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DOHERTY, G. A. ET AL.: "Discovery of diphenyl lactam derivatives as N-type calcium channel blockers", BIOORGANIC & MEDICINAL CHEMISTRY LETTERS, PERGAMON, AMSTERDAM; NL, vol. 22, no. 4, 20 December 2011 (2011-12-20), pages 1716-1718, XP028398239, ISSN: 0960-894X, DOI: 10.1016/J.BMCL.2011.12.100 [retrieved on 2012-01-08]

DESCRIPTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application No. 61/734,394, filed December 7, 2012.

REFERENCE TO SEQUENCE LISTING

[0002] A sequence listing text file is submitted via EFS-Web in compliance with 37 CFR §1.52(e)(5) concurrently with the specification. The sequence listing has the file name "23370-PCT-SEQTXT-15OCT2013", was created on October 15, 2013, and is 470,397 bytes in size. The sequence listing is part of the specification and is incorporated in its entirety by reference herein.

BACKGROUND OF THE INVENTION

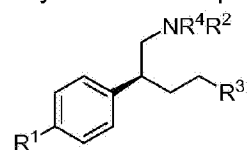
[0003] This invention describes the preparation of chiral compounds by employing dynamic kinetic resolution (DKR) involving an enzymatic enantioselective amination reaction catalyzed by a transaminase. This enzyme-catalyzed transaminase reaction allows convenient access to chiral compounds from an achiral starting material with high stereoselectivity.

[0004] Koszelewski et al. (2009, J. Mol. Catal. B-Enzym. 60:191-194) describes preparation of an enantiomerically enriched 4-phenylpyrrolidin-2-one using dynamic kinetic resolution involving an enzymatic enantioselective amination reaction catalyzed by ω -transaminases.

[0005] Wallace et al. (2011, Organic Process Research and Development 15:831-840) describes large-scale synthesis (up to 5 kg) routes of 2-{4-[(3S)-Piperidin-3-yl]phenyl}-2H-indazole-7-carboxamide relying on either classical resolution or chiral separation.

SUMMARY OF THE INVENTION

[0006] The present invention provides an efficient process for the preparation of an asymmetric compound of formula I:



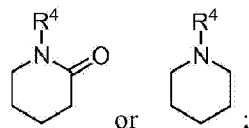
wherein:

R^1 is a leaving group, a protected amino group, NO_2 , or OH or its protected form;

R^2 is hydrogen;

R^3 is $(\text{C}=\text{O})\text{OR}^5$, CH_2R^6 , or a protected aldehyde; or,

R^2 and R^3 are combined to form a nitrogen containing heterocyclyl selected from

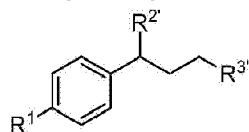


R^4 is hydrogen or an amino protecting group;

R^5 is C_{1-6} alkyl, C_{3-10} cycloalkyl, C_{4-10} heterocyclyl, aryl, or heteroaryl; and,

R^6 is a leaving group or OH or its protected form.

[0007] The process of the present invention relates to a method for the preparation of an asymmetric compound of formula I in an efficient enantioselective fashion via transaminase-catalyzed dynamic kinetic resolution (DKR) of a compound of formula II:



II

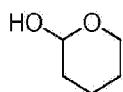
wherein:

R^1 is a leaving group, a protected amino group, NO_2 , or OH or its protected form;

$R^{2'}$ is an aldehyde or an aldehyde equivalent; and,

$R^{3'}$ is $(\text{C}=\text{O})\text{OR}^5$, CH_2R^6 , or a protected aldehyde; or

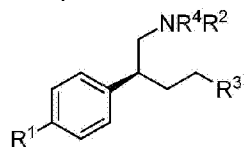
$R^{2'}$ and $R^{3'}$ are combined to form



[0008] The process described as part of the present invention can be used to manufacture key intermediates in the preparation of poly (ADP-ribose) polymerase (PARP) inhibitors disclosed in U.S. Patent No. 8,071,623, which may be useful for the treatment of cancer.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The present invention provides processes for the preparation of an asymmetric compound of formula I:

**I**

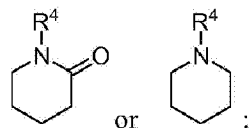
wherein:

