcttgcttct gatgcaccag    420

agtcattttc ttggtcttct gtgatactcc cgtgcgtatt gatccttctc gttaatttga    480

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<211> LENGTH: 5119
<212> TYPE: DNA
<213> ORGANISM: Arabidopsis thaliana

<400> SEQUENCE: 8

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aacggtgtga gagagttttc atttgaagta tacgtctcct ttcatctgaa gcttaattct 300

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<210> SEQ ID NO 9

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<211> LENGTH: 1644
<212> TYPE: DNA
<213> ORGANISM: Candida intermedia

<400> SEQUENCE: 9

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agaattagat ccaaggccat gtctattgct accgctgcta actggttgtg gggtttcttg 1380

atttccttct tcactccatt catcaccagt gccatccact tctactacgg tttcgttttc 1440

actggttgtt tggctttctc tttcttctac gtctacttct tcgtctacga aaccaagggt 1500

ctttctttgg aggaggttga tgagatgtac gcttccggtg ttcttccact caagtctgcc 1560

agctgggttc caccaaatct tgagcacatg gctcactctg ccggttacgc tggtgctgac 1620

aaggccaccg acgaacaggt ttaa 1644

<210> SEQ ID NO 10
<211> LENGTH: 1569
<212> TYPE: DNA
<213> ORGANISM: Candida intermedia

<400> SEQUENCE: 10

atgggtttgg aggacaatag aatggttaag cgtttcgtca acgttggcga gaagaaggct 60

ggctctactg ccatggccat catcgtcggt ctttttgctg cttctggtgg tgtccttttc 120

ggatacgata ctggtactat ttctggtgtg atgaccatgg actacgttct tgctcgttac 180

ccttccaaca agcactcttt tactgctgat gaatcttctt tgattgtttc tatcttgtct 240

gttggtactt tctttggtgc actttgtgct ccattcctta acgacaccct cggtagacgt 300

-continued

tggtgtctta ttctttctgc tcttattgtc ttcaacattg gtgctatctt gcaggtcatc 360

tctactgcca ttccattgct ttgtgctggt agagttattg caggttttgg tgtcggtttg 420

atttctgcta ctattccatt gtaccaatct gagactgctc caaagtggat cagaggtgcc 480

attgtctctt gttaccagtg ggctattacc attggtcttt tcttggcctc ttgtgtcaac 540

aagggtactg agcacatgac taactctgga tcttacagaa ttccacttgc tattcaatgt 600

ctttggggtc ttatcttggg tatcggtatg atcttcttgc cagagactcc aagattctgg 660

atctccaagg gtaaccagga gaaggctgct gagtctttgg ccagattgag aaagcttcca 720

attgaccacc cagactctct cgaggaatta agagacatca ctgctgctta cgagttcgag 780

actgtgtacg gtaagtcctc ttggagccag gtgttctctc acaagaacca ccagttgaag 840

agattgttca ctggtgtggc tatccaggct ttccagcaat tgaccggtgt taacttcatt 900

ttctactacg gtactacctt cttcaagaga gctggtgtta acggtttcac tatctccttg 960

gccactaaca ttgtcaatgt cggttctact attccaggta ttcttttgat ggaagtcctc 1020

ggtagaagaa acatgttgat gggtggtgct actggtatgt ctctttctca attgatcgtt 1080

gccattgttg gtgttgctac ctcggaaaac aacaagtctt cccagtccgt ccttgttgct 1140

ttctcctgta ttttcattgc cttcttcgct gccacctggg gtccatgtgc ttgggttgtt 1200

gttggtgagt tgttcccatt gagaaccaga gctaagtctg tctccttgtg tactgcttcc 1260

aactggttgt ggaactgggg tattgcttac gctactccat acatggtgga tgaagacaag 1320

ggtaacttgg gttccaatgt gttcttcatc tggggtggtt tcaacttggc ttgtgttttc 1380

ttcgcttggt acttcatcta cgagaccaag ggtctttctt tggagcaggt cgacgagttg 1440

tacgagcatg tcagcaaggc ttggaagtct aagggcttcg ttccatctaa gcactctttc 1500

agagagcagg tggaccagca aatggactcc aaaactgaag ctattatgtc tgaagaagct 1560

tctgtttaa 1569

<210> SEQ ID NO 11
<211> LENGTH: 1584
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 11

atgggtttag aagataatgc gcttattaga aagtatgtca atgtcgggga aaaaagggct 60

gggtcagcat ctatggggat tttcgtaggt gccttcgcag ctttcggggg tgttttgttc 120

gggtatgata ctggaaccat ttcaggtatc atggccatga actatgtcaa aggagaattt 180

cctgccaata aggagagttt tacgtcaaaa gaaagttcgt tgattgtttc catcttatca 240

gcaggtactt tcttcggtgc gttgttagca ccgtttatgt ctgatacttt aggtagaaga 300

tggtcattaa ttatttcaac attcattgtt ttcaacttgg gagtgatttt acaaactgtt 360

tcaactggta ttccattact atgtgctgga agagctattg ctggttttgg tgttggtctt 420

atatctgctg tcattccatt atatcaatca gaagccactc caaaatggat tagaggggct 480

gttgtatctt gttatcaatg ggccattact attggcttat tgttagcggc ttgtgttaac 540

caaggtactc ataatagaaa tgactcgggt tcatacagaa ttccaattgc tgttcaactt 600

ttatggtcgt taattttggg tactggtatg atcttcttgc ctgacacgcc acgtttctgg 660

atccacaaag gtaatgaatc tgaagctaag aaatcgttga agattttaag aaaattacca 720

cttgaccacc cagacttaat tgaagaatac gaagacatca aagctgctta cgatttcgag 780

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tgttctttcg gaaaatcgtc ttggatggat ctttttacca caaggaatag gcaattgaag 840

agattattta ccggtgttgc tcttcaagca tttcaacaat taactggtgt taactttatc 900

ttctattttg gtacctcttt cttcaagagt gctggtattg aaaacgaatt tcttatttct 960

ttagccacca gtattgttaa cgtaggtatg actgttccag gtatcttttt aattgaatta 1020

gtgggtcgtc gttctatgtt gttgtggggt gctgttggta tgtcggtttc tcaatttatc 1080

gttgctattg ttggtattgc cactgatagt gccgacgcta acaaagtctt gatcgcattc 1140

acttgtttct tcattgcatt ctttgcttct acctggggtc caattgcttg ggttgttgtt 1200

ggtgagattt tcccattaag aactagagct aagtccgttg cattatctgc cgcttccaac 1260

tggctttgga actgggctat cgcatacgct actccatact tggtagaaga tggtaagggt 1320

aatgctaact taggaacaaa cgttttcttc atctggggtg gatgtaactt tctttgtatt 1380

ttgttcactt acgtcttcat ttacgaaacc aagggttact ctttggaaca aattgatgaa 1440

ttatatgaaa aagttccaca tgcttggaaa tctcgtggct tcattccttc tgcccatgct 1500

ttcagagaag atgctccaga gtcaatcagc tctatgggaa aggatatgga aaaagttact 1560

gaaattgaaa ccacttcagt ctaa 1584

<210> SEQ ID NO 12
<211> LENGTH: 2196
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 12

atgtggccat ttctagatag gatcatgtat gatcactcga cggaggagga atattacaaa 60

aagatgcaac agaagtcgtc ttcgtcgagt gccattacag tggggctagt ggcggcggta 120

gggggatttt tgtatgggta cgatactggg ctcattaacg atattatgga gatgacgtac 180

gtgaaggata acttcccggc gaatggacat agcttcagcg tacacgagcg agcgttgata 240

acggccatct tgtcactcgg aacatttttt ggggcgttga tagcgccgtt gatatcggat 300

acgtggggta gaaagttttc gatcattgta tcgtcagctc tcatatttaa tgtgggaaac 360

atcttgcagg tgtcatccac agaggtggtg cttttatgtg ttgggagagc tgtttcgggg 420

ttgtcagtgg gtatactctc agccattgtg ccgttgtatc aagctgaagc ttcgccaaaa 480

tgggtaagag gttccattgt gtatacttac caatgggcga taacatgggg gttgttgatt 540

gctagtgcta tatgtcaggg ggcaaaaaac attatgaatt cgggctcgta tagaataccg 600

gtgggaatac agttcttgtg ggcaattatt ttgtctgtcg ggatgctttt tttacccgaa 660

tctcctcgat tccatgtaca gaaggataat atccaagaag cattgaaatg cttagctaga 720

ctaagaaaag tgccgacaga tgaccctgat ttgatagaag aactagttga aatcaaggcc 780

aactatgact acgagttatc gtttggaaag gcatcctata tagattgctt taagagtggt 840

ggaggaagaa ataagcaact cacgaggatg ctcacaggta ttggggtcca ggcatttcaa 900

caaagttcag gaatcaattt tattttctat tacggggtta atttcttcgc aagttcagga 960

attaagaatt attacttaat gtcatttgta acttatgcag ttaacacact ttttacaata 1020

ccagggataa ttttgattga agtcatagga agaaggaaac tattattatt tggcggcatt 1080

ggaatggctg tttcaaattt cataatagca attgttggtg ttagtatgtc agatgagtca 1140

atcagttcta taatatgtgt gtcattttcg tgtgtcttta ttgcattttt tgcatcatca 1200

tggggcggtg ccgtatgggc gctctcttca gatatatttg gtattggtat tagacaaaaa 1260

gcaatatcgc taacggcagc gacaaattgg ttagttaatt ttacctttgc atttataacg 1320

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ccatatttga ttgatactgg taaacatacc gcagcattgg gtaacaaaat ttttttatc 1380

tggggtggtt gtaatgctct aggcgtcgta tttgtgtact ttatggttta cgaaacgaaa 1440

ggattaaaat tggaagaaat tgatttcatg tacaaaaact gtgtgaacgc tagagcttcg 1500

actaagttca aatctcaaaa gattgtatac gccaatcaaa tttcaacacc gatctcagag 1560

cttcttaatc ccaaccgatc gcatattgcg attgagaaat caagtggaag taacaataat 1620

ggcgatgatg atgagaatag cgaagaaaat caccatgatt ttggtttaga gaacggaaac 1680

gtcttacaca acaatttgga taataggaat ataactctta tcccttataa gaatattatt 1740

tcacctctgc gatcattcag ttcagattct tcaagcgatt ccgactcatc ttcaccactc 1800

aatgattatg aaagatactt acatagcttg caaaaagaag gcagccatca tgacacctct 1860

caaacttcaa cgtccttaat tactgacaat aagctaagtc atcttaattc catgcataat 1920

gcccactcac ggggtaattt tactgaggag gacttgaagt acctcaatga tgaatatgat 1980

ttagcgatgt cgcagaaata cccaggcaca actacggcgc ctctaaaacc aagcacgaat 2040

atgactgtta tagcggcgcc atttttttgac gctccaccaa gcgattcaga cacggacgac 2100

gaaagcgacg acgatgaagt cggtgacgaa gatagcgaaa cagaaccaga aactactaag 2160

ggctcaccgg ttgataccaa ggactctagt tcgtag 2196

<210> SEQ ID NO 13
<211> LENGTH: 1593
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 13

atgttcaata aaatcagatt tggtttctgc agcttaaaca aggagcttga taagtttcat 60

acgacatata atatatatgt tattgctatg attacaacaa tctcaggtat gatgtttgga 120

tttgatgtct cttcaatctc tgcatttata tctgaaccat cctacaggcg gttcttcaat 180

tatccaaact ctacgacaca gggtgcaatt actgcatcca tgtctgcagg gagcttcttg 240

ggtgcaatat tatcatcttt tgtatcagaa agaattggga gaagaacctc attgcttttt 300

tgtgccatgt tctgggtttt aggttccata atccaatcat catgcagaaa ccttggtcaa 360

ttaatcgcag gtcgcataat atccggggta ggtgttggta ttggatccgc aataacccca 420

atatattgtt cagaagtatc tcctgcccct tctagaggtg ttattggagg tttatttcaa 480

ttagctatca catttgggat attgataatg ttttacatag gatatggttg tacatttatt 540

aacggtcagg cgtctttcag attagcttgg gcgctacaaa tgattcccgg tttggttttg 600

tttgctggtg tattcatttt acctgagtca ccacgctggt tagcaaacaa tagtaagtgg 660

gagcaagcag aagaagtgat tcgaagaatt aacgaaaaag acaaaacagg aagatatttg 720

attgaattag aggagttgaa ggaaagtatc acaattcata aattatcaaa agatataggg 780

tacctagatc ttttcaggaa aaagaactat aaaagtagta ttgttggtat ttcggctcaa 840

atctggaatc agcttaccgg aatgaacgtg atgatgtatt atatagtcta tatctttgaa 900

atggtgggat atactggaaa tacagtttta gttagttcaa gtatccaata tgttatcaat 960

tttggcgtga ctttaatagc tttgccttta tctgattatg ttggaagaag aagactaatg 1020

ctaatcggtg gtgtactaat gatggcatgg ctatttgctg ttggtggact ctttgcagcc 1080

tattctgaaa aggtagaaaa cgtcaccagt gacgcaaccg tggttgttac tatccccgaa 1140

gaacatcgaa atattggaaa agccattgtt gcttgctctt atttattcgt tgccaccttc 1200

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gctagtacgt gggcagtatg ttcatggtgt tatttttctg aagtgctccc aactaggaca 1260

agatcaaaag caggactgtt agcagttgca agtgactggg caataaattt tgccatagct 1320

ctttttactt cttcagcatt tagaaatatt acttggaaaa cttactttgt ttttggaaca 1380

ttctgcggcg ctatgaccgt tcataccttc ctttcatacc ctgaaactcg tatgaaaacg 1440

ctagaagaaa ttgatatgac tttccaaaat tgtatcccac catggaggtc cgcgggagtt 1500

actattcaaa gtcttgacgg ttatttaagt gattctaagg aaaataacgt aacgcatgtc 1560

gaacaagtgg aatcaaatag cataagtaag tag 1593

<210> SEQ ID NO 14
<211> LENGTH: 1731
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 14

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gcgattggta ctatgatcgc catcctagag attggtgctt tgatatcatc gttcgttgcg 120

ggtaaagttg gtgatcatat cggaagaaga cgcactatac gttatggatc gtttatcttc 180

ataatcgggg ggcttatcca aacttcgtca atcaatatta ttaacttagg ggcaggaagg 240

tttatcagtg gtgtggcaat tgggtttttg actactatca ttccatgcta tcagtctgaa 300

atcagtccac ctgatgatag aggattctat gcgtgcttag aatttactgg taacatcatt 360

ggttactcta caagtatttg ggtggattat gggttttcgt tcatagaaaa tgactactca 420

tggagaactc cattggccat ccaatgtgtc atgggtggcc ttttgtttat tggatcattc 480

gtaatcgtag aaactccaag atggctttta gatcatgatc atgatattga aggaatgatt 540

gtgatttctg atttgtatgg tgatggtgat gttgaagacg aattatctaa aacggaatat 600

agaaacatta aggaaaacat tctcatcgca agagtggaag gaggggaacg ttcatatcgt 660

tatatgttaa ctaagtataa gaaacgtctt tcagttgcgt gcttttcgca gatgtttgca 720

caattgaatg gtattaatat ggtttcctat tatgcgccta tgatttttga gctggccggt 780

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tataccccaa acatagtggt tgtatcggtg atcatattca atgctgcatt tggtgcaagt 1020

tgggggccaa tcccatggat gatgaatgaa gtattaccta atagtattag atctaaaggt 1080

gctgccatgt ccactgcaac taattggcta ttcaacttca tcgtagggga aatgacccca 1140

atattgttgg ataccattaa atggagaacc tatttgatct cagccgtctc gtgtgcatta 1200

tcatttttat gcgtccactt cttgtttccg gaaacaaagg ggttgagctt agaggacatg 1260

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aacaatgcat caactactac tatcaataac tacggggctg cagatagaga tagcggtatc 1380

gaggttcgca gaactagtat ctccgttgaa actccaaacc atgcaaacat agttaatgaa 1440

gcatttcgcc aatccccagc atcaattgct cgtaattcaa aggccaaacc agagttagac 1500

ggtcttatta ctggtaatcc accacccgta ccacctgacc tctcggtctt ggactccaat 1560

gtacctccac aagaaatcga accaccttca ttcgacgtca ttttcaaata taaagttcgc 1620

caattagaga aaccaaacat attccaaaag gctttccgtg caatctccgg tgatagtacg 1680

ttcaaaccac cacagatcga cgaagaacgt actttgctct cgaataattg a 1731

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<210> SEQ ID NO 15
<211> LENGTH: 1674
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 15

