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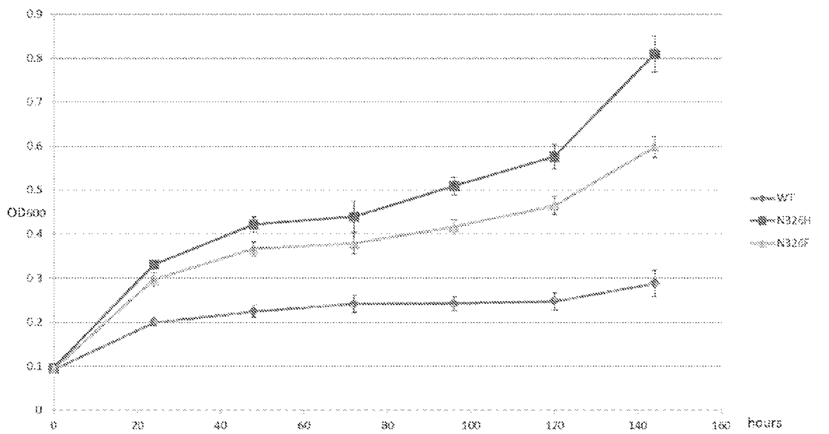
(54) **Title**: ENGINEERED XYLOSE TRANSPORTERS WITH REDUCED GLUCOSE INHIBITION

FIG. 4



(57) **Abstract**: Provided herein are compositions and methods useful for reducing glucose inhibition in transporting xylose, arabinose and other monosaccharides, into a yeast cell.

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ENGINEERED XYLOSE TRANSPORTERS WITH REDUCED GLUCOSE INHIBITION

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to US 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

[0002] 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

[0003] 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

[0004] 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

[0005] Provided herein are compositions and methods useful for transporting xylose, arabinose, and galactose into a yeast cell in the presence of glucose.

[0006] 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.

[0007] 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.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] 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

[0012] 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.

[0013] FIG. 2: SACS HMMTOP Prediction of the mutant 105 xylose transporter and mutant positions: mutations are indicated with arrows.

[0014] FIG. 3: SACS HMMTOP Prediction of the mutant 78 xylose transporter and mutant positions: mutations are indicated with arrows.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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).

[0019] 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.

[0020] FIG. 9A-9F: 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. 9A: WT CiGXS1 (SEQ ID NO:1). FIG. 9B: CiGXS1FIM (SEQ ID NO:2). FIG. 9C: CiGXS1FIM N326H (SEQ ID NO:3). FIG. 9D: CiGXS1FIM T170N (SEQ ID NO:4). FIG. 9E: CiGXS1(FIMH)Δ497 (SEQ ID NO:5). FIG. 9F: CiGXS1(FIMH-Δ497) with I171F (SEQ ID NO:6).

[0021] 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

[0022] 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.

[0023] "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).

[0024] “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.

[0025] 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.

[0026] 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 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] "*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).

[0035] SEQ ID NO: 1:

MGLEDNRMVK RFVNVGEKKA GSTAMAIIVG LFAAS**GGVLF G**YDTGTISGV

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

[0036] 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.

[0037] 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).

[0038] 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).

[0039] 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.

[0040] 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.

[0041] 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*, *Scheffersomyces stipitis*, or *Yarrowia lipolytica*. A “recombinant yeast cell” is a yeast cell which expresses a recombinant transporter protein.

[0042] 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).

[0043] 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).

[0044] 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.

[0045] 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."

[0046] 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).

[0047] 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).

[0048] 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	KFRNFLDKTPNIYNVFVIASISCI	SGLMFG	IDISSMSLFIGDDKYIKYFHK---------	63
Dh2E01166p	KLRLFLDKLPNIYNIYVIATISCI	SGLMFG	IDISSMSAFLSNDAYLKYFGT---------	63
Dh2E01298p	KFRNFLDKFPNIHNVYIVVGISCI	SGMMFG	IDISSMSLFIGDDKYLDYFNS---------	63
SsHGT2	KFRTFLDRLPNIYNVYIIASISCI	SGMMFG	FDISSMSAFIGEDDYKNFFNN---------	63
Dh2A14300p	SLNKELDKFHTTYNIYVIAMITTI	SGMMFG	FDVSSISAFISEPSYRRFFNY---------	61
Yl0B06391p	QVGALQHRFPKLHNPYLTAAVATM	GGLLFG	FDISSVSAFVDTKPYKEYFGY---------	59
Yl0B01342p	--------MYKVHNPYLTAAVATM	GGMLFG	FDISSVSAFVGEDNYMNYFGH---------	43
BmHGT2	--------MGRITNPYVLTALACT	GGLLFG	FDISSMSAIISSPNYLTYFGPKDLTVECPD	52
At5g59250	LASDAPESFSWSSVILPFIFP-AL	GGLLFG	YDIGATSGATLSLQSP----ALSGTTWFNF	139
At5g17010	---HVPENYSVVAAILPFLFP-AL	GGLLYG	YEIGATSCATISLQEPMTLLSYYAVPFSAV	89
SsAUT1	LNAEATNKWHIPPRLIGVIALGSM	AAAVQG	MDESVINGANLFYPKAFGVD----TMHNSD	161
Yl0D00132	LNREITNKWDHPMKVYYLVVCCSL	AAAVQG	MDETVINGANIIFPAQFGIKEDSGVVSRKS	180
BmSTL1	-----FLGMRGIKLNWAIGFAASA	GFLLFG	YDQGVLGSLYTLPSWNAQFPEINTAAVGDS	73
SsXUT6	AKTNSYLGLRGHKLNFAVSCFAGV	GFLLFG	YDQGVMGSLLTLPSFENTFPAMK-------	75
Dh2E01386p	--KTNTMGLRGKPLRVAITICCTI	GFSLFG	YDQGLMSGIITGKQFNEEFPPTHGT-----	59
Dh2B05060p	--RTNTMGLRGKRLRVMFTVVATL	GFSLFG	YDQGLMSGLITGEQFNAEFPPTAGK-----	60
SsSTL1	--RTNTFGLRGKKLRAFITVVAVT	GFSLFG	YDQGLMSGIITADQFNSEFPATR-------	60
ScSTL1	--RTSHWGLTGKKLRYFITIASMT	GFSLFG	YDQGLMASLITGKQFNYEFPATKENG---D	70
BmHXT10	----IDVGLRGNWLLTVITASCAA	GFLLVG	YDNGVMGGVVGLGEFNKTFNNPD-------	66
SsXUT2	----------GKQVSYAVTFTCEL	AFILFG	IEQGIIGNLINNQDFLNTFGNPTG------	53
CnBC3990p	--HKTQRRLVGHNLLYSVSVFLSI	GVWLFG	YDQGVMSGIITGPYFKAYFNQPTS------	62
Yl0F06776p	-----MFSLTGKPLLYFTSVFVSL	GVFLFG	YDQGVMSGIITGFYFKEYFHEPTR------	49
BmXUT3	VGATGAKGLIKNARTFAIAVFASM	GGLIYG	YNQGMFGQILSMHSFQEASGVKGIT-----	78
SsXUT1	AGKSGVAGLVANSRSFFIAVFASL	GGLVYG	YNQGMFGQISGMYSFSKAIGVEKIQD----	77
SsXUT3	AHGNVVTIMMKDPVVFLVILFASL	GGLLFG	YDQGVISGIVTMESF--GAKFPRIFM----	63
SsXUT3-A	AHGNVVTIMMKDPVVFLVILFASL	GGLLFG	YDQGVISGIVTMESF--GAKFPRIFM----	63
SsXUT3-B	AHGNVVTIMMKDPVVFLVILFASL	GGLLFG	YDQGVISGIVTMESF--GAKFPRIFM----	63
DhXylHP	SKGNIITVMSKDPLVFCIIAFASI	GGLLFG	YDQGVISGIVTMESF--AAKFPRIFS----	64
ScGAL2	PIEIPKKPMSEYVTVSLLCLCVAF	GGFMFG	WDTGTISGFVVQTDFLRRFG-MKHKDGT--	113
ScHXT8	EVVVPEKPASAYATVSIMCLCMAF	GGFMSG	WDTGTISGFVNQTDFLRRFGNYSHSKNT--	109
ScHXT1	AVAPPNTGKGVYVTVSICCVMVAF	GGFIFG	WDTGTISGFVAQTDFLRRFG-MKHHDGS--	107
ScHXT3	VLTNPNTGKGAYVTVSICCVMVAF	GGFVFG	WDTGTISGFVAQTDFLRRFG-MKHKDGS--	104
ScHXT7	VVEIPKRPASAYVTVSIMCIMIAF	GGFVFG	WDTGTISGFINQTDFIRRFG-MKHKDGT--	107
ScHXT9	PIDLPQKPLSAYTTVAILCLMIAF	GGFIFG	WDTGTISGFVNLSDFIRRFG-QKNDKGT--	103
ScHXT2	NAELPAKPIAAYWTVICLCLMIAF	GGFVFG	WDTGTISGFVNQTDFKRRFG-QMKSDGT--	98
ScHXT10	SLDIPYKPIIAYWTVMGLCLMIAF	GGFIFG	WDTGTISGFINQTDFKRRFG-ELQRDGS--	91
CiGXF1	QVDAPQKGFKDYIVISIFCFMVAF	GGFVFG	FDTGTISGFVNMSDFKDRFG-QHHADGT--	86
ScHXT13	NVEPPKRGLIGYLVIYLLCYPISF	GGFLPG	WDSGITAGFINMDNFKMNFGSYKHSTGE--	100
BmGXF1	-MVFQVRGTPIGALTLFIAMLASM	GGFLFG	WDTGQISGLTQMADFRQRFATVDNPDAIG-	58
ScHXT14	GQAAKISHNASLHIPVLLCLVISL	GGFIFG	WDIGTIGGMTNMVSFQEKFGTTNIIHDDET	105
BmGXS1	GPVARPASVKQSLPAILVAAASAF	GGVLFG	YDTGTISGLIVMPNFQETFGKPVPGSTTGA	74
BmRGT2	GPVARPASVKQSLPAILVAAASAF	GGVLFG	YDTGTISGLIVMPNFQETFGKPVPGSTTGA	74
CiGXS1	FVNVGEKKAGSTAMAIIVGLFAAS	GGVLFG	YDTGTISGVMTMDYVLARY------PSNK-	64
CiGXS1-A	FVNVGEKKAGSTAMAIIVGLFAAS	GGVLVG	YDTGTISGVMTMDYVLARY------PSNK-	64
CiGXS1-B	FVNVGEKKAGSTAMAIIVGLFAAF	GGVLSG	YDTGTISGVMTMDYVLARY------PSNK-	64
Dh2D01474	YVNVGEKRAGSASMGIFVGAFAAF	GGVLFG	YDTGTISGIMAMNYVKGEF------PANK-	64
Dh0D02167p	YVNVGEKRAGSASMGIFVGAFAAF	GGVLFG	YDTGTISGIMAMNYVKGEF------PANK-	64
SsRGT2	YINFGEKKAGSTTMGICVGLFAAF	GGILFG	YDTGTISGIMAMDYVTARF------PSNH-	64
Yl0C06424p	IINRGEKPEGSAFMAAFVAVFVAF	GGILFG	YDTGTISGVMAMPFVKKTF------TDDG-	58
Yl0C08943p	-------------MAIIVAVFVAF	GGLLYG	YDTGTIAGIMTMGYVKEHF------TDFGK	41
Dh2B14278p	YYKKMQQKS-SSSSAITVGLVAAV	GGFLYG	YDTGLINDIMEMTYVKDNF------PANG-	69
EcXylE	-----MNTQYNSSYIFSITLVATL	GGLLFG	YDTAVISGTVESLHTVFVAPQNLSESAAN-	54
SsXUT5	RSIGPLIPRNKHLFYGSVLLMSIV	HPTIMG	YDSMMVGSILNLDAYVNYFH----------	53
ScMAL11	KSMTLKQALLKYPKAALWSILVST	TLVMEG	YDTALLSALYALPVFQRKFGTLNGEGS---	148