R¹ is a leaving group, a protected amino group, NO₂, or OH or its protected form;

R² is hydrogen;

R³ is (C=O)OR⁵, CH₂R⁶, or a protected aldehyde; or,

R² and R³ are combined to form a nitrogen containing heterocyclyl selected from

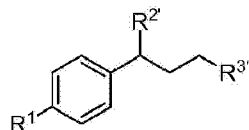


R⁴ is hydrogen or an amino protecting group;

R⁵ is C₁₋₆ alkyl, C₃₋₁₀ cycloalkyl, C₄₋₁₀ heterocyclyl, aryl, or heteroaryl; and,

R⁶ is a leaving group or OH or its protected form;

comprising a biocatalytic transamination of a compound of formula II:

**II**

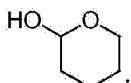
wherein:

R¹ is as defined above;

R²' is an aldehyde or an aldehyde equivalent; and,

R³' is R³; or

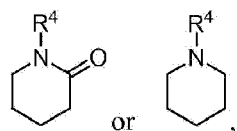
R²' and R³' are combined to form



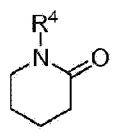
in the presence of a transaminase polypeptide, a coenzyme, and an amino donor.

[0010] In one embodiment of the process of the present invention, R^1 is a leaving group. In a further embodiment, R^1 is Br.

[0011] In another embodiment of the process of the present invention, R^2 and R^3 are combined to form a nitrogen containing heterocyclyl selected from

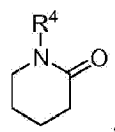


and R^4 is hydrogen. In a further embodiment, R^2 and R^3 are combined to form



and R^4 is hydrogen.

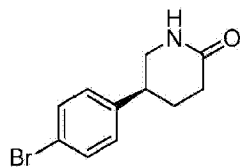
[0012] In a still further embodiment of the process of the present invention, R^1 is Br, R^2 and R^3 are combined to form



and R^4 is hydrogen.

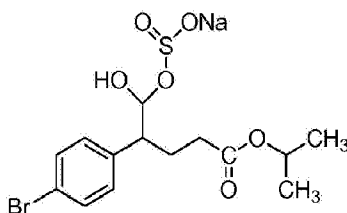
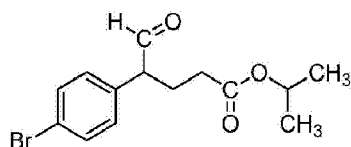
[0013] In another embodiment of the present invention, R^2 is hydrogen, R^3 is CH_2R^6 , R^4 is hydrogen, and R^6 is OH.

[0014] The present invention provides a process for the preparation of an asymmetric compound of formula **III** by transaminase-catalyzed DKR:



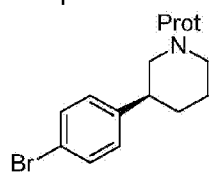
III

comprising a biocatalytic transamination of a compound of formula **IV** or a compound of formula **V**:



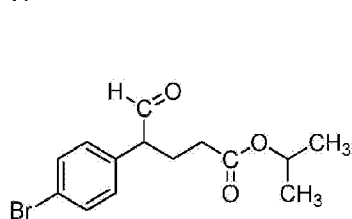
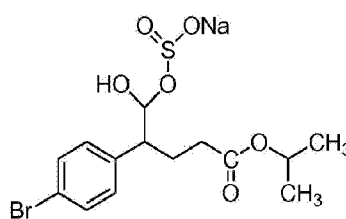
IV **V**
 in the presence of a transaminase polypeptide, a coenzyme, and an amino donor.

[0015] The present invention further provides a process for the preparation of an asymmetric compound of formula **VI**:

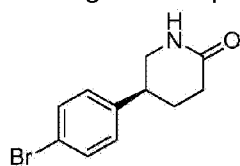
**VI**

by transaminase-catalyzed DKR, wherein Prot is an amino protecting group comprising:

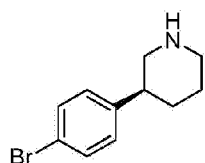
1. (a) a biocatalytic transamination of a compound of formula **IV** or a compound of formula **V**:

**IV****V**

in the presence of a transaminase polypeptide, a coenzyme, and an amino donor, forming the compound of formula **III**:

**III** ;

2. (b) reducing the lactam of the compound of formula **III**, forming the compound of formula **VII**:

**VII** ; and,

3. (c) protecting the piperidine nitrogen of the compound of formula **VII** to form the compound of formula **VI**.