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aaagatccgt tagtgttttg cataattgcg tttgcatcta ttgggggttt actctttggg 120

tacgatcagg gagttattag tggtatagtt actatggagt catttgcggc aaaattcccc 180

agaatttttt ccgatcctga ttataagggt tggtttgttt ctacattttt gttgtgtgct 240

tggtttggtt cgttgataaa ctctcctgtt gttgatcgat ttggaagaag ggatactata 300

agaatagctt gcgttgtatt tgttatcgga tctgtctttc aatgtgcagg tacgtcggtt 360

agtatgcttt tcgctgggag agcagttgct ggtatcggtg tcggacaatt gactatggta 420

gtcccaattt atatgtcgga attagctcca ccttcagtaa gaggtggttt agttgtaata 480

cagcaatttt caataacaat aggtattttg atatcatttt ggataaatta tggcactcaa 540

tttattggag gaactaaatg tgctcctgac caagattaca aaggcgatac tttcgaccca 600

tacattgatg ttcctcaagg tggttgttac ggtcaaaaag atgcttcctg gagaattcca 660

tttgggttac aaattgcacc agctttcatt ttaggtattg gtatgtcttt ttttccaaga 720

tcgccaagat ggctcttatc aagaaaaaga gaagaggagg catgggaggc tttgaattat 780

ttgaggagaa gaaataatcc tgatatgatt gatgctgaat tcaatgaaat taaatcggac 840

gtattatttg aacaaaaata taacgagagg aaatttcaag gaaaaacagg aatgtctttc 900

tttataacat cgtattggga tctagtctct accaaatcaa attttaagag agtttttata 960

ggctctgcgg ttatgttctt ccaacaattt attggttgta atgcaattat ttattacgca 1020

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ggtgcaattg tcggcacata tggtgatact ttatctaagc ataaaactgc tggtagagcg 1260

gcaatagctt ttatttttat atatgatttc aacttttcat atagctgggc acctattgga 1320

tgggttttac catccgaaat cttctctatt ggaatcagat caaaagctat atccattact 1380

acttcatcaa catggatgaa taatttcata attggtttgg tcacccccg tatgttggag 1440

acaatgaaat ggggaacata tatctttttt gcagcatttg ctataattgc atttgctttc 1500

acttggtttg ttatcccaga aactaaagga gtacctttag aagaaatgga tttagttttt 1560

ggtgatttag atgcgttgca agaaaagcaa aacttctctc gcatgaatga attatcaaaa 1620

atggattcaa ttaaagctac aacagatatt tcggaagcac attattctga ttaa 1674

<210> SEQ ID NO 16
<211> LENGTH: 1476
<212> TYPE: DNA
<213> ORGANISM: Escherichia coli

<400> SEQUENCE: 16

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ggtttattat ttggctacga caccgccgtt atttccggta ctgttgagtc actcaatacc 120

gtctttgttg ctccacaaaa cttaagtgaa tccgctgcca actccctgtt agggttttgc 180

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gtggccagcg ctctgattgg ttgcatcatc ggcggtgccc tcggtggtta ttgcagtaac 240

cgcttcggtc gtcgtgattc acttaagatt gctgctgtcc tgtttttttat ttctggtgta 300

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gggaaactgg tctcttttaa ccagtttgcg attattttcg ggcaactttt agtttactgc 540

gtaaactatt ttattgcccg ttccggtgat gccagctggc tgaatactga cggctggcgt 600

tatatgtttg cctcggaatg tatccctgca ctgctgttct taatgctgct gtataccgtg 660

ccagaaagtc ctcgctggct gatgtcgcgc ggcaagcaag aacaggcgga aggtatcctg 720

cgcaaaatta tgggcaacac gcttgcaact caggcagtac aggaaattaa acactccctg 780

gatcatggcc gcaaaaccgg tggtcgtctg ctgatgtttg gcgtgggcgt gattgtaatc 840

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gccgcctttg ccatgtcctg gggtccggta tgctgggtac tgctgtcgga aatcttcccg 1200

aatgctattc gtggtaaagc gctggcaatc gcggtggcgg cccagtggct ggcgaactac 1260

ttcgtctcct ggaccttccc gatgatggac aaaaactcct ggctggtggc ccatttccac 1320

aacggtttct cctactggat ttacggttgt atgggcgttc tggcagcact gtttatgtgg 1380

aaatttgtcc cggaaaccaa aggtaaaacc cttgaggagc tggaagcgct ctgggaaccg 1440

gaaacgaaga aaacacaaca aactgctacg ctgtaa 1476

<210> SEQ ID NO 17
<211> LENGTH: 1701
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 17

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atcgctggta agtctggtgt ggctggttta gtcgcaaact caagatcttt cttcatcgca 120

gtctttgcat ctcttggtgg attggtctac ggttacaatc aaggtatgtt cggtcaaatt 180

tccggtatgt actcattctc caaagctatt ggtgttgaaa agattcaaga caatcctact 240

ttgcaaggtt tgttgacttc tattcttgaa cttggtgcct gggttggtgt cttgatgaac 300

ggttacattg ctgatagatt gggtcgtaag aagtcagttg ttgtcggtgt tttcttcttc 360

ttcatcggtg tcattgtaca agctgttgct cgtggtggta actacgacta catcttaggt 420

ggtagatttg tcgtcggtat tggtgtgggt attctttcta tggttgtgcc attgtacaat 480

gctgaagttt ctccaccaga aattcgtggt tctttggttg ctttgcaaca attggctatt 540

actttcggta ttatgatttc ttactggatt acctacggta ccaactacat tggtggtact 600

ggctctggtc aaagtaaagc ttcttggttg gttcctattt gtatccaatt ggttccagct 660

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gacagagaag acgaatgttt gtccgttctt tccaacttgc gttccttgag taaggaagat 780

actcttgttc aaatggaatt ccttgaaatg aaggcacaaa agttgttcga aagagaactt 840

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tctgcaaagt acttccctca cctccaagac ggttctgcca agagcaactt cttgattggt 900

ttcaaccaat acaagtccat gattactcac tacccaacct tcaagcgtgt tgcagttgcc 960

tgtttaatta tgaccttcca acaatggact ggtgttaact tcatcttgta ctatgctcca 1020

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gacacctctg gtacttccaa gatggaaaag gaaatccatg agcaaaagct taaggaagtt 1620

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<210> SEQ ID NO 18
<211> LENGTH: 1404
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 18

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aaccaggact tcctaaacac ttttggaaac cccaccggta gttatttagg tattatcgtt 180

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caatgtagtt ccttttcagt tgaacaattg atgattggaa gatttatcac tgggcttgga 360

actggttggg aaacttctac ttgtccaatg tatcaggcag aactttcacc tccaaaagtt 420

agaggacgtt tggtgtgctc agaagcattg tttgttggag ttggtttaat ctatgcatat 480

tggtttgatt atgctctttc tttcacttct ggtcctattg catggagact tcctcttgcc 540

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agatacatgt tttacaaagg agagaaagaa gaagccaaaa gaattttatc ttatgtcttt 660

ggaaagccag gagatcatcc tgacattctt aaggaatgga atgatattaa tgatgctgtt 720

attttggaaa cttcagaagg agctttctcg tgggcaaaac ttttcaagcc cgataaggca 780

agaactggat acagagtctt cttggcatac atgagcatgt ttgcgcaaca gttgagtggt 840

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cctactttct ttgctgatag gatgggaaga agattgcctt cagcagttgg agcttttggc 1020

tgtggtgttt gtatgatgct aatttcaatc ttattaagtt ttcaagacaa tccaaagttg 1080

aagaagagca gtggagctgg tgctgtggct ttctttttcg ttttccaact tgtcttcggc 1140

tccactggta attgtattcc atggctgatg atttcagagc ttatccccct tcatgcacgt 1200

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gctaaaggat cttcattagc tacatcaagt aactggcttt ggaatttctt tgttgttgag 1260

atcactccaa ctatcattga aaagttgaag tggaaagcat atttgatctt tatgtgctgc 1320

aacttctcct tcgtaccaat gttttacttt ttctttcccg agacaaagaa ccttacttta 1380

gaagccattg acgatttgtt ctca 1404

<210> SEQ ID NO 19
<211> LENGTH: 1656
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 19

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gatccagtag tatttttggt gattttattt gcatcccttg gaggtttgct ttttggttat 120

gatcaagggg ttattagtgg cattgtcaca atggaatctt ttggtgcaaa attccccaga 180

atttttatgg atgccgatta caagggttgg tttgtgtcta ctttttttgct atgcgcatgg 240

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caactttcga ttacaattgg tatcatgatt tcctattggt tggattatgg cactcatttt 540

attggaggta ctagatgtgc tcctagtcac ccataccaag gtgaaacttt taaccctaat 600

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ggtgttcaga ttgctccagc agtgttgttg ggtattggaa tgatattttt cccaagatct 720

cccagatggt tactctctaa aggtcgcgac gaagaagctt ggagctcttt gaaatatctc 780

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tatggtattg ttaattgtct ttccaccctt ccagcagtgt tcttgatcga tagatgtgga 1140

agaaagactt tgttaatggc aggtgctatt ggaacttta tttccttggt tattgtcggc 1200

gcaatcgttg gcaagtatgg cgatcgttta tctgaattca agacagcagg gagaactgca 1260

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gttttaccct cagagatttt cccaatcggc atcagatcca atgccatctc cataactacc 1380

tcatctactt ggatgaataa ttttattatt ggcttggtca ctccacatat gttagaaaca 1440

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gccaaggatc gcaactcgat tgaaatgtca gaataa 1656

<210> SEQ ID NO 20
<211> LENGTH: 1629
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 20

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gtagtaggcg gtcttgtaca agctacttcg gtcaatattg tcaatctctc actaggaaga 240

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tggaggagcc cattgtatgt tcaggttgtt attggctcca tgttatttat tggttcattc 480

cttattgtag aaacccctag atggctcttg gatcacaacc atgatatcga aggcatgatt 540

gtcatttctg acttgtatgc agatggtgat gtggaagacg atgatgctat tgctgagtac 600

agaaacataa aggaaagtgt cttgatagcc agagttgaag gcggagagag atcgtaccag 660

tatttgttca ccaaatatac caagagactt tctgtggcat gcttttcgca aatgtttgcc 720

cagatgaatg gtataaacat ggtatcttac tatgctccta tgatcttcga atctgctggc 780

tgggttggta gacaagctat cttgatgact ggtatcaact ccattatcta catctttagt 840

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tctgtgctca tgggtgttcc gctcttaacc attgcttgtt cgttattctt aaacaacaca 960

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tatggtgcga ccgagtctaa cagtaatgcc aggagagcaa gtgtcatctc ttcagaaaac 1380

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ccaataaagt ctgatgcgtc agtccattca gtcgatgcca taattccaag catttccagc 1560

aatattccgc aggaaattga accaccaacc tttgatgaaa tctttaagta caagttgaat 1620

gagatggaa 1629

<210> SEQ ID NO 21
<211> LENGTH: 1488
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 21

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gtattattga tgagtattgt tcacccaact atcatgggat acgattccat gatggttggt 120

agtattctta atctagatgc atatgtaaat tatttccact taacggctgc taccactgga 180

ctcaatactg ctgcagtatg gcttgggcaa gtaattgcca cattgacagt tattctgtat 240

ttcaatgaca aatttggtag aagaagttca gtttgtataa gtattgcaat cagtttggtt 300

ggggttgcat tgcaatcagc agcccaaaac attgagatgt ttattatcgg aagaatagtt 360

attggttttg gaatatctat tggttttgtc tcatctacca ttttggtaag tgaactagcc 420

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cctccagaca aaagaggatt tattcttgga ttgagtttta caagctttct agtaggaagt 480

ttaattgcag caggtgtcac atatggaaca agaaatgctc ctggagactg gtgttggaga 540

atcccatcaa ttattcaagg ggctccagat attgttgcta ttattaacat actctttatt 600

tcagaatcac caaggtggtt gattgcaaag gaaagattca gcgaagctcg tgaaattatt 660

tctatcatta gtgatgttcc tattgaagat gcacatgaag aatgtgaaaa gatacatgcc 720

catattcaaa ctgagaagac tgctttccct ggcaataagt ggaaacaaat ggtgagctcc 780

aagagcaata caagaagagt tattatcttg ttcacacagg ccatagttac tgaaatggcc 840

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agtacaggag ttacactctt taatattttc aacggctgct ggggactttt cgcaagtttc 1260

attttaccca ttgcaatgaa tggaattggc tggaaatttt acatcattaa tgcttgctat 1320

gacgtcatat tccttccaat aataatgttc tgttggattg agacaaaggg aattaatttg 1380

gatacaatta gtgaagtatt gcacggaaga ggacctgaag atgaagaaag cattgaagaa 1440

agtcacagcc taatcagaca aggttttgtt gttaatacaa agaagtaa 1488

<210> SEQ ID NO 22
<211> LENGTH: 1635
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 22

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ggctctgcaa agaccaacag ctaccttggc ctcagaggcc acaaacttaa ttttgctgtc 120

tcttgttttg ctggtgttgg tttcttactt ttcggttacg atcaaggtgt catgggttca 180

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gtctgtattg gtgctgcttt gcaagcttct gctttcacta ttgctcactt gactgttgct 420

agaattatca ctggtttagg tacaggtttc atcacttcta ctgttccagt ttaccaatcg 480

gagtgctctc cagccaagaa aagaggacag ttgatcatga tggaaggttc tcttatcgcc 540

cttggcattg ccatctcata ctggattgac tttggatttt acttttgag aaacgatggt 600

ttgcactcct cggcttcttg gagagcacct atcgcgcttc aatgtgtctt cgctgtcttg 660

ttgatttcca cagtcttctt cttcccagaa tctccaagat ggttgctcaa caaaggtagg 720

accgaagaag ctagagaagt tttttctgct ctttacgact tgccagccga ctctgaaaag 780

atttctattc aaattgaaga aattcaagct gctatagatt tagaaagaca agccggagaa 840

ggtttcgtac ttaaggaatt gttcactcag ggcccagcca gaaacttgca gcgtgtggcc 900

ttgtcatgtt ggtctcaaat aatgcaacaa atcactggta ttaacattat tacgtactat 960

gctggtacta tttttgaatc atacattggt atgagtccat ttatgtcaag aatcttggct 1020

gccttgaacg gtactgaata tttccttgtc tctcttattg ctttctacac cgtcgaaaga 1080

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tgtcctgttt gggagccatg gaaggttgtc caaattgcca gagacctccc tattatgcac 1560

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gaaaacatca gctaa 1635

<210> SEQ ID NO 23
<211> LENGTH: 1251
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 23

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ggcaagttgg tgtgtggaga gttcacggga aatatcactg gttatgctct cagtgtatgg 180

gccgattact tctgctactt tattcaagat ataggtgatg caagggagaa gcctcatagc 240

ttctttgccc acttgtcctg gcgattgcct ctattcatcc aggtggtgat agcggctgtt 300

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gaccaacaag gattccatgt attagcgttg ctctatgatt cacatctaga tgataacaaa 420

ccacgtgaag agttctttat gatcaaaaac tccatcttgt tagaaagaga aactacacct 480

aagagcgaac gaacttggaa acatatgttc aagaactaca tgacccgagt gcttatagct 540

tgttcagcac ttggctttgc acagttcaac ggcataaata tcatttcgta ctatgccccc 600

atggtatttg aagaagcagg cttcaacaac tccaaggctt tacttatgac aggcatcaac 660

tctatagtat attggttcag tacgattcct ccgtggtttc tcgtggatca ttggggtaga 720

aagccaattt tgatatccgg gggtttatct atgggaatat gtattggttt gattgcggtg 780

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aagggtgcag agctagagga tatggactct gtgttcgaga gcttttacaa ctacaagtct 1140

ccgttcaaga tttcacgaaa gagacaccag aatgatggcc aggcgtacca aagggtagag 1200

aacgatatcc gccacaacga tgtagaaatg gacgatttgg acgatttgga c 1251

<210> SEQ ID NO 24
<211> LENGTH: 1638
<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 24

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gccggtcgac tcatttccgg ccttggtatc ggtctgggct cctcggttat ccccgtctac 420

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accctcgaag agattgatat gatgtgggcc gcccgagttc ctgcctggag aaccgcaaac 1500

tgggtgcctg accacgttcc tggcgccctt cccgaagacg agaaacactc ggaggagatg 1560

gtcgaggccg tcgaatccaa tgaagaggag cccaagatag ccagtgctaa cgtcgacgcc 1620

cctccctctc aattgtaa 1638

<210> SEQ ID NO 25
<211> LENGTH: 1665
<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 25

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tttggtcatc ccacctcctt ccagcaggga ggtatcaccg cctccatggc cggaggatcc 180

atgctgtcgt gtgcgtttgc cggctacatt tccgaccggg ttggccgaaa gcccaccatt 240

caatttgccg ccgcctggtg gatggttggc gcctccattc aatgctctgc ccagaatatg 300

ggccaactga ttgccggccg ggccatttcc gggcttggaa tcggcctcgg ctcgtcccag 360

atccccgtct tcatctccga gttgtccccc aagaagatcc gaggccggct cgtcggctgc 420

ttccaatggt ccgttacctg gggtattctc atcatgttct acatttcgtt cggctgctca 480

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tacatcaagg gccactcgtc cttccgactg gcgtggggca tccagctgat tccaggagcc 540