[0049] 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).

[0050] 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.

[0051] 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).

[0052] 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.

[0053] 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-gluose, D/L-idose, D/L-galactose, and D/L-talose.

[0054] 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).

[0055] 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.

[0056] 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), hemicelluose, 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] “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

[0068] 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

[0069] 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 embomdiments, 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).

[0070] 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.

[0071] 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).

[0072] 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.

[0073] 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.

[0074] 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*.

[0075] 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.

[0076] 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.

[0077] 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 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 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.

[0078] 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.

[0079] 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

[0080] Also provided herein is a recombinant arabinose transporter protein that includes an arabinose transporter motif sequence and a glucose mitigation mutation.

[0081] 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).

[0082] 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.

[0083] 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).

[0084] 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

[0085] Provided herein is a recombinant galactose transporter protein that includes an galactose transporter motif sequence and a glucose mitigation mutation.

[0086] 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.

[0087] 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

[0088] 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

[0089] 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

[0090] 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.

[0091] 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.

[0092] 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.

[0093] 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.

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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.

[0098] 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.

[0099] 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.

[0100] 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.

[0101] 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.

[0102] 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.

[0103] 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.

[0104] 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.

[0105] 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.

[0106] 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.

[0107] 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.

[0108] 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.

[0109] 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 xylose-glucose 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.

[0110] 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.

[0111] 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.

[0112] 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.

[0113] 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.

[0114] 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.

[0115] 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.

[0116] 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.

[0117] In embodiments, the growth rate of the recombinant yeast cell in xylose-glucose growth media is about 0.1x 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 0.2x 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 0.3x 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 0.4x 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 0.5x 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 0.6x 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 0.7x 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 0.8x 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 0.9x 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 1x fold greater than a wildtype yeast cell in xylose-glucose growth media.

[0118] The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 2x 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 3x 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 4x 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 5x 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 6x 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 7x 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 8x 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 9x 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 10x fold greater than a wildtype yeast cell in xylose-glucose growth media.

[0119] The growth rate of the recombinant yeast cell in xylose-glucose growth media may be about 11x 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 12x 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 13x 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 14x 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 15x 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 16x 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 17x 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 18x 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 19x 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 20x fold greater than a wildtype yeast cell in xylose-glucose growth media.

[0120] 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.

[0121] 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.

[0122] 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.

[0123] 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.

[0124] 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.

[0125] 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.

[0126] 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.

[0127] 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.

[0128] 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.

[0129] 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.

[0130] 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.

[0131] 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.

[0132] 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

[0133] 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.

[0134] 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.

[0135] 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.

[0136] 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.

[0137] 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.

[0138] 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.

[0139] 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.

[0140] 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.

[0141] 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.

[0142] 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.

[0143] 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.

[0144] In embodiments, the growth rate of the recombinant yeast cell in arabinose-glucose growth media is about 0.1x 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 0.2x 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 0.3x 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 0.4x 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 0.5x 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 0.6x 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 0.7x 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 0.8x 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 0.9x 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 1x fold greater than a wildtype yeast cell in arabinose-glucose growth media.

[0145] The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 2x 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 3x 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 4x 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 5x 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 6x 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 7x 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 8x 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 9x 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 10x fold greater than a wildtype yeast cell in arabinose-glucose growth media.

[0146] The growth rate of the recombinant yeast cell in arabinose-glucose growth media may be about 11x 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 12x 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 13x 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 14x 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 15x 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 16x 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 17x 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 18x 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 19x 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 20x fold greater than a wildtype yeast cell in arabinose-glucose growth media.

[0147] 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.

[0148] 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.

[0149] 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.

[0150] 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.

[0151] 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.

[0152] 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.

[0153] 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.

[0154] 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.

[0155] 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.

[0156] 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.

[0157] 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.

[0158] 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

[0159] 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.

[0160] 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.

[0161] 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.

[0162] 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.

[0163] 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.

[0164] 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.

[0165] 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.

[0166] 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.

[0167] 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.

[0168] 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.

[0169] 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.

[0170] In embodiments, the growth rate of the recombinant yeast cell in galactose-glucose growth media is about 0.1x 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 0.2x 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 0.3x 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 0.4x 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 0.5x 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 0.6x 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 0.7x 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 0.8x 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 0.9x 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 1x fold greater than a wildtype yeast cell in galactose-glucose growth media.

[0171] The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 2x 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 3x 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 4x 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 5x 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 6x 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 7x 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 8x 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 9x 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 10x fold greater than a wildtype yeast cell in galactose-glucose growth media.

[0172] The growth rate of the recombinant yeast cell in galactose-glucose growth media may be about 11x 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 12x 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 13x 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 14x 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 15x 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 16x 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 17x 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 18x 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 19x 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 20x fold greater than a wildtype yeast cell in galactose-glucose growth media.

[0173] 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.

[0174] 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.

[0175] 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.

[0176] 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.

[0177] 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.

[0178] 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.

[0179] 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.

[0180] 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.

[0181] 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.

[0182] 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.

[0183] 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.

[0184] 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

[0185] 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.

[0186] 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

[0187] 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.

[0188] 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} $gDCW^{-1}$.

[0189] 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} $gDCW^{-1}$.

[0190] 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} $gDCW^{-1}$.

[0191] 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} $gDCW^{-1}$.

[0192] 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} $gDCW^{-1}$.

[0193] 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

[0194] 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.

[0195] 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.

[0196] 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.

[0197] 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} $gDCW^{-1}$.