[0016] In one embodiment of the processes of the invention, the biocatalytic transamination provides a compound of formula **I** having an enantiomeric excess of at least about 95% e.e., at least about 96% e.e., at least about 97% e.e., at least about 98% e.e., at least about 99% e.e., or at least about 99.9% e.e. In another embodiment of the process of the present invention,

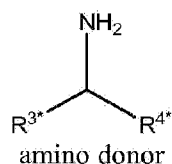
the transaminase-catalyzed DKR of a compound of formula II as described provides a compound of formula I having an enantiomeric excess of at least 95%. In a further embodiment of the process of the present invention, the transaminase-catalyzed DKR of a compound of formula II as described provides a compound of formula I having an enantiomeric excess of at least 99%.

[0017] In one embodiment of the instant processes, the transaminase polypeptide is a naturally occurring transaminase. In another embodiment, the transaminase polypeptide is a synthetic variant of a naturally occurring transaminase. In a further embodiment, the transaminase polypeptide is selected from SEQ ID NO: 18 or SEQ ID NO: 180. In a further embodiment, the transaminase polypeptide is SEQ ID NO: 180.

[0018] In one embodiment of the instant process, isopropylamine is used as an amino donor.

[0019] In another embodiment of the instant process, pyridoxal-phosphate is used as a coenzyme.

[0020] "Amino donor" or "amine donor" refers to an amino compound which donates an amino group to an amino acceptor, thereby becoming a carbonyl species. Amino donors are molecules of general formula shown below,



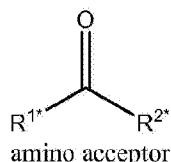
in which each of R^{3*} , R^{4*} , when taken independently, is an alkyl, an alkylaryl group, or aryl group which is unsubstituted or substituted with one or more enzymatically non-inhibiting groups. R^{3*} can be the same or different from R^{4*} in structure or chirality. In some embodiments, R^{3*} and R^{4*} , taken together, may form a ring that is unsubstituted, substituted, or fused to other rings. Typical amino donors that can be used with the embodiments of the present disclosure include chiral and achiral amino acids, and chiral and achiral amines.

[0021] "Chiral amine" refers to amines of general formula $\text{R}^{\alpha}\text{-CH(NH}_2\text{)-R}^{\beta}$ and is employed herein in its broadest sense, including a wide variety of aliphatic and alicyclic compounds of different, and mixed, functional types, characterized by the presence of a primary amino group bound to a secondary carbon atom which, in addition to a hydrogen atom, carries either (i) a divalent group forming a chiral cyclic structure, or (ii) two substituents (other than hydrogen) differing from each other in structure or chirality. Divalent groups forming a chiral cyclic structure include, for example, 2-methylbutane-1,4-diyl, pentane-1,4-diyl, hexane-1,4-diyl, hexane-1,5-diyl, 2-methylpentane-1,5-diyl. The two different substituents on the secondary carbon atom (R^{α} and R^{β} above) also can vary widely and include alkyl, arylalkyl, aryl, halo, hydroxy, lower alkyl, lower alkyloxy, lower alkylthio, cycloalkyl, carboxy, carbalkyloxy, carbamoyl, mono- and di-(lower alkyl) substituted carbamoyl, trifluoromethyl, phenyl, nitro, amino, mono- and di-(lower alkyl) substituted amino, alkylsulfonyl, arylsulfonyl,

alkylcarboxamido, arylcarboxamido, etc., as well as alkyl, arylalkyl, or aryl substituted by the foregoing.