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tacatcatca acgtggtcat gaccatcccg gcgctgcttt tcattgataa aatcggacga 960

agacccctgc tcctctgtgg aagcatgctc atggccacct ggctgctagc tgtcggagga 1020

atgctaggag cctacggaat ccaaatgccc caaggtctac cggcagtacc ctccaaaaac 1080

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cacgtcttcc tgctcttccc cgaaaccaag ggcaagagtc tggaggtgat tgaccagatg 1440

tgggacgccc gcgtgcccgc ttggaaaacc gcctcctggg tccccgacca catgccttct 1500

cattacgcag gggaccagga ggaaaagccc accgacgaac tggccgaggc gccgtttcac 1560

gaggagaatg ccccggtgaa caccgagacc cctcctcatg aggatgagcc cacttttgcg 1620

gagaccgagc ccaagaccca gtatcctgga actgagcatg tctaa 1665

<210> SEQ ID NO 26
<211> LENGTH: 1599
<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 26

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gtgttcctgt ttggatacga ccagggagtc atgtccggca tcatcacggg cttctacttc 120

aaggagtact tccatgagcc cacccgagcc gaaatcggaa ccatggtgtc gattcttgag 180

gtcggagcgt ttgtctcgtc gctcatggtc ggccgaatcg gtgacattat tggccgacga 240

aaaaccatca tgtacggtgc cttcatcttc atcatcggag gtgccttcca gacatttgcc 300

gtcagcatgt ccgagatgat tttgggccga gtagtggccg gtttcggcgt tggtatgctg 360

tcgaccattg tgccagtcta tcagtctgag atctcgcctc ctcacaaccg aggcaagctc 420

gcgtgcatcg agttcacggg aaacattgtg ggctatgcca gctcagtgtg ggtggactac 480

ttctgcagtt tcatcaattc caacatgagc tggcgtatcc cactgtttct gcagtgtgct 540

atgggcgctc ttttgtttgg aggctcgttc ctaattgccg agactcctcg atggttgctg 600

gataacgacc atgacgagga gggattggtt gtcctggcca acctgcatgg aggaggagac 660

attgactctc ctctggctaa gcaggaatat cgggagatta agcagtccgt tttgatccac 720

cggctcgagg gcgagcgatc atataccgac atgtggaaga agtacaagaa gcgagtgctg 780

attgccatgt cgtcgcagat gtttgcccag ctcaacggta tcaacgtcat ctcttactac 840

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ggccgaagac ctattcttct gtccggtgca gtaattatgg ctatttccct ggcgtctgtg 1020

gcgttctgga tgcgtctaga ctttgcacat acaccggctc tggtggtgat ttccgtcgtc 1080

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gagacctcgg gaatcaactt ggaagacatg gactcgttgt tcggcgacaa gtctgttgtg 1380

aacacccccg actcgcggtc tttgcttggt gatcgagaca ctccagagcc tgacgtgcct 1440

cacagttata ctgatgctgc caccgatcga ctgcctgctg gtatgcaggg ctatggctcc 1500

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gggtctccca agcgggactt ccctcaacct ccggtataa 1599

<210> SEQ ID NO 27
<211> LENGTH: 1548
<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 27

atgggactcg ctaacatcat caaccgtgga gaaaagcccg agggctcggc cttcatggcg 60

gcctttgtgg ccgtgtttgt cgcgtttgga ggtattctgt ttggatacga cactggaacc 120

atttccggcg tcatggccat gccattcgtc aagaagacct ttacagatga cggcctggag 180

ttcacttctg agcagacctc gctcatcact tccattcttt ctgcaggcac cttcactgga 240

gccatttctg ctccctgggc ctctgatact ctgggaagac gactgggtct gatcctcttc 300

tgtgtcgtct tctctgttgg cgctattctt cagactgctg ccaccggccg aacgcttttg 360

attgtcggac gagttgttgc tggtcttggt gttggtggag tctcttccat cgttcctctt 420

taccagtctg aggttgcccc caagtggatc cgaggtgccg ttgtctccat ctaccagttt 480

gccatcacca ttggtcttct gctggctgcc attgtcaaca acgcaaccaa aaacaaagac 540

aacagtgctt cctaccgaat tcctctcggc cttcagcttc tgtgggccgt catcctgagt 600

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aaggccgccg attccctgcg acgactacga cgacttcctg ttgagcacga ggctgtacag 720

aaggagctcc tggagatcca atcttctcac gaccacgaga tgcagatcgg tagcgccacc 780

tgggccgcct gcttctcccc caaggggtcc cagctgaagc gaatgctgac cggtattgcc 840

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gtggttatga ccatccccgg tatcatgttt gttgatcgag tcggacgacg aaagctgctg 1020

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gtcttcttca tctggggagg ctgcaacttc ctgtgcatcg ccttcactta cttcttcatc 1380

tacgagacca agggtcttac tctggaggag gtggaccaga tgtacgccga gatcaagatt 1440

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gcttctcgat cccaccagtt tgtgcctacc actcgagtcg ctgcttacga cgagcacgct 1500

tctgacgaca agaaggacgg acagcacgtc tacattgagt ctgtctag 1548

<210> SEQ ID NO 28
<211> LENGTH: 1485
<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 28

atggccatta ttgtggctgt atttgtggct tttggaggac ttctctacgg ctacgacaca 60

ggaactattg ctggaatcat gaccatgggc tatgtgaaag aacactttac agactttggg 120

aagaacgact tcacctcggg ccaatcatct ctcaccacat ctatcctatc tgtgggcaca 180

tttaccggag ccatcgttgc tcccttagct gctgacacgg ctggtcgacg tctgggtctt 240

ctgttgtatt gtcttgtatt ctctgtgggt gctattttgc agaccgtcac aaccggaaga 300

gtcttgctaa ttgtgggacg ggtgattgct ggtcttggtg tgggaggtat ctcgtccatt 360

gtgcctctct atcagtcaga agtgtctccc aaatggatca gaggggccgt tgtttctgtc 420

taccagtttg ccatcactgt gggtcttcta ctggcagcta ttgtcaacaa tgccactaag 480

gaccgtccaa atacgtcatc ataccgtatc cctcttggta ttcaactcat ttgggctctt 540

attctttcag caggacttgt gtttcttcct gagactcctc gtttctgggt caagaagaac 600

cggccagaga aagccgccga agcactctca cggctaagaa ggctaccaac agactcgaaa 660

ccggtaaaaa aggaactgct tgaactacag aagtcgttcg aaatggaaat ggaggttgga 720

aactcctcct ggaaggcttg tttcagtcca catggatcac agctcaaaag actgctgaca 780

ggagtctcaa tccaggctct gcaacaacta acaggcatca atttcatatt ctactatgga 840

accaactttt tcaaaacagc tggcataaaa gatccctttg tggtgtccat gatcacctct 900

gccgtcaatg tggccttcac ccttccgggt attctgtttg tcgacaaagt gggccgaaga 960

aagctgctct tgattggagc cgtggtaatg tgtgtttcag aattaattgt ggcagctgta 1020

ggagcagctc tggatagcca ggtgtcttcc aaggtcctta ttgccttcac ttgtacgttc 1080

atcgcaggct ttgcatccac ctggggacct atagcctggg tggttgttgc ggagattttc 1140

ccgcttcgaa tccgggccaa gggagtggct atcagtgtgg ctgccaactg gattttcaac 1200

tttgccattg cctttgcaac tccgtacttg gtcgacaaga aacctgggtc tgccggtctc 1260

gagtccaagg tgtttttcat ctggggaggt tgcaattttc tagccattgc ctttgtgtac 1320

ttgtttgtct atgaaaccaa agggttgtca ctggagcagg tggacgaaat gtactcggag 1380

gtcaagtacg cctggcagag tgataggttc cagaccgaga tcatgtctgg aaagacggag 1440

gtttcgccgg atcagagctg cgattctgga tttgattcgg attag 1485

<210> SEQ ID NO 29
<211> LENGTH: 2881
<212> TYPE: DNA
<213> ORGANISM: Cryptococcus neoformans

<400> SEQUENCE: 29

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aacctactgt acagtgtttc agtgtttctt agcataggag tctggttatt tgggtaggtg 120

ttttgtgaat ccggatggtg ttgtgctgat atgataaccg gttaagatat gaccaggggt 180

aagttcactt caagcgctta tccttaagct tcgctgatca tggccttcaa actgtgaaag 240

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gtaaggaatt attaccggcc catactttaa gtaggtatga agtaaatact gagtatcttt 360

cattaacatt tatggcacgt gtctacagag cttattgtga gtaaagccct aatcaagcaa 420

actaagctga cgtttttagt caaccaacca acgtcaacgc agattggcaa gtaagttagt 480

cattcagtgc cagtagcaat gtctgaacat tcgatagtat ggtggccgtt ttggagattg 540

gtgccttcag taagattatt ccatgtcatg tcattctttc aagaactcac ggcaatcacg 600

cagttacttc tctggctgcc gctcatattg cagataatta tggaaggcgt atgacccttc 660

gcacaggtgc aatagtcttc accattggag gtgctataca gacttttgc gttggatata 720

attccatggt acttggaaga attgtcagcg gctttggggt agggatgttg agtatggtcg 780

tgccaatcta tcaggtatgt ggtttacaat agtaaaggcg cggagcataa gccaatgtgt 840

gtcaccctcg cgcagtccga aatatctcct gcagaccatg taagaaacac ttcaatattt 900

ccagaagatt tttctaataa aacacgatga tagcgaggcc ttttgggctc tgtcgaattc 960

acaggtaata tcattggcta tgcctcctct gttgtacgat gtgtcacctg cctatgtcaa 1020

gcaccatgct cactcaacgt tcatagtgga tcgactatgc ctgttcattc ttccagtctg 1080

actggtcttg gcgcctcccg ctttctgttc aatgtatagg cggctctgtt ctcttcatcg 1140

gcagcttcgt cacaccagag tctccccggt aagccttcta tatgtgcatc atatgtaggt 1200

gcagaactaa gagctgttca aaggtatctt gtcgatacag accaagaggt ggaaggttta 1260

gcagtcatcg ctgattttca agggaaagcg ctggacgata tttcagtgca agccgagtac 1320

aaagaaattc gagatgctgt tctagccgac gtgagacaat cctctcaacg ttatccccat 1380

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gcgctttaat cctgcttttt gctaacgact gttgtatctg cagaattggt gggtaggggt 2400

ttcaacaccg ctctttcaag aacttatcgg atggcgatta tatccgatgc acgcattctt 2460

ttgtgcatta tcattcatcc tcgtgtactt ccgtgagttg tcagccgaga ttcgtaaacc 2520

accactcatg cacatggaac tagtctatcc cgaaacccga ggcgtaccgc ttgaagaaat 2580

ggacaaattg tttggggatg aaagtgatga agacgaggtt gattcggact tcgatgaagt 2640

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gattggaagc acaaaacagc aaagcaggag cgtggggtat actgctgtca acgaggaata 2880

g 2881

<210> SEQ ID NO 30
<211> LENGTH: 1713
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 30

atgtcacaag acgctgctat tgcagagcaa actcctgtgg agcatctctc tgctgttgac 60

tcagcctccc actcggtttt atctacacca tcaaacaagg ctgaaagaga tgaaataaaa 120

gcttatggtg aaggtgaaga gcacgaacct gtcgttgaaa ttccaaagag accagcttct 180

gcctatgtca ctgtctctat tatgtgtatc atgatcgcct ttggtggttt cgttttcggt 240

tgggatactg gtaccatttc tggtttcatc aatcaaaccg atttcatcag aagatttggt 300

atgaagcata aagatggtac taattatttg tctaaggtta gaactggttt gattgtctcc 360

attttcaaca ttggttgtgc cattggtggt attattcttt ccaaattggg tgatatgtac 420

ggtcgtaagg tgggtttgat tgtcgttgtt gtcatctaca tcatcggtat tattattcaa 480

attgcatcta tcaacaaatg gtaccaatat ttcatcggta gaattatttc cggtttgggt 540

gttggtggta ttgccgtttt atctcctatg ttgatttctg aagtatcccc aaagcattta 600

aggggtactt tagtctcttg ctaccaattg atgattactg ccggtatttt cttgggttac 660

tgtaccaact tcggtactaa gaactactcc aactctgtgc aatggagagt tccattaggt 720

ttgtgttttg cctgggcttt gtttatgatt ggtggtatga catttgttcc agagtctcca 780

cgttatttgg ctgaagtcgg taagatcgaa gaagccaaac gttctattgc cgtttctaac 840

aaggttgctg ttgatgatcc atctgttttg gctgaagtcg aagctgtctt ggctggtgta 900

gaggcagaga aattagctgg taatgcatcc tggggtgaat tgtttagtag caagacaaag 960

gtccttcagc gtttgatcat gggtgctatg attcaatctc tacaacaatt gacaggtgat 1020

aactatttct tctactatgg tactactatt ttcaaggctg ttggtttgag tgactctttc 1080

gaaacctcta ttgtcttggg tattgttaac tttgcttcca cctttgttgg tatttacgtt 1140

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ttggaagaag tcaacaccat gtgggaagaa ggtgttctac catggaagtc tgcctcatgg 1620

gttccaccat ccagaagagg tgccaactac gacgctgaag aaatgactca cgatgacaag 1680

ccattgtaca agagaatgtt cagcaccaaa taa 1713

<210> SEQ ID NO 31

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<211> LENGTH: 1695
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 31

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ggggataacg ttgagccacc aaaaagaggg ctcataggtt atcttgtcat ttacttactg 180

tgttatccaa tatcctttgg gggtttcctg cctggttggg atagtggtat cacagcaggt 240

ttcattaaca tggacaactt taaaatgaac ttcggttctt acaagcatag cactggtgaa 300

tattatttga gcaacgtgcg tatgggtctt cttgtggcta tgttcagtat tggatgtgcc 360

ataggtggcc ttatttttgc ccgtcttgct gatactttag gtagaaggct ggcaattgtg 420

atcgtggtgt tggtatatat ggttggtgca attattcaga tcagttcaaa tcacaaatgg 480

taccagtact ttgtcggtaa gatcatctac ggtcttggtg ctggtggctg ttcggtgttg 540

tgtccaatgc ttttgtctga aatagccccc acagatttga gaggtggact ggtctcattg 600

taccaactga acatgacgtt cggtattttc ttgggttatt gtagcgttta tggtacgaga 660

aaatacgata acactgcaca atggagagtc ccccttgggc tttgcttttt atgggctttg 720

attatcatca ttggtatgtt attggttcca gagtccccaa gatatctgat tgaatgtgag 780

agacacgaag aggcccgtgc ttccattgcc aaaatcaaca aggtttcacc agaggatcca 840

tgggtactca aacaggctga tgaaatcaac gccggtgtcc ttgcccaaag ggaactagga 900

gaagcttcat ggaaagaact tttctctgta aaaactaaag tccttcaacg tttgatcaca 960

ggtattcttg tgcaaacctt tttgcaactt actggtgaaa actacttctt cttctacgga 1020

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tacgaagaag gtataaaacc atggaaatct gcatcttggg tcccaccttc taggagaggt 1620

atttcttccg aagaaagtaa gaccgagaag aaggattgga agaaatttttt gaagttctca 1680

aagaattctg attga 1695

<210> SEQ ID NO 32
<211> LENGTH: 1704
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 32

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ctgccttcga atagctctca ggtaatgaac atgcctgaag aaaaaggtgt tcaagatgat 120

ttccaagctg aggccgacca agtacttacc aacccaaata caggtaaagg tgcatatgtc 180

actgtgtcta tctgttgtgt tatggttgcc ttcggtggtt tcgttttcgg ttgggatact 240

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ggtaccattt ctggtttcgt cgcccaaact gatttcttga gaagattcgg tatgaagcat 300

aaagatggta gttattattt gtctaaggtt agaactggtt taattgtctc cattttcaac 360

attggttgtg ccattggtgg tattattttg gctaaattgg gtgatatgta cggtcgtaaa 420

atgggtttga ttgtcgttgt tgttatctac atcatcggta ttattattca aattgcatcc 480

atcaacaaat ggtaccaata tttcatcggt agaattattt ccggtttggg tgttggtggt 540

attgccgttt tatctcctat gttgatttct gaagtcgctc ctaaggaaat gagaggtact 600

ttagtctcct gttaccaact gatgattacc ttgggtattt tcttgggtta ctgtaccaac 660

ttcggtacta agaactactc caactctgtg caatggagag ttccattagg tttgtgtttt 720

gcctgggctt tgtttatgat cggtggtatg actttcgttc cagaatcccc acgttatttg 780

gttgaagctg gtcaaattga cgaagcaaga gcatctcttt ccaaagttaa caaggttgcc 840

ccagaccatc cattcattca acaagagttg gaagttattg aagctagtgt tgaagaagct 900

agagctgctg gttcagcatc atggggtgag ttgttcactg gtaagccggc catgtttaag 960

cgtactatga tgggtatcat gatccaatct ctacaacaat tgactggtga taactatttc 1020

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tgggctccaa ttgcttatgt tgttatttct gaaactttcc cattgagagt caagtctaag 1380