[0198] 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} $gDCW^{-1}$.

[0199] 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} $gDCW^{-1}$.

[0200] 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} $gDCW^{-1}$.

[0201] 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} $gDCW^{-1}$.

[0202] 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} $gDCW^{-1}$. 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 150 nmol min^{-1} $gDCW^{-1}$.

3. Transporting Galactose into a recombinant yeast cell

[0203] 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.

[0204] 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.

[0205] 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.

[0206] 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} $gDCW^{-1}$.

[0207] 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} $gDCW^{-1}$.

[0208] 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} $gDCW^{-1}$.

[0209] 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} $gDCW^{-1}$.

[0210] 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 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} $gDCW^{-1}$ 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} $gDCW^{-1}$.

[0211] 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

[0212] 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.

[0213] A library of randomly mutated FIM was generated by error-prone PCR with a library size of over 1 x 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 dropout 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).

[0214] 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 Figure 1

[0215] 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

[0228] Embodiment P 1. A recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation.

[0229] 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.

[0230] 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).

[0231] 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).

[0232] 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).

[0233] 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.

[0234] 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.

[0235] 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.

[0236] Embodiment P 9. The recombinant xylose transporter protein of any one of embodiments P 1 to5, or embodiment P 8, wherein said glucose mitigation mutation is at a position corresponding N326 of *Candida intermedia GXS1* protein.

[0237] Embodiment P 10. The recombinant xylose transporter protein of embodiment P 9, wherein said glucose mitigation mutation is a N326S mutation.

[0238] Embodiment P 11. A recombinant yeast cell comprising a recombinant xylose transporter protein of any one of embodiments P 1 to 10.

[0239] 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.

[0240] 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.

[0241] 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.

[0242] 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.

[0243] 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.

[0244] 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.

[0245] 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.

[0246] 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.

[0247] 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.

[0248] 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.

[0249] 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.

[0250] 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.

[0251] 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.

[0252] 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.

[0253] 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.

[0254] 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.

[0255] 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.

[0256] 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.

[0257] 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.

[0258] 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.

[0259] 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.

[0260] 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.

[0261] 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).

[0262] 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).

[0263] 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).

[0264] 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.

[0265] 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.

[0266] 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.

[0267] 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.

[0268] Embodiment P 41. The method of embodiment P 40, wherein said glucose mitigation mutation is a N326S mutation.

[0269] Embodiment P 42. The method of any one of embodiments P 32 to 41, wherein said recombinant yeast cell metabolizes said xylose compound.

[0270] 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.

[0271] 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.

[0272] 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.

[0273] 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.

[0274] 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.

[0275] 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.

[0276] 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.

[0277] 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.

[0278] 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.

[0279] 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.

[0280] 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 recombinant xylose transporter transports said xylose compound into said yeast in a xylose growth media.

[0281] 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.

[0282] 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.

[0283] 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.

[0284] 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.

[0285] 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.

[0286] 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.

[0287] 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.

[0288] 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.

[0289] 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.

[0290] 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.

[0291] 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.

[0292] 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} $gDCW^{-1}$.

[0293] Embodiment P 66. A nucleic acid encoding the recombinant xylose transporter protein of one of embodiments P 1 to 10.

VII. Further Embodiments

[0294] Embodiment 1. A recombinant xylose transporter protein comprising a xylose transporter motif sequence and a glucose mitigation mutation.

[0295] 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*.

[0296] 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.

[0297] 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).

[0298] 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).

[0299] 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).

[0300] 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*.

[0301] 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*.

[0302] 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*.

[0303] 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*.

[0304] Embodiment 11. The recombinant xylose transporter protein of embodiment 10, wherein said glucose mitigation mutation is a N326H mutation.

[0305] Embodiment 12. The recombinant xylose transporter protein of embodiment 10, wherein said glucose mitigation mutation is a N326S mutation.

[0306] 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*.

[0307] 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*.

[0308] 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*.

[0309] Embodiment 16. The recombinant xylose transporter protein of embodiment 15, wherein said glucose mitigation mutation is a T170N mutation.

[0310] Embodiment 17. The recombinant xylose transporter protein of embodiment 15, wherein said glucose mitigation mutation is a I171F mutation.

[0311] Embodiment 18. The recombinant xylose transporter protein of one of embodiments 1-17 further comprising an amino acid deletion.

[0312] 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*.

[0313] Embodiment 20. The recombinant xylose transporter protein of embodiment 18 or embodiment 19, wherein said deletion is at least 10 amino acids in length.

[0314] Embodiment 21. A recombinant yeast cell comprising a recombinant xylose transporter protein of any one of embodiments 1 to 20

[0315] 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.

[0316] 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.

[0317] 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.

[0318] 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.

[0319] 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.

[0320] 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.

[0321] 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.

[0322] 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.

[0323] 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.

[0324] 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.

[0325] 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.

[0326] 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.

[0327] 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.

[0328] 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.

[0329] 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.

[0330] 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.

[0331] 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.

[0332] 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.

[0333] 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.

[0334] 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.

[0335] 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.

[0336] 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*.

[0337] 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.

[0338] 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).

[0339] 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).

[0340] 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).

[0341] 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*.

[0342] 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*.

[0343] 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*.

[0344] 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*.

[0345] Embodiment 52. The method of embodiment 51, wherein said glucose mitigation mutation is a N326H mutation.

[0346] Embodiment 53. The method of embodiment 51, wherein said glucose mitigation mutation is a N326S mutation.

[0347] 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*.

[0348] 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*.

[0349] 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*.

[0350] Embodiment 57. The method of embodiment 56, wherein said glucose mitigation mutation is a T170N mutation.

[0351] Embodiment 58. The method of embodiment 56, wherein said glucose mitigation mutation is a I171F mutation.

[0352] Embodiment 59. The method of any one of embodiments 42 to 58, further comprising an amino acid deletion.

[0353] 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*.

[0354] Embodiment 61. The method of any one of embodiments 42 to 53, wherein said recombinant yeast cell metabolizes said xylose compound.

[0355] Embodiment 62. The method of any one of embodiments 42 to 61, wherein said recombinant yeast cell converts said xylose compound to a biofuel.

[0356] Embodiment 63. The method of any one of embodiments 42 to 62, wherein said xylose compound forms part of lignocellulosic biomass, hemicellulose, or xylan.

[0357] 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.

[0358] 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.

[0359] 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.

[0360] 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.

[0361] 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.

[0362] 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.

[0363] 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.

[0364] 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.

[0365] 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.

[0366] 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.

[0367] 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.

[0368] 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.

[0369] 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.

[0370] 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.

[0371] Embodiment 78. The method l of any one of embodiments 64 to 77, wherein said xylose-glucose growth media comprises about 5 g/L glucose.

[0372] Embodiment 79. The method of any one of embodiments 64 to 78, wherein said xylose-glucose growth media comprises about 10 g/L glucose.

[0373] Embodiment 80. The method of any one of embodiments 64 to 79, wherein said xylose-glucose growth media comprises about 20 g/L glucose.

[0374] 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.

[0375] 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.

[0376] Embodiment 83. The method of any one of embodiments 64 to 82, wherein said xylose growth media comprises about 20 g/L xylose.

[0377] 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} $gDCW^{-1}$

[0378] Embodiment 85. A nucleic acid encoding the recombinant xylose transporter protein of one of embodiments 1 to 21.

WHAT IS CLAIMED IS:

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

2. The recombinant xylose transporter protein of claim 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*.

3. The recombinant xylose transporter protein of claim 1 or claim 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.

4. The recombinant xylose transporter protein of one of claims 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)..

5. The recombinant xylose transporter protein of any one of claims 1 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).

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

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

8. The recombinant xylose transporter protein of any one of claims 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*.

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

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

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

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

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

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

15. The recombinant xylose transporter protein of any one of claims 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*.

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

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

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

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

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

21. A recombinant yeast cell comprising a recombinant xylose transporter protein of any one of claims 1 to 20.

22. The recombinant yeast cell of claim 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.

23. The recombinant yeast cell of claim 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.

24. The recombinant yeast cell of claim 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.

25. The recombinant yeast cell of claim 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.

26. The recombinant yeast cell of claim 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.

27. The recombinant yeast cell of claim 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.

28. The recombinant yeast cell of claim 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.

29. The recombinant yeast cell of claim 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.

30. The recombinant yeast cell of claim 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.

31. The recombinant yeast cell of claim 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.

32. The recombinant yeast cell of claim 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.

33. The recombinant yeast cell of claim 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.

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

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

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

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

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

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

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

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

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.