[0022] Exemplary amino donors that can be used with the embodiments herein include, by way of example and not limitation, isopropylamine (also referred to as 2-aminopropane, and referred to elsewhere herein as "IPM"), α -phenethylamine (also termed 1-phenylethanamine), and its enantiomers (*S*)-1-phenylethanamine and (*R*)-1-phenylethanamine, 2-amino-4-phenylbutane, glycine, L-glutamic acid, L-glutamate, monosodium glutamate, L-alanine, D-alanine, D,L-alanine, L-aspartic acid, L-lysine, D,L-ornithine, β -alanine, taurine, n-octylamine, cyclohexylamine, 1,4-butanediamine (also referred to as putrescine), 1,6-hexanediamine, 6-aminohexanoic acid, 4-aminobutyric acid, tyramine, and benzyl amine, 2-aminobutane, 2-amino-1-butanol, 1-amino-1-phenylethane, 1-amino-1-(2-methoxy-5-fluorophenyl)ethane, 1-amino-1-phenylpropane, 1-amino-1-(4-hydroxyphenyl)propane, 1-amino-1-(4-bromophenyl)propane, 1-amino-1-(4-nitrophenyl)propane, 1-phenyl-2-aminopropane, 1-(3-trifluoromethylphenyl)-2-aminopropane, 2-aminopropanol, 1-amino-1-phenylbutane, 1-phenyl-2-aminobutane, 1-(2,5-dimethoxy-4-methylphenyl)-2-aminobutane, 1-phenyl-3-aminobutane, 1-(4-hydroxyphenyl)-3-aminobutane, 1-amino-2-methylcyclopentane, 1-amino-3-methylcyclopentane, 1-amino-2-methylcyclohexane, 1-amino-1-(2-naphthyl)ethane, 3-methylcyclopentylamine, 2-methylcyclopentylamine, 2-ethylcyclopentylamine, 2-methylcyclohexylamine, 3-methylcyclohexylamine, 1-aminotetralin, 2-aminotetralin, 2-amino-5-methoxytetralin, and 1-aminoindan, including both (*R*) and (*S*) single isomers where possible and including all possible salts of the amines.

[0023] "Amino acceptor" and "amine acceptor," "keto substrate," "keto," and "ketone" are used interchangeably herein to refer to a carbonyl (keto, or ketone) compound which accepts an amino group from a donor amine. Amino acceptors are molecules of general formula shown below,



in which each of R^{1*} , R^{2*} , when taken independently, is an alkyl, an alkylaryl group, or aryl group which is unsubstituted or substituted with one or more enzymatically acceptable groups. R^{1*} may be the same or different from R^{2*} in structure or chirality. In some embodiments, R^{1*} and R^{2*} , taken together, may form a ring that is unsubstituted, substituted, or fused to other rings. Amino acceptors include keto carboxylic acids, alkanones (ketones), and alkanals (aldehydes).

[0024] "Coenzyme," as used herein, refers to a non-protein compound that operates in combination with an enzyme in catalyzing a reaction. As used herein, "coenzyme" is intended to encompass the vitamin B₆ family compounds PLP, PN, PL, PM, PNP, and PMP.

[0025] "Pyridoxal-phosphate," "PLP," "pyridoxal-5'-phosphate," "PYP," and "P5P" are used

interchangeably herein to refer to a compound that acts as a coenzyme in transaminase reactions. In some embodiments, pyridoxal phosphate is defined by the structure 1-(4'-formyl-3'-hydroxy-2'-methyl-5'-pyridyl)methoxyphosphonic acid, CAS number [54-47-7]. Pyridoxal-5'-phosphate can be produced *in vivo* by phosphorylation and oxidation of pyridoxol (also known as Vitamin B₆). In transamination reactions using transaminase enzymes, the amine group of the amino donor is transferred to the coenzyme to produce a keto by-product, while pyridoxal-5'-phosphate is converted to pyridoxamine phosphate. Pyridoxal-5'-phosphate is regenerated by reaction with a different keto compound (the amino acceptor). The transfer of the amine group from pyridoxamine phosphate to the amino acceptor produces an amine and regenerates the coenzyme. In some embodiments, the pyridoxal-5'-phosphate can be replaced by other members of the vitamin B₆ family, including pyridoxine (PN), pyridoxal (PL), pyridoxamine (PM), and their phosphorylated counterparts; pyridoxine phosphate (PNP), and pyridoxamine phosphate (PMP).