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gtcaatgata tgtacgctga aggtgttcta ccatggaagt ctgcttcatg ggttccaaca 1620

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aagaaaatgt tcggcaagaa ataa 1704

<210> SEQ ID NO 33
<211> LENGTH: 1713
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 33

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ttggaatctg gtcgttcaaa ggccatgaat actccagaag gtaaaaatga aagttttcac 120

gacaacttaa gtgaaagtca agtgcaaccc gccgttgccc ctccaaacac cggaaaaggt 180

gtctacgtaa cggtttctat ctgttgtgtt atggttgctt tcggtggttt catatttgga 240

tgggatactg gtaccatttc tggttttgtt gctcaaactg attttctaag aagatttggt 300

atgaagcacc acgacggtag tcattacttg tccaaggtga gaactggttt aattgtctct 360

atttttaaca ttggttgtgc cattggtggt atcgtcttag ccaagctagg tgatatgtat 420

ggtcgtagaa tcggtttgat tgtcgttgta gtaatctaca ctatcggtat cattattcaa 480

atagcctcga tcaacaagtg gtaccaatat ttcattggta gaattatctc tggtttaggt 540

gtcggtggta tcacagtttt atctcccatg ctaatatctg aggtcgcccc cagtgaaatg 600

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agaggcacct tggtttcatg ttaccaagtc atgattactt taggtatttt cttaggttac 660

tgtaccaatt ttggtaccaa gaattactca aactctgtcc aatggagagt tccattaggt 720

ttgtgtttcg cctgggcctt atttatgatt ggtggtatga tgtttgttcc tgaatctcca 780

cgttatttgg ttgaagctgg cagaatcgac gaagccaggg cttctttagc taaagttaac 840

aaatgcccac ctgaccatcc atacattcaa tatgagttgg aaactatcga agccagtgtc 900

gaagaaatga gagccgctgg tactgcatct tggggcgaat tattcactgg taaaccagcc 960

atgtttcaac gtactatgat gggtatcatg attcaatctc tacaacaatt aactggtgat 1020

aactatttct tctactacgg taccattgtt ttccaggctg tcggtttaag tgactctttt 1080

gaaacttcta ttgtctttgg tgtcgtcaac ttcttctcca cttgttgttc tctgtacacc 1140

gttgaccgtt ttggccgtcg taactgtttg atgtggggtg ctgtcggtat ggtctgctgt 1200

tatgttgtct atgcctctgt tggtgttacc agattatggc caaacggtca agatcaacca 1260

tcttcaaagg gtgctggtaa ctgtatgatt gttttcgcat gtttctacat tttctgtttc 1320

gctactacct gggccccaat tgcttacgtt gttatttcag aatgtttccc attaagagtc 1380

aaatccaagt gtatgtctat tgccagtgct gctaactgga tctggggttt cttgattagt 1440

ttcttcaccc catttattac tggtgccatc aacttctact acggttacgt tttcatgggc 1500

tgtatggttt tcgcttactt ttacgtcttt ttcttcgttc cagaaactaa aggtttatca 1560

ttagaagaag ttaatgatat gtacgccgaa ggtgttctac catggaaatc agcttcctgg 1620

gttccagtat ccaagagagg cgctgactac aacgctgatg acctaatgca tgatgaccaa 1680

ccattttaca agagtttgtt tagcaggaaa taa 1713

<210> SEQ ID NO 34
<211> LENGTH: 1644
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 34

atgggttacg aagataaatt agtggctcct gctttaaagt ttagaaactt tttggacaag 60

actccaaata tctataatgt ttttgttatt gctctgattt catgtatctc cgggttgatg 120

tttggtattg atatctcatc tatgtcttta tttattgggg atgacaaata cattaaatac 180

ttccataaac ctagcacaac catgcaatcg tttattactt cggctatgtc tttgggttca 240

ttttttggat caatatgttc ttcttttgtg tccgaaccat ttggcagaag atcatcgtta 300

atggtatgtg ggtttttctg gtgtgttggt gctgctattc aatcatctgc tcaaaatcaa 360

gcgcaattga ttatcggccg ttttatttct ggttttggtg ttggtttcgg ttcatcagtt 420

gctccagttt atggatctga attagctcct agaaagatca gaggtttaat tgggggtctt 480

tttcaattct ctgtcacttt gggtatctta atcatgttct atatctgtta tggtttgaat 540

tttattaacg gtgtcgcatc cttcagagtt gcttggggtt tacaaatcat accaggttta 600

gttttgatcc ttggttgttt ctttattcca gaatctccta gatggttagc taaacaaggt 660

tactgggaag atgctgaata tgttgttgcc aagatccaag ctaagggtaa cagagaagat 720

ccagatgttt taattgaaat gtctgaaatt aaggaacaaa ttatgttaga tgaacacatc 780

aaggctttca catatgctga tttgttcact aagaagtata tattgagaac tgttactgct 840

tgttgggctc aagcctggca acaattaacc ggtatgaata ctttgatgta ttatattgtt 900

tatgttttcc aaatggccgg ttacgaaggt gatgctaatt tggttgctag ttccattcaa 960

tactgtctta acactggtat gaccattccc gcattatact tcatggataa gcttggtaga 1020

-continued

agaccagttt tattaactgg ggctgcattc atgatggctt ggcaattcgc cgttggtgga 1080

ttattggcaa cttacagtgt tgataaccct atcagtgaaa ccgtcagaat tcaaattcca 1140

gaagaacatg gcaaggccgc caaagctgtc attgcttgct gttatttatt cgttgtttct 1200

ttcgcttgta gttggggtgt ttgtatttgg gtttactgtg ctgaagtctg gggtgatagt 1260

gcttcaagac aaagaggtgc tgctcttacc acttctgtta attggatttt caatttcgcc 1320

attgctatgt tcactccaag tgctttcaag aacattactt ggaagactta catggtcttc 1380

gctacattct gtggttgtat gtttatccat gtcttcttct tcttcccaga aactaagggt 1440

aagagattgg aagaaattgg tcaaatgtgg gccgaaggtg taccagcttg gaagtctgct 1500

tcttggcaac catctattcc aatcgtgtcc gataatgaat tacataacaa gatgaagatt 1560

gaccataatg aagataactt attaaattct tcttcacatt ctgaagtatc ccaagagaag 1620

ggcgatactt ctcacatgac ttaa 1644

<210> SEQ ID NO 35
<211> LENGTH: 1638
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 35

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cttccaaaca tttataatat ttatgtcatt gctactattt cgtgtatttc ggggttgatg 120

ttcggtatcg acatttcatc gatgtcggcg ttccttagta atgacgctta ccttaaatat 180

tttggtaccc ctgaacctga tatgcaagga ttcattactg ctgctatgtc tcttgggtca 240

ttctttgggt ctcttgcatc ggcattttgt tcagagccat ttggtagaag agcttcattg 300

ttgctttgtg gattcttttg gtctgttggg gctgcaattc aatcttcatc acagaatgtc 360

gcccagttaa ttattggtcg ttttatttct ggttttggaa ttggtttcgg ctcatctgtg 420

gcacccgtgt atggatcaga gttggcacct agaaaaatta gagggttaat tggtggtctt 480

ttccaacttt cagttacctt aggtattttg attatgttct atatctgtta cgggttaggt 540

aaaatccaag ccgtcggctc attcagaact gcgtggggtt tgcaaattat cccaggattg 600

atcttaatac ttggatgttt ctttattcca gaatcaccta gatggttagc caaacagaac 660

tactgggaag aggcggagga cattgtcgct agagtccaag ctaaaggtaa cagagaagac 720

cctgaagtat taattgaaat ggctgaaatt agagaccaga ttctgacgtt agacaaagtt 780

aagtctttta cttatattga tttattcaaa aagaagtatc ttcttagaac tgtaacggca 840

atatttgctc aaatttggca acaattaaca ggtatgaaca ccttaatgta ttatattgtc 900

tatgttttcg aaatggctgg ttatcatggt gatgcaaatt tggttgcctc ttcaattcaa 960

tattgtatca attttgccat gactattcct gcattgtact taatggataa ggtcggtagg 1020

agaccagtgt tgttaactgg agctgcgctc atgatggcct ggcaatttgc tatagggggc 1080

ttgcttgcca cttatgctga acccaccgat atttttgggg gtaataatac cgttaaaatc 1140

agtatcccag aagatgaatc tcctgccgcc aaggctgtta ttgcatgttg ttacttattc 1200

gttgtttcat ttgcgtctac ttggggtgtt ggtatctggg tttactgtgc tgaagtctgg 1260

ggtgatagtg cctcaagaca aagaggtgcg tgtgttgcaa ctgctggtaa ttggattttt 1320

aatttcgcaa ttgcaatgtt cactccgcac gctttcagta ctattacttg gaaaacatac 1380

atgatttttg ctactttctg tgcatgtatg tttcttcatg ttttcttctt tttccctgaa 1440

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actaagggta aaagattgga agaaattggt caaatgtggg acgagcatgt tccagcttgg 1500

aagtctgctt cgtggcaacc acacgtacca ctcgtttcag ataatgaaat acacgggaag 1560

atggattctg cgcatgatga acattcatct cgttcggagt ctactggaga aaaggtggtc 1620

gcagatcaca ttgcttga 1638

<210> SEQ ID NO 36
<211> LENGTH: 1638
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 36

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tttccgaaca tccataatgt ctatattgtt gttggtattt cttgtatatc tggtatgatg 120

tttggcattg atatttcttc aatgtcttta ttcattggag atgataaata tttagactat 180

ttcaattcac cagattctac acttcaaggg tttattacag catccatgtc tttagggtct 240

ttctttgggg ccttattttc cgcatttata tcagaacctt tcggtagaag aatgtcgttg 300

atgttctgtg catttttttg gtgtgttgga gctgccattc aatcatcgtc acagaacgtc 360

gtccagttaa ttataggtcg ttttatttct ggttttggtg ttggatttgg atcctcagta 420

gccccagttt atggtacaga attggcacca agaaaaataa gaggattaat tggtggatta 480

tttcagcttt cggtcacttt gggaattttg gttatgttct atgtttgtta tgcattacat 540

tatatcaatg gtgtggcttc ttttagatta tcttgggggt tacaaatagt tcctggtctt 600

cttttgttca ttggctgttt tttcatccct gaatcaccta gatggttagc aaagcaaggc 660

tgttgggagg aggctgaata cattgtggca atgattcagg ccaaaggcaa tagggaagat 720

cccgatgtca tgattgagat tactgagatc aaagatcaaa ttttgacaga ggaaaatatt 780

aaggctttca cttatgcaga tttattcaag cgcaaatatc tccttagaac tgtcaccgca 840

acatttgctc aaatatggca acaattaacg ggtatgaata cattaatgta ttatattgtt 900

tatgtttttg atatggctgg ctatcagggc gatgcaaatt taattgcatc ttcaattcaa 960

tacgttcttt ttttcgttat gactgcccct tcattatatt taatggataa acttggtaga 1020

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ttgctttcca cttatgctga gcccaccaat gatgttggtg gaaatgatac tgtcagatta 1140

aggatcccag ctgataactc aaccgctgcc aagggtgtaa ttgcatgttg ctatttgttt 1200

gttgtatcat ttgcatatag ttggggtgtt tgtatctgga tgtattgtgc tgaagtttgg 1260

ggtgatagcg cctcaagaca aagaggggcc tgttttacaa cttcagctaa ttggattttt 1320

aacttcgcga tcgcaatgtt taccccctct gcgttcaaaa acattacttg gaaaacatac 1380

atgatttttg ctacgttctg cggttgtatg ttccttcacg tatttttctt tttcccagaa 1440

actaaaggta aaagattgga ggaaattggc caaatgtggg atgaaggaat tccagcatgg 1500

agaacagccg catgggagcc atctattcca ttcttatctg ataatgactt gcgtgaaaag 1560

ctagaagtaa aacacgtcga agattcaaac tccagtaatt cggatgctga aaagcctagt 1620

gctgtccata ttgcttag 1638

<210> SEQ ID NO 37
<211> LENGTH: 1851
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 37

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atgaaaaata tcatttcatt ggtaagcaag aagaaggctg cctcaaaaaa tgaggataaa 60

aacatttctg agtcttcaag agatattgta aaccaacagg aggttttcaa tactgaagat 120

tttgaagaag ggaaaaagga tagtgccttt gagctagacc acttagagtt caccaccaat 180

tcagcccagt taggagattc tgacgaagat aacgagaatg tgattaatga gatgaacgct 240

actgatgatg caaatgaagc taacagcgag gaaaaaagca tgactttgaa gcaggcgttg 300

ctaaaatatc caaaagcagc cctgtggtcc atattagtgt ctactaccct ggttatggaa 360

ggttatgata ccgcactact gagcgcactg tatgccctgc cagtttttca gagaaaattc 420

ggtactttga acggggaggg ttcttacgaa attacttccc aatggcagat tggtttaaac 480

atgtgtgtcc tttgtggtga gatgattggt ttgcaaatca cgacttatat ggttgaattt 540

atggggaatc gttatacgat gattacagca cttggtttgt taactgctta tatctttatc 600

ctctactact gtaaaagttt agctatgatt gctgtgggac aaattctctc agctatacca 660

tggggttgtt tccaaagttt ggctgttact tatgcttcgg aagtttgccc tttagcatta 720

agatattaca tgaccagtta ctccaacatt tgttggttat ttggtcaaat cttcgcctct 780

ggtattatga aaaactcaca agagaattta gggaactccg acttgggcta taaattgcca 840

tttgctttac aatggatttg gcctgctcct ttaatgatcg gtatcttttt cgctcctgag 900

tcgccctggt ggttggtgag aaaggatagg gtcgctgagg caagaaaatc tttaagcaga 960

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gaattgacta ttgaaaaaga aagactttta gcatctaaat caggatcatt ctttaattgt 1080

ttcaagggag ttaatggaag aagaacgaga cttgcatgtt taacttgggt agctcaaaat 1140

agtagcggtg ccgttttact tggttactcg acatattttt ttgaaagagc aggtatggcc 1200

accgacaagg cgtttacttt ttctctaatt cagtactgtc ttgggttagc gggtacactt 1260

tgctcctggg taatatctgg ccgtgttggt agatggacaa tactgaccta tggtcttgca 1320

tttcaaatgg tctgcttatt tattattggt ggaatgggtt ttggttctgg aagcagcgct 1380

agtaatggtg ccggtggttt attgctggct ttatcattct tttacaatgc tggtatcggt 1440

gcagttgttt actgtatcgt tgctgaaatt ccatcagcgg agttgagaac taagactata 1500

gtgctggccc gtatttgcta caatctcatg gccgttatta acgctatatt aacgccctat 1560

atgctaaacg tgagcgattg gaactggggt gccaaaactg gtctatactg gggtggtttc 1620

acagcagtca ctttagcttg ggtcatcatc gatctgcctg agacaactgg tagaaccttc 1680

agtgaaatta atgaactttt caaccaaggg gttcctgcca gaaaatttgc atctactgtg 1740

gttgatccat tcggaaaggg aaaaactcaa catgattcgc tagctgatga gagtatcagt 1800

cagtcctcaa gcataaaaca gcgagaatta aatgcagctg ataaatgtta a 1851

<210> SEQ ID NO 38
<211> LENGTH: 1710
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 38

atgaaggatt taaaattatc gaatttcaaa ggcaaattta taagcagaac cagtcactgg 60

ggacttacgg gtaagaagtt gcggtatttc atcactatcg catctatgac gggcttctcc 120

ctgtttggat acgaccaagg gttgatggca agtctaatta ctggtaaaca gttcaactat 180

gaatttccag caaccaaaga aaatggcgat catgacagac acgcaactgt agtgcagggc 240

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gctacaacct cctgttatga attaggttgt ttcgcaggtt ctctattcgt tatgttctgc 300