43. The method of claim 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*.

44. The method of claim 42 or claim 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.

45. The method of one of claims 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).

46. The method of any one of claims 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).

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

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

49. The method of any one of claims 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*.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

64. The method of any one of claims 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.

65. The method of any one of claims 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.

66. The method of any one of claims 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.

67. The method of any one of claims 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.

68. The method of any one of claims 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.

69. The method of any one of claims 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.

70. The method of any one of claims 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.

71. The method of any one of claims 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.

72. The method of any one of claims 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.

73. The method of any one of claims 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.

74. The method of any one of claims 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.

75. The method of any one of claims 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.

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

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

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

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

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

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

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

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

84. The method of any one of claims 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}.

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

FIG. 1

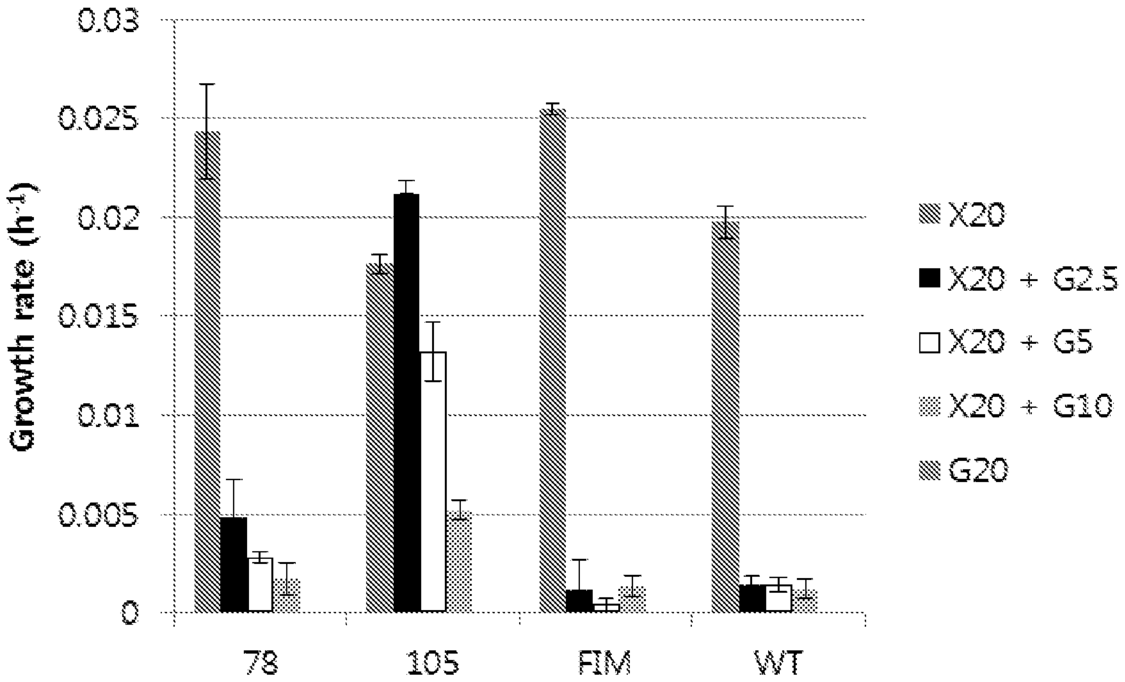

Growth rate (h-1)
0.03
0.025
0.02
0.015
0.01
0.005
0
78
105
FIM
WT
X20
X20 + G2.5
X20 + G5
X20 + G10
G20

FIG. 2

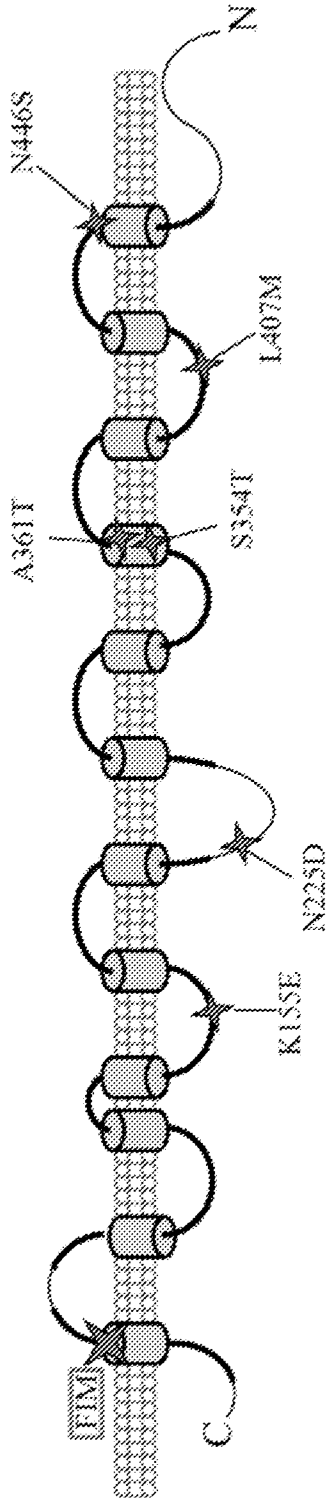


FIG. 3

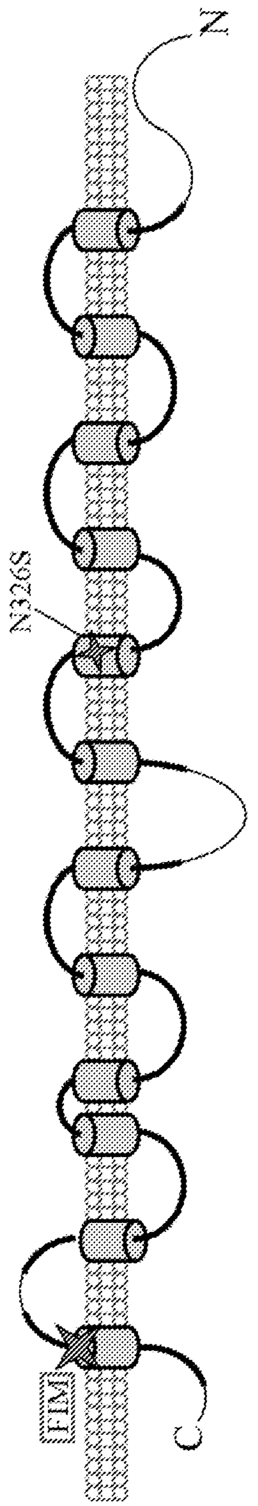


FIG. 4

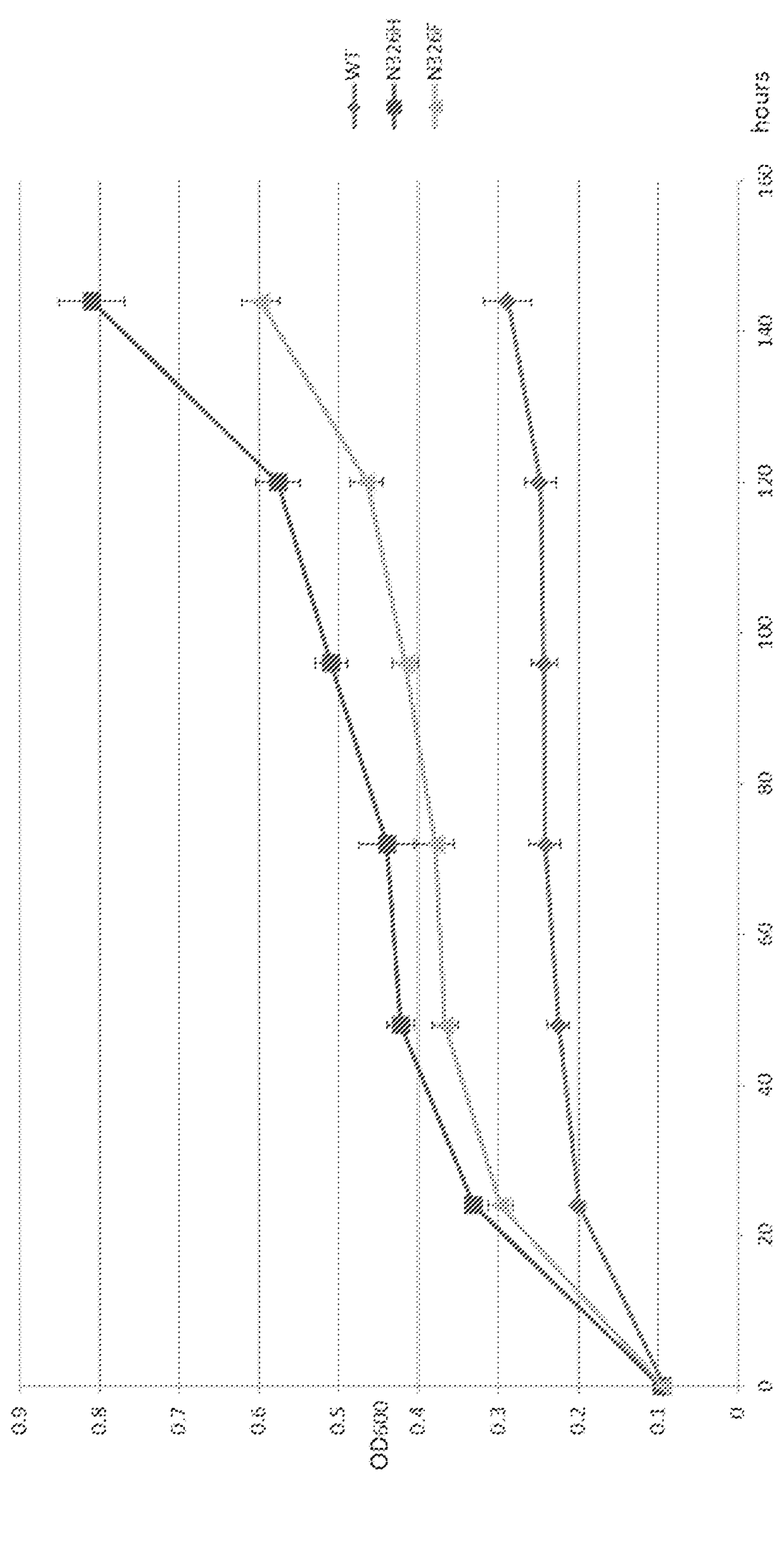

OD600
hours
WT
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
20
40
60
80
100
120
140
160

FIG. 5

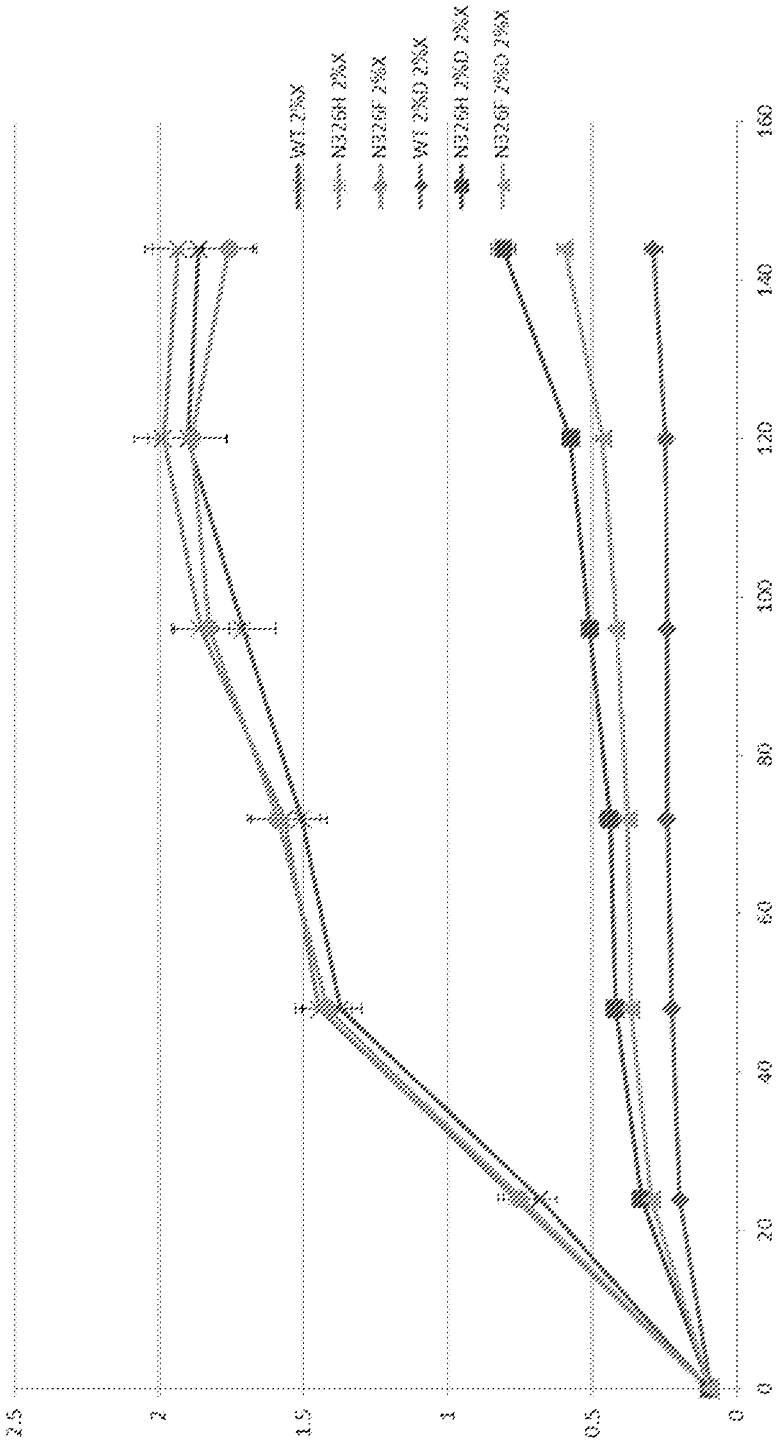

WT 2%X
N326H 2%X
N326F 2%X
WT 2%D 2%X
N326H 2%D 2%X
N326F 2%D 2%X
0
20
40
60
80
100
120
140
160
0
0.5
1
1.5
2
2.5

FIG. 6

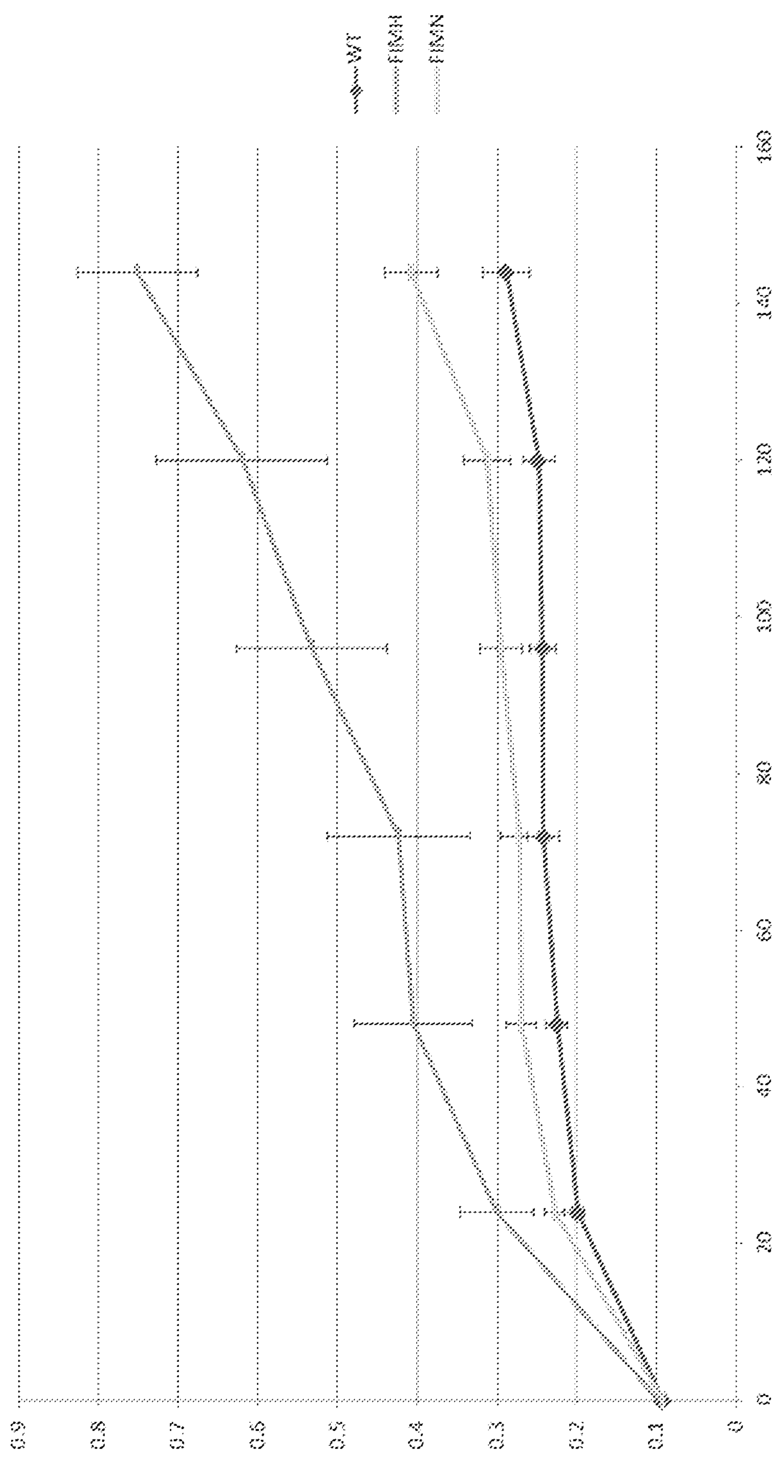

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
20
40
60
80
100
120
140
160
WT
FliMH
FliMN