ggtgaaagaa ttggtagaaa accattaatc ctgatgggtt ccgtaataac catcattggt 360

gccgttattt ctacatgcgc atttcgtggt tactgggcat taggccagtt tatcatcgga 420

agagtcgtca ccggtgttgg aacagggttg aatacatcta ctattcccgt ttggcaatca 480

gaaatgtcaa aagctgaaaa tagagggttg ctggtcaatt tagaaggttc cacaattgct 540

tttggtacta tgattgctta ttggattgat tttgggttgt cttataccaa cagttctgtt 600

cagtggagat tccccgtgtc aatgcaaatc gtttttgctc tcttcctgct tgctttcatg 660

attaaactac ctgaatcgcc acgttggctg atttctcaaa gtcgaacaga agaagctcgc 720

tacttggtag gaacactaga cgacgcggat ccaaatgatg aggaagttat aacagaagtt 780

gctatgcttc acgatgctgt taacaggacc aaacacgaga aacattcact gtcaagtttg 840

ttctccagag gcaggtccca aaatcttcag agggctttga ttgcagcttc aacgcaattt 900

ttccagcaat ttactggttg taacgctgcc atatactact ctactgtatt attcaacaaa 960

acaattaaat tagactatag attatcaatg atcataggtg gggtcttcgc aacaatctac 1020

gccttatcta ctattggttc atttttttcta attgaaaagc taggtagacg taagctgttt 1080

ttattaggtg ccacaggtca agcagtttca ttcacaatta catttgcatg cttggtcaaa 1140

gaaaataaag aaaacgcaag aggtgctgcc gtcggcttat ttttgttcat tacattcttt 1200

ggtttgtctt tgctatcatt accatggata tacccaccag aaattgcatc aatgaaagtt 1260

cgtgcatcaa caaacgcttt ctccacatgt actaattggt tgtgtaactt tgcggttgtc 1320

atgttcaccc caatatttat tggacagtcc ggttggggtt gctacttatt ttttgctgtt 1380

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ttggaggaaa tcgacatcat ctttgctaaa gcatacgagg atggcactca accatggaga 1500

gttgctaacc atttgcccaa gttatcccta caagaagtcg aagatcatgc caatgcattg 1560

ggctcttatg acgacgaaat ggaaaaagag gactttggtg aagatagagt agaagacacc 1620

tataaccaaa ttaacggcga taattcgtct agttcttcaa acatcaaaaa tgaagataca 1680

gtgaacgata aagcaaattt tgagggttga 1710

<210> SEQ ID NO 39
<211> LENGTH: 1626
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 39

atgtctgaat tcgctactag ccgcgttgaa agtggctctc aacaaacttc tatccactct 60

actccgatag tgcagaaatt agagacggat gaatctccta ttcaaaccaa atctgaatac 120

actaacgctg aactcccagc aaagccaatc gccgcatatt ggactgttat ctgtttatgt 180

ctaatgattg catttggtgg gtttgtcttt ggttgggata ctggtaccat ctctggtttt 240

gttaatcaaa ccgatttcaa aagaagattt ggtcaaatga aatctgatgg tacctattat 300

ctttcggacg tccggactgg tttgatcgtt ggtatcttca atattggttg tgcctttggt 360

gggttaacct taggacgtct gggtgatatg tatggacgta gaattggttt gatgtgcgtc 420

gttctggtat acatcgttgg tattgtgatt caaattgctt ctagtgacaa atggtaccaa 480

tatttcattg gtagaattat ctctggtatg ggtgtcggtg gtattgctgt cctatctcca 540

actttgattt ccgaaacagc accaaaacac attagaggta cctgtgtttc tttctatcag 600

ttaatgatca ctctaggtat tttcttaggt tactgtacca actatggtac taaagactac 660

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atcgctggta tgctaatggt tccagaatct ccaagattct tagtcgaaaa aggcagatac 780

gaagacgcta aacgttcttt ggcaaaatct aacaaagtca ccattgaaga tccaagtatt 840

gttgctgaaa tggatacaat tatggccaac gttgaaactg aaagattagc cggtaacgct 900

tcttggggtg agttattctc caacaaaggt gctattttac ctcgtgtgat tatgggtatt 960

atgattcaat ccttacaaca attaactggt aacaattact tcttctatta tggtactact 1020

attttcaacg ccgtcggtat gaaagattct ttccaaactt ccatcgtttt aggtatagtc 1080

aacttcgcat ccactttcgt ggccttatac actgttgata aatttggtcg tcgtaagtgt 1140

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acaagcttat atccaaatgg taaagatcaa ccatcttcca aggctgccgg taacgtcatg 1260

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gttattgttg ccgaatccta tcctttgcgt gtcaaaaatc gtgctatggc tattgctgtt 1380

ggtgccaact ggatttgggg tttcttgatt ggtttcttca ctcccttcat tacaagtgca 1440

attggatttt catacgggta tgtcttcatg ggctgtttgg tattttcatt cttctacgtg 1500

ttttttctttg tctgtgaaac caagggctta acattagagg aagttaatga aatgtatgtt 1560

gaaggtgtca aaccatggaa atctggtagc tggatctcaa aagaaaaaag agtttccgag 1620

gaataa 1626

<210> SEQ ID NO 40
<211> LENGTH: 1710
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 40

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ggctgccctt cgatagaaaa ttcttcacat ctgtcagtac ctacagtgga ggaaaacaag 120

gacttttccg agtataatgg ggaagaggca gaggaagttg ttgttccaga aaagcctgct 180

tcagcctatg ctactgtttc tatcatgtgt ttatgtatgg ctttcggtgg atttatgtcc 240

ggttgggaca caggtacgat ttctggtttc gtcaatcaga ctgatttttt aagaagattt 300

ggtaattata gccattccaa gaacacttac tacttatcta atgtgagaac tgggttgatt 360

gtgtccatct tcaatgtggg aagcgccatt ggctgtcttt tcttgtctaa attgggtgat 420

atttacggcc gctgcatggg tttgattata gttattgtcg tttatatggt tggtattgtc 480

attcaaattg cctctataga taagtggtat cagtatttta ttggaagaat tatcgctggt 540

ataggtgctg gttccattag tgttcttgcc ccgatgctta tttcggaaac tgcgccaaag 600

catatcagag gtacgttgct agcttgttgg caattgatgg tgactttcgc aattttcttg 660

ggttattgta ccaattatgg taccaagact tactcgaatt ctgtccagtg gcgtgttccg 720

cttggtctat gttttgcatg ggctattatt atgattggtg gtatgacgtt tgttccggaa 780

tctcctcggt ttttggtgca agtcggtaag attgagcaag ctaaagcttc ttttgccaag 840

tcgaacaagc ttagtgttga cgatcctgct gtggttgcag agattgatct tcttgttgct 900

ggtgtggagg cagaagaagc aatgggaact gcttcatgga aggaattatt ttcgagaaag 960

actaaagttt ttcaacgttt aacgatgaca gtcatgatta actctctgca gcaactaacc 1020

ggtgacaact atttcttcta ctacggtact actatcttca aatctgtcgg tatgaatgac 1080

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tcttttgaga cttcaattgt cttgggtatt gtgaattttg cttcttgctt cttttcactt 1140

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gaaccatcat ctaaaggtgc tggtaattgt acgattgttt tcacgtgttt ttacattttc 1320

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agggtgagat ccaagtgtat gtccgttgca acagcggcca acttattgtg ggggttccta 1440

atcgggtttt tcactccttt tattacttcg gcaattaatt tctactacgg ttacgttttc 1500

atgggttgct tagcgttttc atatttttac gtctttttct ttgttccaga aacaaaaggt 1560

ctaactttag aagaagttga tgagatgtgg atggacggtg tattaccttg gaaatctgaa 1620

tcctgggtac cagcttctag aagggatggt gattatgata acgaaaaatt acagcatgac 1680

gagaaaccct tctacaaaag aatgttttag 1710

<210> SEQ ID NO 41
<211> LENGTH: 1704
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 41

atgtccggtg ttaataatac atccgcaaat gatttatcca ctaccgagtc taactctaac 60

tcagtagcaa atgcaccatc tgtaaaaact gagcataatg actctaaaaa ctccctcaac 120

ctggatgcca ctgaaccacc tattgactta cctcaaaaac ccctctctgc atataccacc 180

gtcgcaatcc tgtgtttgat gattgcattt ggcggcttca tctttggttg ggataccggt 240

accatttctg gttttgttaa cctttctgat ttcatcagaa ggttcggtca aaaaaatgac 300

aagggaacct actacttatc gaaagtaaga atgggtttga tcgtctcaat attcaacatt 360

ggctgcgcca taggcggaat tgtcttgtca aaagtcggtg atatatatgg tcgtcgtatt 420

ggattgatta cagttactgc catttacgtt gtaggcatcc taatccaaat aacttccata 480

aacaagtggt accaatactt cattggaaga attatttctg gcctaggagt gggaggcatt 540

gctgtccttt ccccaatgtt gatatctgaa gttgctccca aacaaatcag aggaaccctg 600

gtccaattgt accagctgat gtgtacgatg ggtatttttc taggatactg taccaattac 660

ggtaccaaga actatcacaa cgccactcaa tggagagtcg gccttggtct ttgctttgcc 720

tggactacat tcatggttag tggaatgatg tttgtaccag aatcaccacg ttacctgatt 780

gaggttggta aagatgagga agcgaaacgt tcactttcga aatccaacaa agtctcagtc 840

gacgatccag ccttgttagc agaatatgac actataaagg cgggaatcga acttgaaaag 900

ctggcaggta acgcatcatg gtctgaacta ctctccacta aaacaaaggt ctttcagcgt 960

gttctcatgg gagtgatgat ccaatcgctg cagcaattaa ccggtgataa ctacttcttt 1020

tactacggca ccaccatctt caaatctgtc ggtctaaagg actcctttca gacttcgatc 1080

attatcggtg tggttaattt tttctcttca ttcatagcgg tatacaccat tgagaggttt 1140

ggacgccgta cgtgtctatt gtggggtgct gcttctatgc tatgctgctt tgctgtgttt 1200

gcctccgtcg gtgtgacaaa gttgtggcct caaggaagca gtcaccaaga cattacttct 1260

cagggcgccg gtaactgtat gattgtgttt actatgttct tcatttttc gttcgccacc 1320

acttgggcag gcggctgtta cgttattgtc tcagagacgt ttcctcttag ggtcaaatca 1380

agaggaatgg caatcgcaac agctgcaaac tggatgtggg gtttcctgat tagtttcttt 1440

accccattca ttaccggggc aatcaacttt tactacggtt atgtattctt aggctgtctg 1500

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gtttttgcat acttttatgt ctttttcttt gtcccagaaa caaaaggcct gacgctggag 1560

gaggtgaata ctatgtggct ggaaggtgtg ccagcatgga aatcagcctc atgggtgcca 1620

ccagaaagaa gaaccgcaga ttacgatgct gacgccatag accatgacga tagaccaatc 1680

tacaagaggt tcttttccag ctaa 1704

<210> SEQ ID NO 42
<211> LENGTH: 1641
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

<400> SEQUENCE: 42

atggttagtt caagtgtttc cattttgggg actagcgcca aggcatccac ttctctaagt 60

agaaaggatg aaattaaact aacccctgaa acaagggaag ctagcttgga cattccatac 120

aaacccatta ttgcatactg gacggtgatg ggtctctgtc tgatgattgc ctttggtgga 180

ttcatttttg gttgggatac aggaaccatt tcagggttta ttaaccaaac agatttcaag 240

agaaggtttg gtgagttaca aagggacggc agttttcaac tatcagatgt caggacaggg 300

ctaattgtcg gtatcttcaa cataggttgt gctttaggtg gcctaacgct gggacgcctg 360

ggcgatattt atgggcgtaa aatcggctta atgtgtgtta tactggtgta tgttgttggt 420

atcgtgatcc agattgcttc ctctgacaaa tggtatcaat attttattgg tagaattgtt 480

tctggaatgg gtgttggagg tgttgctgtg ctgtcgccaa ctttgatctc agaaatttcc 540

ccaaagcacc taagaggcac ttgtgtctct ttttaccagc taatgattac ccttggaatt 600

ttcttgggct actgtaccaa ttatggtaca aagaaatatt caaattcaat acagtggcgg 660

gttcccttgg gtttgtgttt tgcgtgggca atctttatgg tgattggaat ggttatggtt 720

ccggaatcgc ccagatattt agtagaaaaa ggtaagtatg aagaagctag aaggtctttg 780

gccaaatcaa acaaggtcac agttactgat ccaggcgttg tttttgagtt tgatactata 840

gttgcaaata tggaattaga aagggctgtt ggaaatgcca gttggcacga actcttctca 900

aataaaggag caattctacc aagggtaata atgggaatcg ttatccagtc actgcaacag 960

cttactggct gtaattattt tttctactac ggcacgacca ttttcaatgc tgttggaatg 1020

caagactctt tcgagacttc cattgtcctt ggggctgtta attttgcttc tacatttgtt 1080

gcactataca ttgtggataa atttgggcgt cgaaaatgtt tattgtgggg gtctgcctcg 1140

atggcaattt gtttcgtcat attcgccacc gttggcgtca ctagattatg gccacaaggg 1200

aaagaccaac cttcttcgca aagtgctggt aatgttatga tcgtttttac ttgtttcttc 1260

attttctctt ttgccattac ttgggctcct atcgcctatg tcattgtggc agaaacttat 1320

ccattaagag ttaaaaatcg tgccatggcc attgcggttg gtgcgaactg gatgtggggt 1380

ttcttgattg gatttttcac acccttttatc actagatcca taggattttc ttatggctat 1440

gttttcatgg gttgcttaat cttttcgtac ttctacgttt tcttctttgt ttgcgaaaca 1500

aagggattaa ctctggagga agttaatgaa atgtacgaag aaagaataaa gccatggaag 1560

tccggaggtt ggattcccag ttctagaaga acaccacaac caacaagcag tacaccatta 1620

gttattgttg atagtaaata a 1641

<210> SEQ ID NO 43
<211> LENGTH: 1623
<212> TYPE: DNA
<213> ORGANISM: Saccharomyces cerevisiae

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<400> SEQUENCE: 43

atgactgctc agattccgta tcaacatagc tcgggataca tctctcattt tcacaataat 60

gagcttgatg caggcagggg aagggattat aatgtaacca ttaagtatct agatgataaa 120

gaagaaaata tagaaggcca agcagcaaag attagtcaca atgcgagtct gcatattccc 180

gttttattgt gcttggtaat ctcgcttggt ggctttattt ttggatggga cattggaacc 240

atcggtggaa tgacaaatat ggttagcttt caagaaaaat ttggcacaac taatattatc 300

catgacgatg aaacaatttt tgtatctact aagaaactta ctgatctgca aataggccta 360

attatcagta tttttaacat cagttgtggc gtaggggctt taactctgtc aaaaatcggt 420

gattggattg gtaggaaagg tggtatatgg tttgccttag tagtgtactg catcggtata 480

accattcaaa ttctctccta tggaaggtgg tatttttga cattgggaag agccgtaacg 540

ggaatcggtg tgggagtaac cactgtcttg gtgccaatgt ttctctccga gaattctcca 600

ctaaaaatca gaggctccat ggtatctacg tatcaattga ttgtaacatt tggcatacta 660

atgggaaaca ttttaaattt catatgcgaa agatgttata aagatcctac acaaaatata 720

gcctggcaat tgccattgtt cttgggatac atttgggcaa ttataattgg aatgtcactt 780

gtttacgttc ctgaatctcc acagtacttg gcaaaaatca aaaatgatgt gccctctgct 840

aaatactctt ttgcgaggat gaatggcatc cctgcgacgg atagcatggt aattgaattc 900

atcgatgatt tgctggaaaa taactataat aatgaggaaa ctaacaacga atcaaaaaag 960

caaagcttag ttaaaagaaa cacatttgaa tttattatgg gaaagccaaa gttatggttg 1020

agactgatta ttggtatgat gataatggca tttcaacagc tgtccggaat aaattatttc 1080

ttttattacg gaacgtctgt tttcaaaggt gtcgggatta aggatcctta tattacttca 1140

atcatactgt caagtgttaa cttcctttct acgatattag gcatatatta cgtggagaaa 1200

tggggccaca agacatgttt attatatggt tcaacaaatt tattatttta tatgatgaca 1260

tatgctactg tggggacatt tggaagagaa acggacttct caaatattgt tttaattatc 1320

gtgacttgtt gttttatttt ttggtttgca ataacattgg gcccagttac atttgtacta 1380

gtgtccgaat tgttccctct aagaacgagg gccatatcaa tggctatttg cacatttatc 1440

aattggatgt tcaatttctt aatatcactt ttaacaccaa tgattgtatc caaaattgat 1500

ttcaaactag gatacatatt tgctgcttgc ctattagcgt tgataatatt cagttggata 1560

ctagttcctg aaacgaggaa aaagaatgag caagagatca ataaaatatt tgaaccggag 1620

tag 1623

<210> SEQ ID NO 44
<211> LENGTH: 2067
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 44