FIG. 7

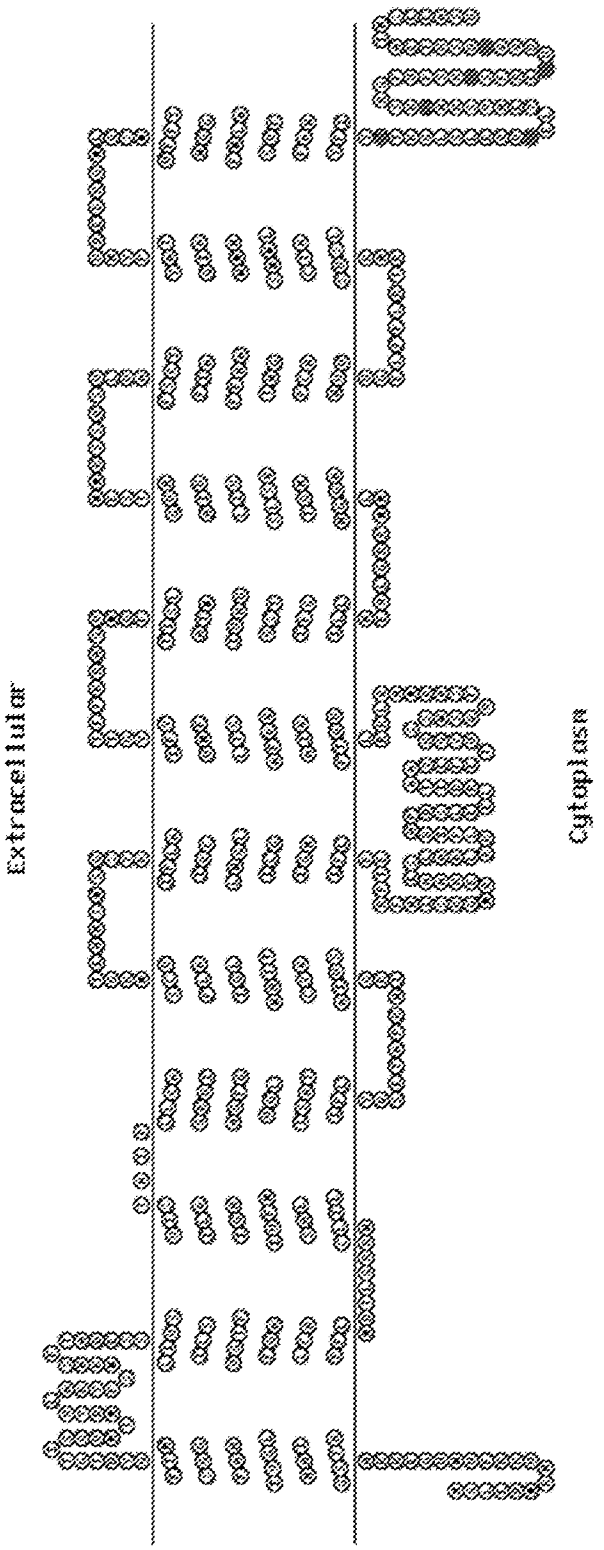


FIG. 8

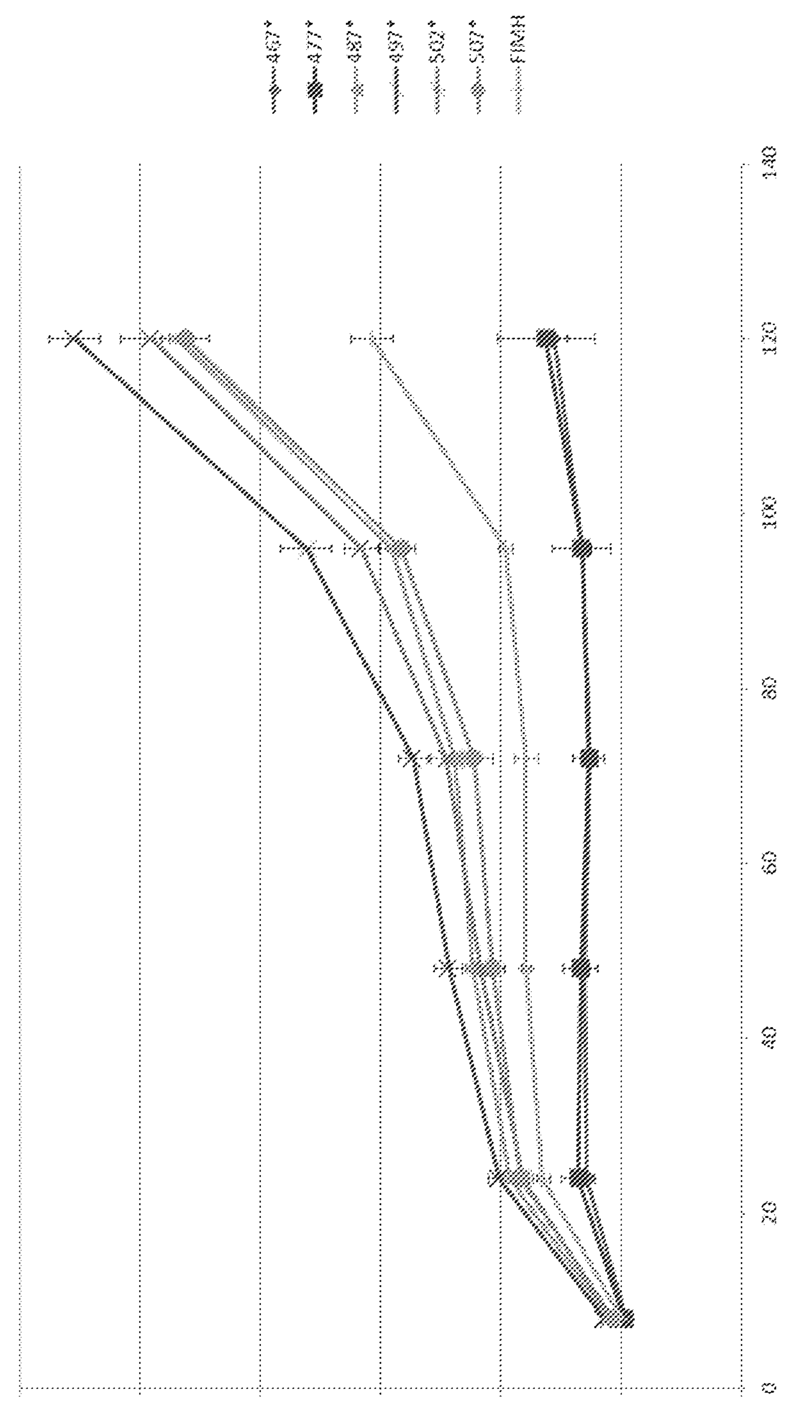


FIG. 9A

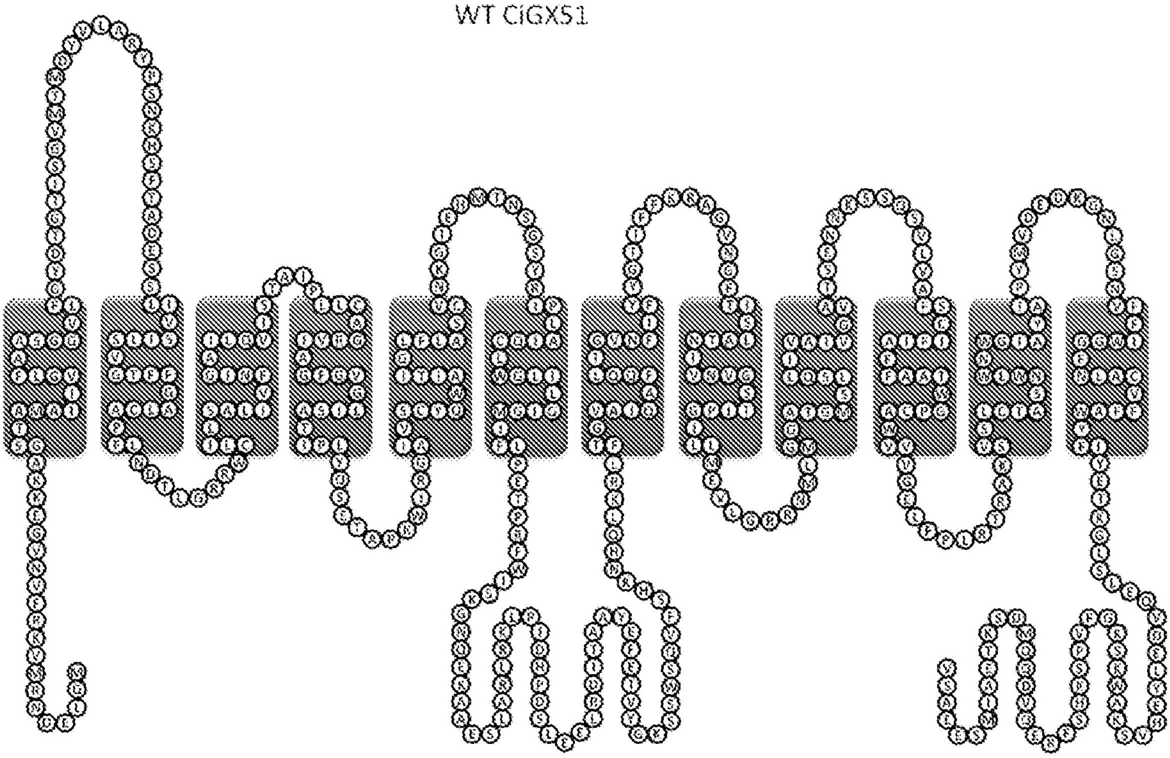


FIG. 9B

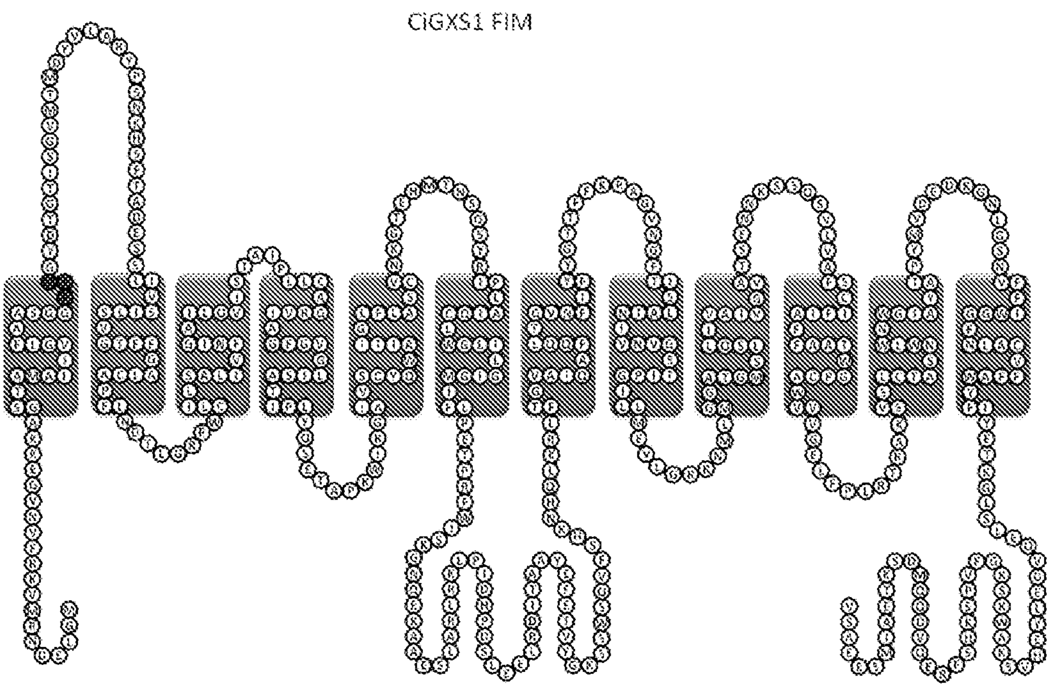


FIG. 9C

CiGXS1 FIM N326H

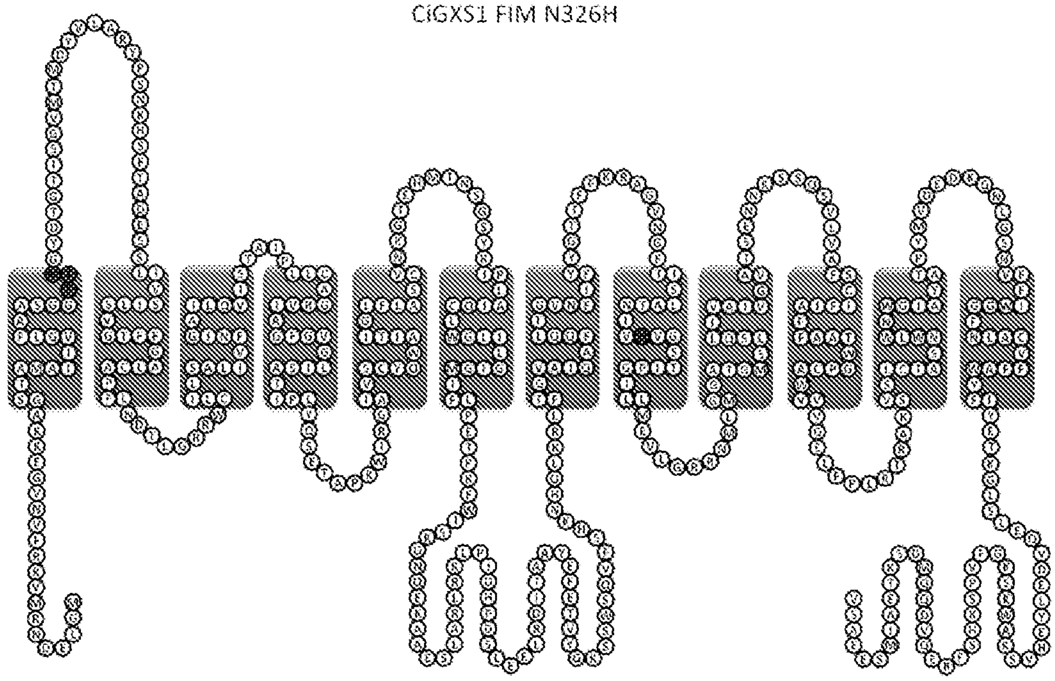


FIG. 9D

CiGXS1 FIM T170N

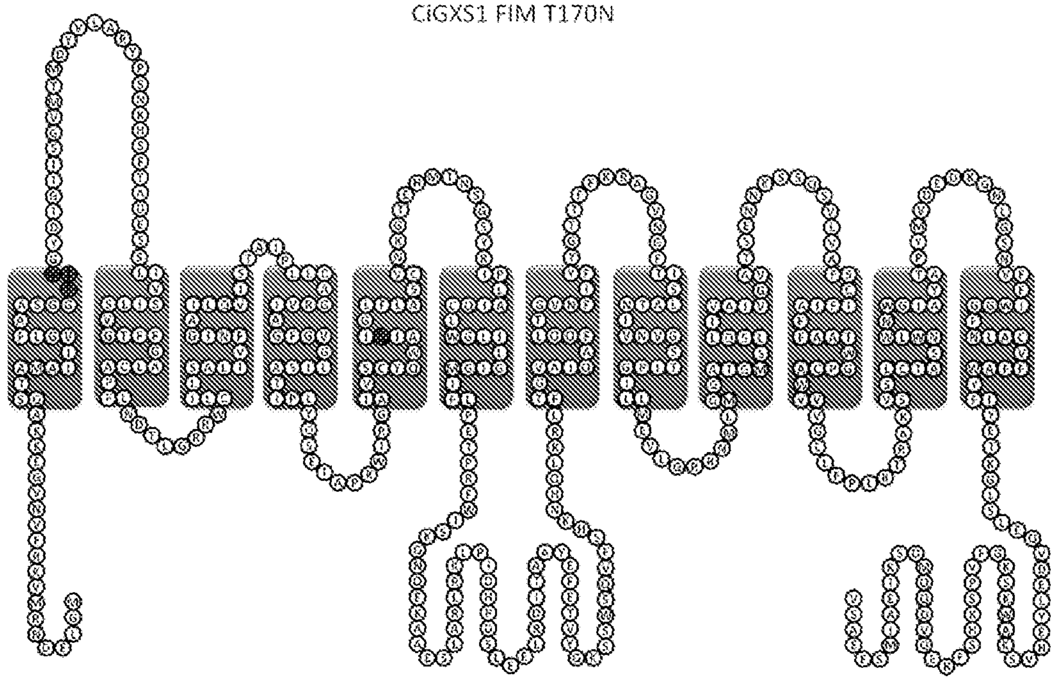


FIG. 9E

CiGXS1 (FIMH) Δ497

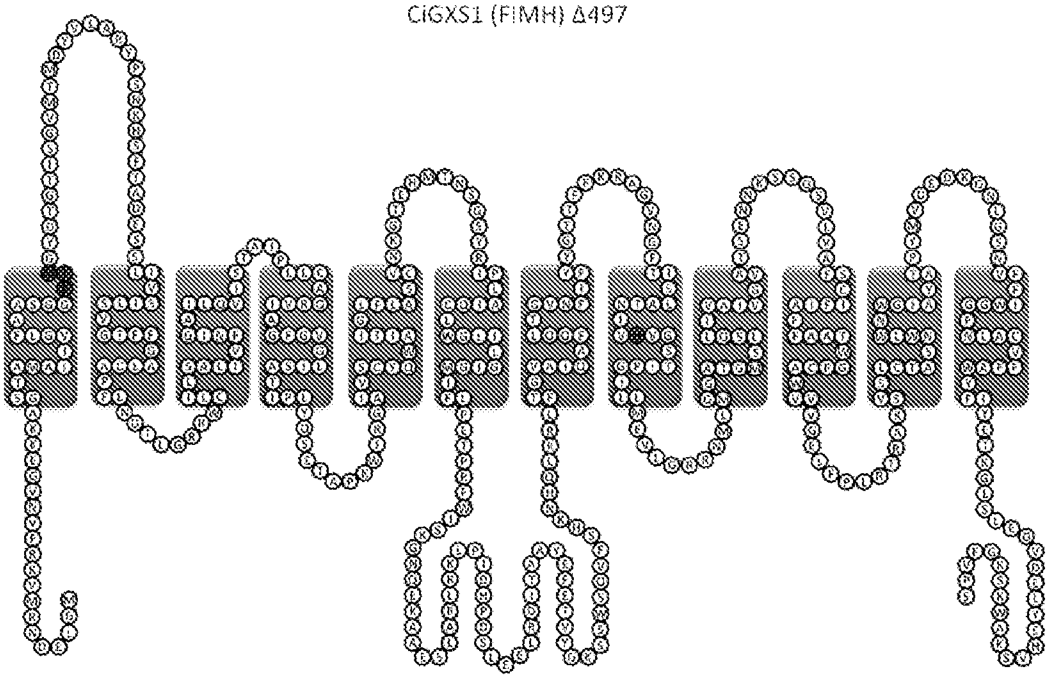


FIG. 9F

GXS1 (FIMH Δ497) with I171F

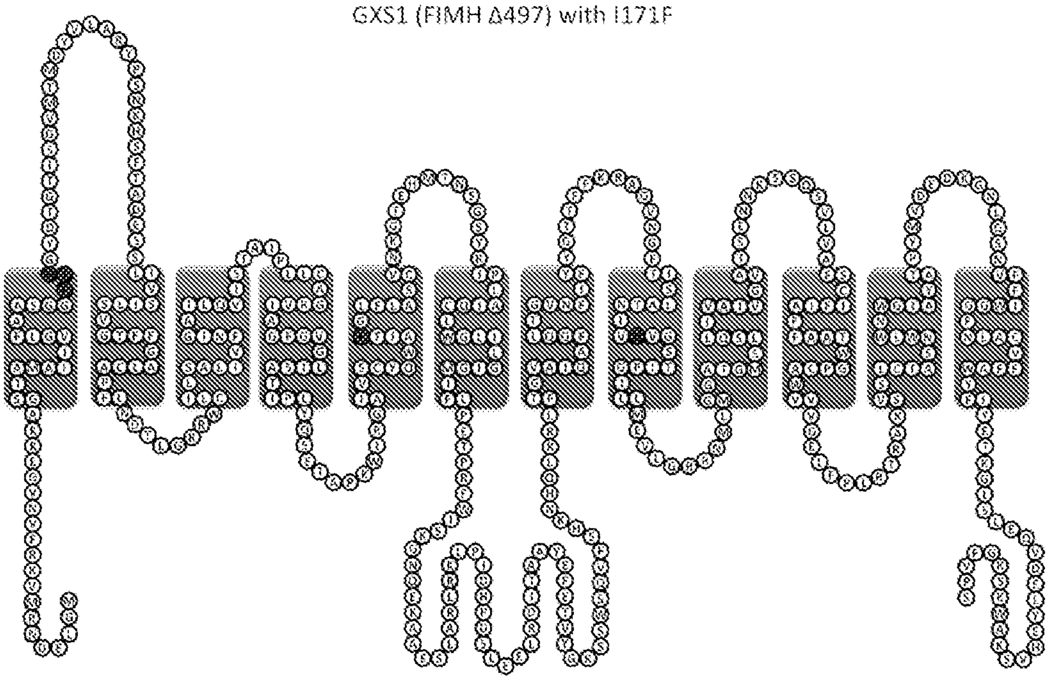
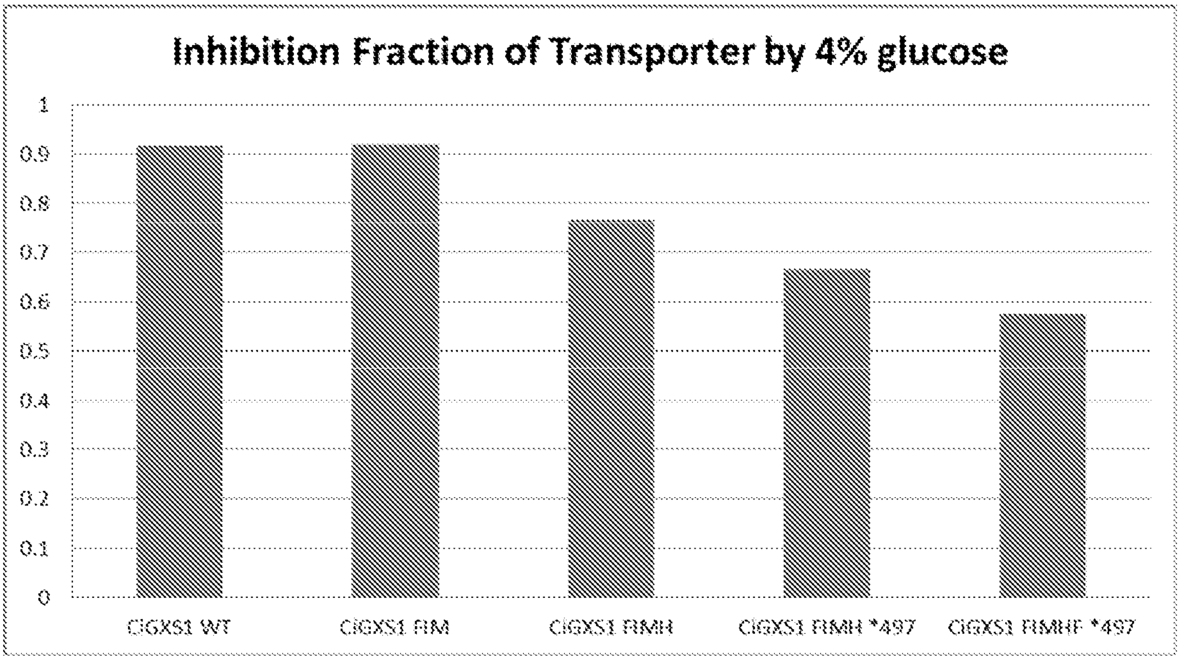


FIG. 10


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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/32058