ctacaagtga cagtcagtcg attagacttt gcatccactt gagtttgaca attgatatat 60

tccactagag acaatgagtg ctgacgaaaa agtcgctgct gccggccagg acggcttgtt 120

tgaacacaac agttccactt cgagcatcga ggacaagaag ccctccaaga gctccgatgt 180

cgattccgtg aactcgcaat tagtagacaa ctcggtagag ggcaacatct tgtcccagta 240

caccgaaagt caggtgatgc agatgggtag aagctatgcc accaagcacg gcttggaccc 300

agaattgttc gccaaggcag ctgctgttgc cagaactcct cttggtttca actccatgcc 360

cttcttgaca gaggaagaga aggttggttt gaatgccgaa gccactaata agtggcacat 420

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tccacccaga ttgatcgggg ttattgcctt gggttctatg gccgctgctg tgcagggtat 480

ggacgaatcg gtcattaacg gtgccaactt gttctacccc aaggctttcg gagtcgacac 540

catgcacaat tcggacttga ttgaaggttt gatcaatggt gctccttacc tttgctgtgg 600

tattctttcc tgttggttgt ctgacgcttg taaccgtcgt cttggtagaa aatggaccat 660

tttctggtgt tgtgtcattt ctgccatcac ctgtgtctgg caaggtcttg tcaacaactg 720

gtaccatttg ttcattgctc gtttcttcct tggatttggt gttggtatca agtccgccac 780

tgttcctgcc tactctgccg aatgtactcc taaacacatc agaggttcgt tagtcatgtt 840

gtggcaattc ttcacagctg ttggtattat gtttggttat gttgcttcct tggctttcta 900

caatgtcgga gatagaggaa tccattacgg gttgaactgg agattgatgc ttggttcggc 960

cgctattcct gctgtcatca tcttgttcca aattcctttc gctcctgaat ctccacgttg 1020

gttaatgggt aaggacagac accttgaagc ctttgagtcc ttgaagcaat tgagatacga 1080

agaacttgct gctgctcgtg actgtttcta ccagtacgtc ttgttagctg aagaaggttc 1140

ttacaagatc ccaaccctca ccagatttaa ggaaatgttc accaagagaa gaaacagaaa 1200

cggtgccatc ggtgcattta ttgtcatgtt catgcaacag ttctgtggta tcaacgtcat 1260

tgcttactac tcttcgtcta tctttgtcca atctggtttc tctcaaactt ctgctttgat 1320

cgcttcttgg ggtttcggta tgcttaactt caccttgcc attcctgcct tcttcacaat 1380

cgatcgtttc ggtagaagat ccttattgtt ggttaccttc cccttgatgg ctattttctt 1440

attgattgcc ggtttcggtt tcttgataaa cgaagaaaca aactccaagg gaagattggg 1500

aatgatcatc atcggtatct atatgttcac catctgttac tcttccggtg aaggtccagt 1560

tcctttcacc tactctgccg aagccttccc attgtacatc agagacttgg gtatgtcttt 1620

tgctactgcc acctgttgga ctttcaactt catcttggcc ttcacctgga acagattggt 1680

caatgcattc acatctactg gtgccttcgg cttctacgct gcttggaaca tcattggttt 1740

cttcttggtc ttatggttct tgccagaaac caagggcttg accttggaag aattggacga 1800

agtcttcgcc gtttccgccg tccaacacgc caagtaccaa accaagagtt tgatcaactt 1860

catccaaaga tacgttttac gttccaaggt ggctccattg cctccattgt acgaccacca 1920

gagattggct gtcaccaacc cagaatggaa cgacaagcca gaagtctctt atgtcgagta 1980

ggctccttga taacacattc atttatttcc tctttataat taatagttaa cttagttgtt 2040

caattcttca catcgcctag atagtaa 2067

<210> SEQ ID NO 45
<211> LENGTH: 1629
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 45

atgagctacg aagataaact cgttcaacct gccttgaagt tcaggacctt cttggacaga 60

cttccaaaca tttacaatgt gtacattatt gcatctattt cctgtatttc aggtatgatg 120

ttcggttttg atatttcatc tatgtctgct tttataggtg aagatgacta caagaacttt 180

ttcaataatc caggctcaga catccaaggt tttatcactt cctgtatggc tttaggttct 240

ttcttcggtt ccatcgtctc ttccttcatt tccgaaccat ttggtagaag agcatccttg 300

ttgttgtgtt cattcttctg gatggtcggt gctgctgtac aatcatcttc tcaaaacaga 360

gcccaattga tgatcggacg tatcatcgct ggtttcggtg ttggttttgg ttcttctgtt 420

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gctccagttt acggttccga attggctcca agaaagatta gaggttttgt tggtggtatt 480

ttccaattct gtgttacctt gggtatcttg attatgttct acatttgtta cggtttgcat 540

ttcattaacg gtgttggctc tttcagaatt gcttggggtt tacaaattgt cccaggtttg 600

gttttatttg tcggttgttt ctttattcca gaatccccaa gatggttagc caaacatggt 660

tactgggatg aagcagaatt catcgttgcc caaattcaag ctaagggtaa tagagaagac 720

ccagacgtgt tgattgaaat ctccgaaatc aaggaccaaa ttttgattga agaaaacctc 780

aagagtttcg gttacgttga cttattcacc aagaagtata tcagaagaac tttaactgcc 840

atatttgctc aaatctggca acaattgacc ggtatgaatg tcatgatgta ctatattgtc 900

tacattttca acatggccgg ttactctaac aacgcaaact tggttgcctc ttccatccaa 960

tacgtcttga acactgctgc aactgttcca gctttgtttt taatggatta cattggtaga 1020

agaagattgt tgattggtgg tgccatcatg atgatgattt tccaatttgg tgttgctggt 1080

atcttaggta aatactccgt ccccgttcca ggcggtcttc caggtaaccc aactgtcacc 1140

atccaaatcc cagaagataa caagtcagct gctagaggtg ttattgcttg ttgttactta 1200

ttcgttgtat cattcgctct gagttggggt gtcggtatct gggtctactg ttcagaagtt 1260

tggggtgact ctgcttccag acagagaggt gctgctgttt caactgctgc caactggatt 1320

cttaactttg ctattgccat gtacactcca tcttccttca agaatatcac ctggaagact 1380

tacatcatct acgccgtctt ctgtcttgtt atggcaatcc atgtctactt tggattccca 1440

gaaaccaagg gcaagcgttt ggaagaagtc ggacaaatgt gggacgaaaa tgttcccgca 1500

tggagatctt ccagctggca accaactgtt ccattgttgt cagatgccga cttggcacac 1560

aagatggatg tttcccacaa ggaagagcaa tctccagatg ccgagtcaag ttctgaggaa 1620

aagccttaa 1629

<210> SEQ ID NO 46
<211> LENGTH: 1673
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 46

acaaaaatgg gtttagaaga cagtgctctc ttgcaaaagt acatcaactt cggtgaaaag 60

aaggctggtt ccaccaccat gggtatctgt gttggtttgt tcgcagcctt cggtggtatc 120

cttttcggtt atgacactgg taccatctcc ggtatcatgg ccatggacta cgtcactgcc 180

agattcccat ccaaccacca atctttcagt tcttctgaat cttcccttat tgtttccatt 240

ttgtctgttg gtaccttctt tggttctctt tctgcatctt tcatctccga cagattgggt 300

cgtagattga ctttaatgat ctccaccttg atcatcttca atgtcggtat tatcttgcaa 360

actgcctcta ctagcattcc acttttgtgt gttggtagag ttcttgctgg tcttggtgtt 420

ggtctcattt ccgctgttat tccattgtac caagctgaaa cagttccaaa gtggatcaga 480

ggtgctgttg tctcctgtta ccaatgggcc attacccttg gtttgttgtt ggctgctgtt 540

gttaaccaag gtacccacaa cagaaatgac tctggttcct acagaatccc aattgctatc 600

caattcttgt gggctttgat tttgggaggt ggtatgtgtt tgttgccaga aaccccaaga 660

ttctgggttt ctaaaggtga caacgacaga gccaaggact ccttgagaag attgagaaag 720

ttgcccctcg accatcccga cttgattgaa gaatacgaag aaatcaaggc taactacgaa 780

tacgaagctc aatacggttc aggttcttgg agtcaagttt ttgctaacaa gaaccaccaa 840

agaaagagat tggccatggg tgttggtatc caagccttgc aacaattgac cggtattaac 900

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tttatcttct actatggtac taacttcttc aagggttctg gtatcaaaaa cgaattcctt 960

atccaaatgg ccactaacat tgtcaacttc ggttctactg tcccaggtat tcttttggtt 1020

gaaattattg gtagaagaaa gttgttgttg ggtggttctg cagttatgtc catttctcaa 1080

ttgattgttg ctattgtcgg tgttgccgct ggtgaaggtt caacttctgc caacaagtgt 1140

ttggttgcct tcgtttgtat cttcattgct gctttcgcag ccacttgggg tcctctttgt 1200

tgggctgtca ttgccgaatg ttacccactt acagttagac aaaagtccat ctccttgtgt 1260

acagcttcca actggttgtg gaactggggt attgcctacg ctactcctta catggtcaac 1320

tccggtccag gtaacgccaa cttgggttcc aaggttttct tcatctgggg tggttgtaat 1380

atcattggtg gtcttttcgt gtggtacctt gtctacgaaa ctaagggctt gaccttagaa 1440

caaatcgatg aaatgtacga aaaggttcca aaggcttggc aatctaccag attcattcca 1500

tccgaacatg cattcactca accatccgca gctgcctctg tctcttctgg taaggctgaa 1560

ggtgtttctg aagttgaaga agcttctgta tagatacctc atgcacatta atcgacttac 1620

gtctttatga attttacttt ctcctaatat aatattatgg ccaattaacg ttg 1673

<210> SEQ ID NO 47
<211> LENGTH: 1650
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 47

atggctttaa aaatcttttc tagaaccaac actatggggt taaggggtaa acgtcttaga 60

gtaatgttca ctgtggtggc tactcttggg ttctccttat tcggttacga tcaaggttta 120

atgtctggtc ttattactgg tgagcaattc aatgctgaat tccctccaac agcaggtaag 180

gatcactggg cttctgttaa tcaaggtgcc gttaccgcct gttacgaaat tggatgtttg 240

tttggtgctt tatttgtttt attctatggt gataaaacag gtagaagaat tttagttgtt 300

tgcggttctt tgattattat tattggtacc gtcatttcta ctgcggcatt tggtccacaa 360

tggggtttag gtcagtttgt tgtcggaaga gtggttacag gtgtaggtaa tggtttgaat 420

accgctacaa ttccagtttg gcaatctgaa atgtctaaag ccgaaaacag aggtctttta 480

gtcaacttcg aaggttctgt cattgcagtg ggtacctttg ttgcttactg gatcgatttc 540

ggattatctt atgttgatag ttctgtccaa tggagattcc cagttgcttt ccaagcatta 600

tttgcaatct tcttgttatt tggagctatt gaaatgccag aatctccaag atggatgttc 660

gctcacgata tgaaagctga aggtatggaa gttttagctg caatgaaaga tatttctcca 720

gatgatgatg aaatctacgc agaatatacg ttcattactg actcgattaa gagattcgat 780

aataaccaag ccggattcaa ggaattattc aaaggtggta aagagcaata ctttgctaga 840

atgataattg gttcatctgg tcaatttttc caacaattta ctggttgtaa tgcggcaatt 900

tattattcta ccgtgttatt tgaagatact attcatttag aaagaagatt ggctttgatt 960

ttaggtggtg tttttgcaac cgtctatgcc ttatccacaa ttccttcgtt cttcttggtt 1020

gatacacttg gtagaagaaa cttattctta attggtgcaa ttggtcaagc tatctcattt 1080

acaattacat ttgcctgttt gattccagaa gatggagaaa acactcaaga tgccaaaggt 1140

gctgctgttg gtcttttctt gtttattgtc tttttcggtt ttactatctt accaatgcct 1200

tggatttatc caccagaaat caatccaatg aagacaagaa ccgtagcttc agctgtttcc 1260

acctgtacta actggttaac taatttcggg gttgttatgt tcaccccaat tttcattgca 1320

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caaagtacct ttggatgtta tttattcttt gcgcttatga attatacttt cattccaatt 1380

attttcttct tttatccaga aactgccggt cgttccttag aagagattga tatcattttc 1440

gccaaagcac atgttgacaa tagattacca ttcagagttg cagctactat gccacgttta 1500

tctgtcaaag atattgaaga atacaatgtt caattaggtc ttgatgatga cttcgataag 1560

gaacagaatg aattgcaaga gaatgcctcc tccaattcag aaaaatcacc tgatgacact 1620

ccagaaggta tcttaactcc taatgcttaa 1650

<210> SEQ ID NO 48
<211> LENGTH: 1650
<212> TYPE: DNA
<213> ORGANISM: Debaryomyces hansenii

<400> SEQUENCE: 48

atgtataaaa tatggtcaaa aactaacact atgggactca gaggtaaacc tcttagagtt 60

gccatcacta tatgctgtac tattggattt tcattattcg gttacgacca aggattaatg 120

tcgggaatta ttactggtaa acaattcaat gaggaatttc cacccactca cggtacagat 180

cagcatgcta ctgttataca aggtgcagtc acgtcgtgct acgagttagg ctgtttttt 240

ggtgctttgt ttgcgttgtt tcaaggtgat aagtatggta gaaggccaat gattattgtt 300

ggatctctgc tcattgtcat aggtactgtt attgcagttt ctgcatttgg tccgcaatgg 360

ggattgggcc aatttgttat tggtagagtt atcacaggat taggtaacgg catggatacg 420

gctactattc cggtgtggca atcggaaatt tctaaggcag aaaatagagg tcttttggtt 480

aacttggaag gttccatggt tgcggttggg acatttattg catattggtt agattttggg 540

ttatcatatg tcgatacttc agttcagtgg agattcccag ttgcttttca gatagtattt 600

gctctttttct tgtttcttgg cgttgcacaa ttaccggaat cacctagatg gttaattgct 660

catggcctca aggatgaagc tcattatgta ttggcaactt taaatgacgt tgatattgat 720

gatgagttcg taattgaaga aagcgccatt ataactgatg gtgtcaatag atttgccaga 780

acccaaattg ggttcaaaga actattttcc ggcggcaagc aacagaactt cgctagaatg 840

ataattggtg catctacaca attctttcag caatttactg gatgtaacgc ttccatctat 900

tattcaactg ttttatttga aaatagtatt ggattgaccg gtaaattgcc cttaattcta 960

ggaggtgttt ttgctaccat ttatgcttta tctactattc catctttctt cttgattgat 1020

aggctaggca gaagagcttt gtttttgatc ggtgccaccg gtcaaggcat atcattcacc 1080

atcacttttg catgcttgat ccctgataat ggacaaaata aggaaacagc caaaggtgct 1140

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atttaccctc cagaaatcaa ccccttgaga acaagaacag ttgctactgc ggtatcaaca 1260

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agtagttatg gctgttactt attctttgct ataatgaatt tccttttcat tcctgtcatt 1380

ttctggtttt atcccgagac tgctggtcgt gagttggaag agattgatat tattttcgca 1440

aaggcatacg ttgataatag actaccatgg agagttgctg ctactttacc acacttgaat 1500

ttcaaggaac aagaacaaga gggaatcaaa ttgggtcttt atgatgactt cgaaaaggaa 1560

gcacctgaac atgtaaacac tttgtccgac gcctcaggct cagaagatgg ctcaaatgaa 1620

gccgcttcag ttaagcctgc ggaagtttaa 1650

<210> SEQ ID NO 49
<211> LENGTH: 1980

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<212> TYPE: DNA
<213> ORGANISM: Yarrowia lipolytica

<400> SEQUENCE: 49

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catgatgatc tccccactat ccccaaaccc gagggagatg ccccagtcaa ctctgaactg 180

gaccccgaca atccgctgat tcgatacagt cgcgctgagc tcctcgagat tgccacccag 240

tttgcggtgg ataacgacct tgccgacaaa gcggaagcat tcagaaaggg cgccctagtg 300

gcccaagacc cttccggttt cgagaacatc gacatacttg atgacgacga cagatactgg 360

cttaaccgtg agatcaccaa taagtgggat catcccatga aggtttacta ccttgttgtg 420

tgctgctcct tggctgctgc tgtccagggt atggatgaga ctgttatcaa cggcgccaac 480

atcattttcc ctgctcagtt tggtatcaag gaggattccg gtgttgtgtc tcgaaagagt 540

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tcggctgaag ccttcccttt gtacgttcga gatttgggta tgtcgtttgc caccgccgtt 1620

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tgtttcttgc ccgagaccaa gaacctgact ctggaagagc ttgacaaggt cttcagtgtc 1800

cccacccgag tccacatgaa gtaccagttc aacgccttca aaatcaacat tcagcgaaca 1860

atattacgaa aggatgtgcc caagcctcct ccgctctatg cccacgaagc cggtattggt 1920

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<210> SEQ ID NO 50
<211> LENGTH: 1587
<212> TYPE: DNA
<213> ORGANISM: Scheffersomyces stipitis

<400> SEQUENCE: 50

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gggttgatgt ccggaattat tactgctgat caattcaact ctgagtttcc cgccactaga 180

aataacagta ctatccaagg tgccgtcacc tcctgttacg agcttggttg tttctttggt 240

gctgtgtttg ccttgttaag aggtgaaaga attggaagaa gacctcttgt gctttgtggc 300

tcgcttatta tcatcttggg aacagttatt tctgtaaccg ccttccatcc acactggtca 360

ttaggtcagt ttgttattgg tagagttatc actggtattg gtaatggtat gaatactgcc 420

accattccag tttggcaatc ggaaatgtca agagctgaaa acagaggaag attggtcaac 480

ttggaaggtt ccgttgtcgc tgtgggtaca tgtattgcct actggttgga tttcggtttg 540

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tccgttttat ttgtgggaat gttgcaattg cccgactctc caagatggtt ggttgctaac 660

cacagaagag cagaggctct tcaagtgttg tctgctttga aagacttgcc cgaagacgac 720

gaagaaattc ttaatgaagc tgaagttatt caggaaagtg tagacaagtt tgctggacat 780

gcttccgtca aggaagtgtt tactggtggt aagacccagc actggcaaag aatggttatt 840

ggatccagca cccaattctt tcagcagttc actggttgta acgctgccat ttactattcc 900

actgtcttgt ttcaagacac tattggttta gaaagaagaa tggcattgat tatcggtggt 960

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tatcttttct ttgctgtgat gaacttcctt ttcgttccta ttattttctt cttctaccca 1380

gaaacagctg gaagatcgtt ggaagaaatc gatatcatct ttgcgaaggc attcgttgac 1440

aaaagacagc catggagagt tgctgcaacc atgccaaagt tgtccaacca cgaaattgaa 1500

gacgaagcca acagattggg cttgtttgac gatggtacat tcgacaagga agcatttgaa 1560

accaaagaaa acgcatccag cagctct 1587

<210> SEQ ID NO 51
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 51

Lys Phe Arg Asn Phe Leu Asp Lys Thr Pro Asn Ile Tyr Asn Val Phe
1 5 10 15

Val Ile Ala Ser Ile Ser Cys Ile Ser Gly Leu Met Phe Gly Ile Asp
20 25 30

Ile Ser Ser Met Ser Leu Phe Ile Gly Asp Asp Lys Tyr Ile Lys Tyr
35 40 45

Phe His Lys
50

<210> SEQ ID NO 52
<211> LENGTH: 51

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<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 52

Lys Leu Arg Leu Phe Leu Asp Lys Leu Pro Asn Ile Tyr Asn Ile Tyr
1 5 10 15

Val Ile Ala Thr Ile Ser Cys Ile Ser Gly Leu Met Phe Gly Ile Asp
20 25 30

Ile Ser Ser Met Ser Ala Phe Leu Ser Asn Asp Ala Tyr Leu Lys Tyr
35 40 45

Phe Gly Thr
50

<210> SEQ ID NO 53
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 53

Lys Phe Arg Asn Phe Leu Asp Lys Phe Pro Asn Ile His Asn Val Tyr
1 5 10 15

Ile Val Val Gly Ile Ser Cys Ile Ser Gly Met Met Phe Gly Ile Asp
20 25 30

Ile Ser Ser Met Ser Leu Phe Ile Gly Asp Asp Lys Tyr Leu Asp Tyr
35 40 45

Phe Asn Ser
50

<210> SEQ ID NO 54
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 54

Lys Phe Arg Thr Phe Leu Asp Arg Leu Pro Asn Ile Tyr Asn Val Tyr
1 5 10 15

Ile Ile Ala Ser Ile Ser Cys Ile Ser Gly Met Met Phe Gly Phe Asp
20 25 30

Ile Ser Ser Met Ser Ala Phe Ile Gly Phe Asp Asp Tyr Lys Asn Phe
35 40 45

Phe Asn Asn
50

<210> SEQ ID NO 55
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 55

Ser Leu Asn Lys Phe Leu Asp Lys Phe His Thr Thr Tyr Asn Ile Tyr
1 5 10 15

Val Ile Ala Met Ile Thr Thr Ile Ser Gly Met Met Phe Gly Phe Asp
20 25 30

-continued

Val Ser Ser Ile Ser Ala Phe Ile Ser Glu Pro Ser Tyr Arg Arg Phe
35 40 45

Phe Asn Tyr
50

<210> SEQ ID NO 56
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 56

Gln Val Gly Ala Leu Gln His Arg Phe Pro Lys Leu His Asn Pro Tyr
1 5 10 15

Leu Thr Ala Ala Val Ala Thr Met Gly Gly Leu Leu Phe Gly Phe Asp
20 25 30

Ile Ser Ser Val Ser Ala Phe Val Asp Thr Lys Pro Tyr Lys Glu Tyr
35 40 45

Phe Gly Tyr
50

<210> SEQ ID NO 57
<211> LENGTH: 43
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 57

Met Tyr Lys Val His Asn Pro Tyr Leu Thr Ala Ala Val Ala Thr Met
1 5 10 15

Gly Gly Met Leu Phe Gly Phe Asp Ile Ser Ser Val Ser Ala Phe Val
20 25 30

Gly Phe Asp Asn Tyr Met Asn Tyr Phe Gly His
35 40

<210> SEQ ID NO 58
<211> LENGTH: 52
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 58

Met Gly Arg Ile Thr Asn Pro Tyr Val Leu Thr Ala Leu Ala Cys Thr
1 5 10 15

Gly Gly Leu Leu Phe Gly Phe Asp Ile Ser Ser Met Ser Ala Ile Ile
20 25 30

Ser Ser Pro Asn Tyr Leu Thr Tyr Phe Gly Pro Lys Asp Leu Thr Val
35 40 45

Glu Cys Pro Asp
50

<210> SEQ ID NO 59
<211> LENGTH: 55
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 59

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Leu Ala Ser Asp Ala Pro Glu Ser Phe Ser Trp Ser Ser Val Ile Leu
1               5                   10                  15

Pro Phe Ile Phe Pro Ala Leu Gly Gly Leu Leu Phe Gly Tyr Asp Ile
            20                  25                  30

Gly Ala Thr Ser Gly Ala Thr Leu Ser Leu Gln Ser Pro Ala Leu Ser
        35                  40                  45

Gly Thr Thr Trp Phe Asn Phe
    50                  55


<210> SEQ ID NO 60
<211> LENGTH: 56
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 60

His Val Pro Glu Asn Tyr Ser Val Val Ala Ala Ile Leu Pro Phe Leu
1               5                   10                  15

Phe Pro Ala Leu Gly Gly Leu Leu Tyr Gly Tyr Glu Ile Gly Ala Thr
            20                  25                  30

Ser Cys Ala Thr Ile Ser Leu Gln Glu Pro Met Thr Leu Leu Ser Tyr
        35                  40                  45

Tyr Ala Val Pro Phe Ser Ala Val
    50                  55


<210> SEQ ID NO 61
<211> LENGTH: 56
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 61

Leu Asn Ala Glu Ala Thr Asn Lys Trp His Ile Pro Pro Arg Leu Ile
1               5                   10                  15

Gly Val Ile Ala Leu Gly Ser Met Ala Ala Ala Val Gln Gly Met Asp
            20                  25                  30

Glu Ser Val Ile Asn Gly Ala Asn Leu Phe Tyr Pro Lys Ala Phe Gly
        35                  40                  45

Val Asp Thr Met His Asn Ser Asp
    50                  55


<210> SEQ ID NO 62
<211> LENGTH: 60
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 62

Leu Asn Arg Phe Ile Thr Asn Lys Trp Asp His Pro Met Lys Val Tyr
1               5                   10                  15

Tyr Leu Val Val Cys Cys Ser Leu Ala Ala Ala Val Gln Gly Met Asp
            20                  25                  30

Glu Thr Val Ile Asn Gly Ala Asn Ile Ile Phe Pro Ala Gln Phe Gly
        35                  40                  45

Ile Lys Glu Asp Ser Gly Val Val Ser Arg Lys Ser
    50                  55                  60
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<210> SEQ ID NO 63
<211> LENGTH: 55
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 63

Phe Leu Gly Met Arg Gly Ile Lys Leu Asn Trp Ala Ile Gly Phe Ala
1 5 10 15

Ala Ser Ala Gly Phe Leu Leu Phe Gly Tyr Asp Gln Gly Val Leu Gly
20 25 30

Ser Leu Tyr Thr Leu Pro Ser Trp Asn Ala Gln Phe Pro Glu Ile Asn
35 40 45

Thr Ala Ala Val Gly Asp Ser
50 55

<210> SEQ ID NO 64
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 64

Ala Lys Thr Asn Ser Tyr Leu Gly Leu Arg Gly His Lys Leu Asn Phe
1 5 10 15

Ala Val Ser Cys Phe Ala Gly Val Gly Phe Leu Leu Phe Gly Tyr Asp
20 25 30

Gln Gly Val Met Gly Ser Leu Leu Thr Leu Pro Ser Phe Glu Asn Thr
35 40 45

Phe Pro Ala Met Lys
50

<210> SEQ ID NO 65
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 65

Lys Thr Asn Thr Met Gly Leu Arg Gly Lys Pro Leu Arg Val Ala Ile
1 5 10 15

Thr Ile Cys Cys Thr Ile Gly Phe Ser Leu Phe Gly Tyr Asp Gln Gly
20 25 30

Leu Met Ser Gly Ile Ile Thr Gly Lys Gln Phe Asn Glu Glu Phe Pro
35 40 45

Pro Thr His Gly Thr
50

<210> SEQ ID NO 66
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 66

Arg Thr Asn Thr Met Gly Leu Arg Gly Lys Arg Leu Arg Val Met Phe
1 5 10 15

Thr Val Val Ala Thr Leu Gly Phe Ser Leu Phe Gly Tyr Asp Gln Gly

-continued

```
            20                  25                  30

Leu Met Ser Gly Leu Ile Thr Gly Glu Gln Phe Asn Ala Glu Phe Pro
        35                  40                  45

Pro Thr Ala Gly Lys
    50


<210> SEQ ID NO 67
<211> LENGTH: 51
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 67

Arg Thr Asn Thr Phe Gly Leu Arg Gly Lys Lys Leu Arg Ala Phe Ile
1               5                   10                  15

Thr Val Val Ala Val Thr Gly Phe Ser Leu Phe Gly Tyr Asp Gln Gly
            20                  25                  30

Leu Met Ser Gly Ile Ile Thr Ala Asp Gln Phe Asn Ser Glu Phe Pro
        35                  40                  45

Ala Thr Arg
    50


<210> SEQ ID NO 68
<211> LENGTH: 55
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 68

Arg Thr Ser His Trp Gly Leu Thr Gly Lys Lys Leu Arg Tyr Phe Ile
1               5                   10                  15

Thr Ile Ala Ser Met Thr Gly Phe Ser Leu Phe Gly Tyr Asp Gln Gly
            20                  25                  30

Leu Met Ala Ser Leu Ile Thr Gly Lys Gln Phe Asn Tyr Phe Phe Pro
        35                  40                  45

Ala Thr Lys Glu Asn Gly Asp
    50                  55


<210> SEQ ID NO 69
<211> LENGTH: 49
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 69

Ile Asp Val Gly Leu Arg Gly Asn Trp Leu Leu Thr Val Ile Thr Ala
1               5                   10                  15

Ser Cys Ala Ala Gly Phe Leu Leu Phe Gly Tyr Asp Asn Gly Val Met
            20                  25                  30

Gly Gly Val Val Gly Leu Gly Glu Phe Asn Lys Thr Phe Asn Asn Pro
        35                  40                  45

Asp


<210> SEQ ID NO 70
<211> LENGTH: 44
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
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<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 70

Gly Lys Gln Val Ser Tyr Ala Val Thr Phe Thr Cys Glu Leu Ala Phe
1 5 10 15

Ile Leu Phe Gly Ile Glu Gln Gly Ile Ile Gly Asn Leu Ile Asn Asn
20 25 30

Gln Asp Phe Leu Asn Thr Phe Gly Asn Pro Thr Gly
35 40

<210> SEQ ID NO 71
<211> LENGTH: 52
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 71

His Lys Thr Gln Arg Arg Leu Val Gly His Asn Leu Leu Tyr Ser Val
1 5 10 15

Ser Val Phe Leu Ser Ile Gly Gly Val Leu Phe Gly Tyr Asp Gln Gly
20 25 30

Val Met Ser Gly Ile Ile Thr Gly Pro Tyr Phe Lys Ala Tyr Phe Asn
35 40 45

Gln Pro Thr Ser
50

<210> SEQ ID NO 72
<211> LENGTH: 49
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 72

Met Phe Ser Leu Thr Gly Lys Pro Leu Leu Tyr Phe Thr Ser Val Phe
1 5 10 15

Val Ser Leu Gly Val Phe Leu Phe Gly Tyr Asp Gln Gly Val Met Ser
20 25 30

Gly Ile Ile Thr Gly Phe Tyr Phe Lys Phe Tyr Phe His Glu Pro Thr
35 40 45

Arg

<210> SEQ ID NO 73
<211> LENGTH: 55
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 73

Val Gly Ala Thr Gly Ala Lys Gly Leu Ile Lys Asn Ala Arg Thr Phe
1 5 10 15

Ala Ile Ala Val Phe Ala Ser Met Gly Gly Leu Ile Tyr Gly Tyr Asn
20 25 30

Gln Gly Met Phe Gly Gln Ile Leu Ser Met His Ser Phe Gln Phe Ala
35 40 45

Ser Gly Val Lys Gly Ile Thr
50 55

-continued

<210> SEQ ID NO 74
<211> LENGTH: 56
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 74

Ala Gly Lys Ser Gly Val Ala Gly Leu Val Ala Asn Ser Arg Ser Phe
1 5 10 15

Phe Ile Ala Val Phe Ala Ser Leu Gly Gly Leu Val Tyr Gly Tyr Asn
20 25 30

Gln Gly Met Phe Gly Gln Ile Ser Gly Met Tyr Ser Phe Ser Lys Ala
35 40 45

Ile Gly Val Glu Lys Ile Gln Asp
50 55

<210> SEQ ID NO 75
<211> LENGTH: 54
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 75

Ala His Gly Asn Val Val Thr Ile Met Met Lys Asp Pro Val Val Phe
1 5 10 15

Leu Val Ile Leu Phe Ala Ser Leu Gly Gly Leu Leu Phe Gly Tyr Asp
20 25 30

Gln Gly Val Ile Ser Gly Ile Val Thr Met Glu Ser Phe Gly Ala Lys
35 40 45

Phe Pro Arg Ile Phe Met
50

<210> SEQ ID NO 76
<211> LENGTH: 54
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 76

Ala His Gly Asn Val Val Thr Ile Met Met Lys Asp Pro Val Val Phe
1 5 10 15

Leu Val Ile Leu Phe Ala Ser Leu Gly Gly Leu Leu Phe Gly Tyr Asp
20 25 30

Gln Gly Val Ile Ser Gly Ile Val Thr Met Glu Ser Phe Gly Ala Lys
35 40 45

Phe Pro Arg Ile Phe Met
50

<210> SEQ ID NO 77
<211> LENGTH: 54
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 77

Ala His Gly Asn Val Val Thr Ile Met Met Lys Asp Pro Val Val Phe
1 5 10 15

Leu Val Ile Leu Phe Ala Ser Leu Gly Gly Leu Leu Phe Gly Tyr Asp

```
            20                  25                  30

Gln Gly Val Ile Ser Gly Ile Val Thr Met Glu Ser Phe Gly Ala Lys
        35                  40                  45

Phe Pro Arg Ile Phe Met
    50


<210> SEQ ID NO 78
<211> LENGTH: 54
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 78

Ser Lys Gly Asn Ile Ile Thr Val Met Ser Lys Asp Pro Leu Val Phe
1               5                   10                  15

Cys Ile Ile Ala Phe Ala Ser Ile Gly Gly Leu Leu Phe Gly Tyr Asp
            20                  25                  30

Gln Gly Val Ile Ser Gly Ile Val Thr Met Glu Ser Phe Ala Ala Lys
        35                  40                  45

Phe Pro Arg Ile Phe Ser
    50


<210> SEQ ID NO 79
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 79

Pro Ile Glu Ile Pro Lys Lys Pro Met Ser Glu Tyr Val Thr Val Ser
1               5                   10                  15

Leu Leu Cys Leu Cys Val Ala Phe Gly Gly Phe Met Phe Gly Trp Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Phe Val Val Gln Thr Asp Phe Leu Arg Arg
        35                  40                  45