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61K 38/00, 47/00 (2015.01)
CPC - A61K 38/00, 47/48238; C07K 7/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): A61K 38/00, 47/00 (2015.01)
CPC: A61K 38/00, 47/48238; C07K 7/06; USPC: 514/1.2, 1.1, 1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatSeer; Google; Google Scholar; Dialog ProQuest; Entrez PubMed; EBSCO; NCBI BLAST; recombinant; yeast, 'xylose transporter,' 'Candida intermedia,' 'GXS1,' 'mutant motif,' 'glucose mitigation,' 'GGFIMG,' 'GFFIMG,' 'GGFISG,' 'GFFISG'

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2012/0329109 A1 (CHUA, P et al.) December 27, 2012; paragraphs [0017], [0018], [0020], [0049], [0062], [0075], [0149], [0312], [0313], [0319]; SEQ ID NO: 39	1, 2, 42, 43 ----- 3/1, 3/2, 44/42, 44/43
Y -- A	WO 2014/018552 A1 (BP CORPORATION NORTH AMERICA, INC.) January 30, 2014; abstract; paragraphs [0016], [0017], [0019], [0060], [0062], [0069], [0079]	1, 2, 42, 43 ----- 3/1, 3/2, 44/42, 44/43
A	US 2010/0017904 A1 (ABAD, MS et al.) January 21, 2010; SEQ ID NO: 33569	3/1, 3/2, 44/42, 44/43
A	US 7910718 B2 (SIMKIN, A et al.) March 22, 2011; SEQ ID NO: 12	3/1, 3/2, 44/42, 44/43

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 August 2015 (11.08.2015)	26 AUG 2015

Name and mailing address of the ISA/	Authorized officer
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-41, 45-85
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.