Phe Gly Met Lys His Lys Asp Gly Thr
    50                  55


<210> SEQ ID NO 80
<211> LENGTH: 58
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 80

Glu Val Val Val Pro Glu Lys Pro Ala Ser Ala Tyr Ala Thr Val Ser
1               5                   10                  15

Ile Met Cys Leu Cys Met Ala Phe Gly Gly Phe Met Ser Gly Trp Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Phe Val Asn Gln Thr Asp Phe Leu Arg Arg
        35                  40                  45

Phe Gly Asn Tyr Ser His Ser Lys Asn Thr
    50                  55


<210> SEQ ID NO 81
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
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<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 81

Ala Val Ala Pro Pro Asn Thr Gly Lys Gly Val Tyr Val Thr Val Ser
1 5 10 15

Ile Cys Cys Val Met Val Ala Phe Gly Gly Phe Ile Phe Gly Trp Asp
20 25 30

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

Phe Gly Met Lys His His Asp Gly Ser
50 55

<210> SEQ ID NO 82
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 82

Val Leu Thr Asn Pro Asn Thr Gly Lys Gly Ala Tyr Val Thr Val Ser
1 5 10 15

Ile Cys Cys Val Met Val Ala Phe Gly Gly Phe Val Phe Gly Trp Asp
20 25 30

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

Phe Gly Met Lys His Lys Asp Gly Ser
50 55

<210> SEQ ID NO 83
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 83

Val Val Glu Ile Pro Lys Arg Pro Ala Ser Ala Tyr Val Thr Val Ser
1 5 10 15

Ile Met Cys Ile Met Ile Ala Phe Gly Gly Phe Val Phe Gly Trp Asp
20 25 30

Thr Gly Thr Ile Ser Gly Phe Ile Asn Gln Thr Asp Phe Ile Arg Arg
35 40 45

Phe Gly Met Lys His Lys Asp Gly Thr
50 55

<210> SEQ ID NO 84
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 84

Pro Ile Asp Leu Pro Gln Lys Pro Leu Ser Ala Tyr Thr Thr Val Ala
1 5 10 15

Ile Leu Cys Leu Met Ile Ala Phe Gly Gly Phe Ile Phe Gly Trp Asp
20 25 30

Thr Gly Thr Ile Ser Gly Phe Val Asn Leu Ser Asp Phe Ile Arg Arg
35 40 45

Phe Gly Gln Lys Asn Asp Lys Gly Thr
50 55

<210> SEQ ID NO 85
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 85

Asn Ala Glu Leu Pro Ala Lys Pro Ile Ala Ala Tyr Trp Thr Val Ile
1 5 10 15

Cys Leu Cys Leu Met Ile Ala Phe Gly Gly Phe Val Phe Gly Trp Asp
20 25 30

Thr Gly Thr Ile Ser Gly Phe Val Asn Gln Thr Asp Phe Lys Arg Arg
35 40 45

Phe Gly Gln Met Lys Ser Asp Gly Thr
50 55

<210> SEQ ID NO 86
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 86

Ser Leu Asp Ile Pro Tyr Lys Pro Ile Ile Ala Tyr Trp Thr Val Met
1 5 10 15

Gly Leu Cys Leu Met Ile Ala Phe Gly Gly Phe Ile Phe Gly Trp Asp
20 25 30

Thr Gly Thr Ile Ser Gly Phe Ile Asn Gln Thr Asp Phe Lys Arg Arg
35 40 45

Phe Gly Glu Leu Gln Arg Asp Gly Ser
50 55

<210> SEQ ID NO 87
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 87

Gln Val Asp Ala Pro Gln Lys Gly Phe Lys Asp Tyr Ile Val Ile Ser
1 5 10 15

Ile Phe Cys Phe Met Val Ala Phe Gly Gly Phe Val Phe Gly Phe Asp
20 25 30

Thr Gly Thr Ile Ser Gly Phe Val Asn Met Ser Asp Phe Lys Asp Arg
35 40 45

Phe Gly Gln His His Ala Asp Gly Thr
50 55

<210> SEQ ID NO 88
<211> LENGTH: 58
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 88

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Asn Val Glu Pro Pro Lys Arg Gly Leu Ile Gly Tyr Leu Val Ile Tyr
1               5                   10                  15

Leu Leu Cys Tyr Pro Ile Ser Phe Gly Gly Phe Leu Pro Gly Trp Asp
            20                  25                  30

Ser Gly Ile Thr Ala Gly Phe Ile Asn Met Asp Asn Phe Lys Met Asn
        35                  40                  45

Phe Gly Ser Tyr Lys His Ser Thr Gly Glu
    50                  55


<210> SEQ ID NO 89
<211> LENGTH: 58
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 89

Met Val Phe Gln Val Arg Gly Thr Pro Ile Gly Ala Leu Thr Leu Phe
1               5                   10                  15

Ile Ala Met Leu Ala Ser Met Gly Gly Phe Leu Phe Gly Trp Asp Thr
            20                  25                  30

Gly Gln Ile Ser Gly Leu Thr Gln Met Ala Asp Phe Arg Gln Arg Phe
        35                  40                  45

Ala Thr Val Asp Asn Pro Asp Ala Ile Gly
    50                  55


<210> SEQ ID NO 90
<211> LENGTH: 60
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 90

Gly Gln Ala Ala Lys Ile Ser His Asn Ala Ser Leu His Ile Pro Val
1               5                   10                  15

Leu Leu Cys Leu Val Ile Ser Leu Gly Gly Phe Ile Phe Gly Trp Asp
            20                  25                  30

Ile Gly Thr Ile Gly Gly Met Thr Asn Met Val Ser Phe Gln Glu Lys
        35                  40                  45

Phe Gly Thr Thr Asn Ile Ile His Asp Asp Glu Thr
    50                  55                  60


<210> SEQ ID NO 91
<211> LENGTH: 59
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 91

Gly Pro Val Ala Arg Pro Ala Ser Val Lys Gln Ser Leu Pro Ala Ile
1               5                   10                  15

Leu Val Ala Ala Ala Ser Ala Phe Gly Gly Val Leu Phe Gly Tyr Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Leu Ile Val Met Pro Asn Phe Gln Thr Glu
        35                  40                  45

Gly Lys Pro Val Pro Gly Ser Thr Thr Gly Ala
    50                  55
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<210> SEQ ID NO 92
<211> LENGTH: 60
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 92

Gly Pro Val Ala Arg Pro Ala Ser Val Lys Gln Ser Leu Pro Ala Ile
1 5 10 15

Leu Val Ala Ala Ala Ser Ala Phe Gly Gly Val Leu Phe Gly Tyr Asp
20 25 30

Thr Gly Thr Ile Ser Gly Leu Ile Val Met Pro Asn Phe Gln Glu Thr
35 40 45

Phe Gly Lys Pro Val Pro Gly Ser Thr Thr Gly Ala
50 55 60

<210> SEQ ID NO 93
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 93

Phe Val Asn Val Gly Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile
1 5 10 15

Ile Val Gly Leu Phe Ala Ala Ser Gly Gly Val Leu Phe Gly Tyr Asp
20 25 30

Thr Gly Thr Ile Ser Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg
35 40 45

Tyr Pro Ser Asn Lys
50

<210> SEQ ID NO 94
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 94

Phe Val Asn Val Gly Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile
1 5 10 15

Ile Val Gly Leu Phe Ala Ala Ser Gly Gly Val Leu Val Gly Tyr Asp
20 25 30

Thr Gly Thr Ile Ser Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg
35 40 45

Tyr Pro Ser Asn Lys
50

<210> SEQ ID NO 95
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 95

Phe Val Asn Val Gly Glu Lys Lys Ala Gly Ser Thr Ala Met Ala Ile
1 5 10 15

-continued

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Ile Val Gly Leu Phe Ala Ala Phe Gly Gly Val Leu Ser Gly Tyr Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Val Met Thr Met Asp Tyr Val Leu Ala Arg
        35                  40                  45

Tyr Pro Ser Asn Lys
    50


<210> SEQ ID NO 96
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 96

Tyr Val Asn Val Gly Glu Lys Arg Ala Gly Ser Ala Ser Met Gly Ile
1               5                   10                  15

Phe Val Gly Ala Phe Ala Ala Phe Gly Gly Val Leu Phe Gly Tyr Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Ile Met Ala Met Asn Tyr Val Lys Gly Glu
        35                  40                  45

Phe Pro Ala Asn Lys
    50


<210> SEQ ID NO 97
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 97

Tyr Val Asn Val Gly Glu Lys Arg Ala Gly Ser Ala Ser Met Gly Ile
1               5                   10                  15

Phe Val Gly Ala Phe Ala Ala Phe Gly Gly Val Leu Phe Gly Tyr Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Ile Met Ala Met Asn Tyr Val Lys Gly Glu
        35                  40                  45

Phe Pro Ala Asn Lys
    50


<210> SEQ ID NO 98
<211> LENGTH: 53
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 98

Tyr Ile Asn Phe Gly Glu Lys Lys Ala Gly Ser Thr Thr Met Gly Ile
1               5                   10                  15

Cys Val Gly Leu Phe Ala Ala Phe Gly Gly Ile Leu Phe Gly Tyr Asp
            20                  25                  30

Thr Gly Thr Ile Ser Gly Ile Met Ala Met Asp Tyr Val Thr Ala Arg
        35                  40                  45

Phe Pro Ser Asn His
    50


<210> SEQ ID NO 99
<211> LENGTH: 53
<212> TYPE: PRT
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<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 99

Ile Ile Asn Arg Gly Glu Lys Pro Glu Gly Ser Ala Phe Met Ala Ala
1 5 10 15

Phe Val Ala Val Phe Val Ala Phe Gly Gly Ile Leu Phe Gly Tyr Asp
20 25 30

Thr Gly Thr Ile Ser Gly Val Met Ala Met Pro Phe Val Lys Lys Thr
35 40 45

Phe Thr Asp Asp Gly
50

<210> SEQ ID NO 100
<211> LENGTH: 41
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 100

Met Ala Ile Ile Val Ala Val Phe Val Ala Phe Gly Gly Leu Leu Tyr
1 5 10 15

Gly Tyr Asp Thr Gly Thr Ile Ala Gly Ile Met Thr Met Gly Tyr Val
20 25 30

Lys Phe His Phe Thr Asp Phe Gly Lys
35 40

<210> SEQ ID NO 101
<211> LENGTH: 52
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 101

Tyr Tyr Lys Lys Met Gln Gln Lys Ser Ser Ser Ser Ser Ala Ile Thr
1 5 10 15

Val Gly Leu Val Ala Ala Val Gly Gly Phe Leu Tyr Gly Tyr Asp Thr
20 25 30

Gly Leu Ile Asn Asp Ile Met Phe Met Thr Tyr Val Lys Asp Asn Phe
35 40 45

Pro Ala Asn Gly
50

<210> SEQ ID NO 102
<211> LENGTH: 54
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 102

Met Asn Thr Gln Tyr Asn Ser Ser Tyr Ile Phe Ser Ile Thr Leu Val
1 5 10 15

Ala Thr Leu Gly Gly Leu Leu Phe Gly Tyr Asp Thr Ala Val Ile Ser
20 25 30

Gly Thr Val Glu Ser Leu His Thr Val Phe Val Ala Pro Gln Asn Leu
35 40 45

Ser Glu Ser Ala Ala Asn

50

<210> SEQ ID NO 103
<211> LENGTH: 50
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 103

Arg Ser Ile Gly Pro Leu Ile Pro Arg Asn Lys His Leu Phe Tyr Gly
1 5 10 15

Ser Val Leu Leu Met Ser Ile Val His Pro Thr Ile Met Gly Tyr Asp
20 25 30

Ser Met Met Val Gly Ser Ile Leu Asn Leu Asp Ala Tyr Val Asn Tyr
35 40 45

Phe His
50

<210> SEQ ID NO 104
<211> LENGTH: 57
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 104

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

Leu Trp Ser Ile Leu Val Ser Thr Thr Leu Val Met Glu Gly Tyr Asp
20 25 30

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

Phe Gly Thr Leu Asn Gly Glu Gly Ser
50 55

<210> SEQ ID NO 105
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 105

Gly Gly Leu Ile Phe Gly
1 5

<210> SEQ ID NO 106
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 106

Gly Gly Phe Ile Phe Gly
1 5

<210> SEQ ID NO 107
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 107

Gly Gly Phe Ile Met Gly
1 5

<210> SEQ ID NO 108
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 108

Gly Phe Phe Ile Met Gly
1 5

<210> SEQ ID NO 109
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 109

Gly Gly Phe Ile Ser Gly
1 5

<210> SEQ ID NO 110
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 110

Gly Phe Phe Ile Ser Gly
1 5

<210> SEQ ID NO 111
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 111

Gly Gly Phe Ile Thr Gly
1 5

<210> SEQ ID NO 112
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 112

Gly Phe Phe Ile Thr Gly
1 5

<210> SEQ ID NO 113
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 113

Gly Gly Phe Leu Met Gly
1 5

<210> SEQ ID NO 114
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 114

Gly Phe Phe Leu Met Gly
1 5

<210> SEQ ID NO 115
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 115

Gly Gly Phe Leu Ser Gly
1 5

<210> SEQ ID NO 116
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 116

Gly Phe Phe Leu Ser Gly
1 5

<210> SEQ ID NO 117
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 117

Gly Gly Phe Leu Thr Gly
1 5

<210> SEQ ID NO 118
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 118

Gly Phe Phe Leu Thr Gly
1 5

<210> SEQ ID NO 119
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 119

Gly Gly Phe His Met Gly
1 5

<210> SEQ ID NO 120
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 120

Gly Phe Phe His Met Gly
1 5

<210> SEQ ID NO 121
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 121

Gly Gly Phe His Ser Gly
1 5

<210> SEQ ID NO 122
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 122

Gly Phe Phe His Ser Gly
1 5

<210> SEQ ID NO 123
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 123

Gly Gly Phe His Thr Gly
1 5

<210> SEQ ID NO 124
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 124

Gly Phe Phe His Thr Gly
1 5

<210> SEQ ID NO 125
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 125

Gly Gly Leu Val Tyr Gly
1 5

<210> SEQ ID NO 126
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 126

Gly Gly Phe Val Phe Gly
1 5

<210> SEQ ID NO 127
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 127

Gly Gly Arg Pro Thr Gly
1 5

<210> SEQ ID NO 128
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 128

Gly Phe Arg Pro Thr Gly
1 5

<210> SEQ ID NO 129
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 129

Gly Gly Thr Pro Thr Gly
1 5

<210> SEQ ID NO 130
<211> LENGTH: 6
<212> TYPE: PRT
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: Synthetic polypeptide

<400> SEQUENCE: 130

Gly Phe Thr Pro Thr Gly
1 5

What is claimed is:

1. A recombinant xylose transporter protein comprising a xylose transporter motif sequence and at least one glucose mitigation mutation; wherein said xylose transporter motif sequence corresponds to amino acid residue positions 36, 37, 38, 39, 40, and 41 of SEQ ID NO: 1, and wherein the xylose transporter motif comprises the sequence -G-G/F-X^1-X^2-X^3-G-;

wherein,

X^1 is D, C, G, H, I, L, or F;

X^2 is A, D, C, E, G, H, or I; and

X^3 is N, C, Q, F, G, L, M, S, T, or P;

and further wherein said glucose mitigation mutation is at a position corresponding to N326, T170, I171, K155, N225, S354, A361, L407, and/or N446 of SEQ ID NO: 1 wherein the xylose transporter protein is at least 95% identical to the sequence of SEQ ID NO: 1 and has xylose transporter protein activity.

2. The recombinant xylose transporter protein of claim **1**, wherein said xylose transporter motif sequence is G-G-F-I-M-G- (SEQ ID NO:107), -G-F-F-I-M-G- (SEQ ID NO:108), -G-G-F-I-S-G- (SEQ ID NO:109), or -G-F-F-I-S-G- (SEQ ID NO: 110).

3. The recombinant xylose transporter protein of claim **1**, wherein said glucose mitigation mutation is a N326H mutation.

4. The recombinant xylose transporter protein of claim **1**, wherein said glucose mitigation mutation is a N326S mutation.

5. The recombinant xylose transporter protein of claim **1** further comprising an amino acid deletion.

6. The recombinant xylose transporter protein of claim **5**, wherein said deletion is within a protein domain corresponding to residue 497-522 of SEQ ID NO: 1.

7. A recombinant yeast cell comprising a recombinant xylose transporter protein of claim **1**.

8. The recombinant yeast cell of claim **7**, wherein the growth rate of said recombinant yeast cell in a xylose-glucose growth media is at least about 50% of the growth rate of said recombinant yeast cell in a xylose growth media.

9. A nucleic acid encoding the recombinant xylose transporter protein of claim **1**.

* * * * *