[0026] "Leaving group" is defined as a term that would be understood by one of ordinary skill in the art; that is, a group on a carbon where, upon reaction, a new bond is to be formed and the carbon loses the group upon formation of the new bond. A typical example employing a suitable leaving group is a nucleophilic substitution reaction, *e.g.*, on a sp³ hybridized carbon (S_N2 or S_N1), *e.g.* where the leaving group is a halide, such as a bromide, the reactant might be benzyl bromide. Another typical example of such a reaction is a nucleophilic aromatic substitution reaction (S_NAr). Another example is an insertion reaction (for example by a transition metal) into the bond between an aromatic reaction partner bearing a leaving group followed by reductive coupling. "Leaving group" is not limited to such mechanistic restrictions. Examples of suitable leaving groups include halogens (fluorine, chlorine, bromine or iodine), optionally substituted aryl or alkyl sulfonates, phosphonates, azides and -S(O)₀₋₂R where R is, for example optionally substituted alkyl, optionally substituted aryl, or optionally substituted heteroaryl. Those of skill in the art of organic synthesis will readily identify suitable leaving groups to perform a desired reaction under different reaction conditions. Characteristics and examples of leaving groups can be found in Organic Chemistry, 2nd ed., Francis Carey (1992), pages 328-331; Introduction to Organic Chemistry, 2d ed., Andrew Streitwieser and Clayton Heathcock (1981), pages 169-171; and Organic Chemistry, 5th Ed., John McMurry, Brooks/Cole Publishing (2000), pages 398 and 408. "Protecting group" refers to a group of atoms that mask, reduce or prevent the reactivity of the functional group when attached to a reactive functional group in a molecule. Typically, a protecting group may be selectively removed as desired during the course of a synthesis. Examples of protecting groups can be found in Wuts and Greene, "Greene's Protective Groups in Organic Synthesis," 4th Ed., Wiley Interscience (2006), and Harrison et al., Compendium of Synthetic Organic Methods, Vols. 1-8, 1971-1996, John Wiley & Sons, NY. Functional groups that can have a protecting group include hydroxy, amino, and carboxy groups.

[0027] Representative amino protecting groups include formyl, acetyl (Ac), trifluoroacetyl, benzyl (Bn), benzoyl (Bz), carbamate, benzyloxycarbonyl ("CBZ"), *p*-methoxybenzyl carbonyl (Moz or MeOZ), *tert*-butoxycarbonyl ("Boc"), trimethylsilyl ("TMS"), 2-trimethylsilyl-

ethanesulfonyl ("SES"), trityl and substituted trityl groups, allyloxycarbonyl, 9-fluorenylmethyloxycarbonyl ("Fmoc"), nitro-veratryloxycarbonyl ("NVOC"), *p*-methoxybenzyl (PMB), tosyl (Ts). Representative hydroxyl protecting groups include, those where the hydroxyl group is either acylated (e.g., methyl and ethyl esters, acetate or propionate groups or glycol esters) or alkylated such as benzyl and trityl ethers, as well as alkyl ethers, tetrahydropyranyl ethers, trialkylsilyl ethers (e.g., TMS or TIPS groups) and allyl ethers. Other protecting groups can be found in the references noted herein.

[0028] A "protected aldehyde" is defined as the term would be understood by one of ordinary skill in the art; that is, the aldehyde is protected with a group such that it may be converted under assays conditions to an unprotected aldehyde. Examples of protected aldehydes include, an acetal or hemiacetal which can be converted into a free aldehyde group by treatment with acids (organic or inorganic acids), such as acetal groups formed with a polyalcohol such as propane diol or ethylene glycol, or hemiacetal groups in a sugar or in a sugar-related compound such as an aldose sugar, e.g. glucose or galactose. Further examples of protected aldehydes are imino groups (e.g., =NH groups), which give aldehyde groups upon treatment with acids; thioacetal or dithioacetal groups (e.g., C(SR)₂ groups wherein R may be an alkyl radical), which give aldehyde groups upon treatment with mercury salts; oxime groups (e.g., =NOH groups), which give aldehyde groups upon treatment with acids; hydrazone groups (e.g., =N-NHR groups wherein R may be an alkyl radical), which give aldehyde groups upon treatment with acids; and imidazolone or imidazolidine groups or benzothiazole or dihydrobenzothiazole groups, which give aldehydes upon hydrolysis, e.g. with acid.

[0029] As used herein except where noted, "alkyl" is intended to include both branched- and straight-chain saturated aliphatic hydrocarbon groups having the specified number of carbon atoms. For example, "C₁-C₆" or "C₁₋₆," as in "C₁-C₆ alkyl" or "C₁₋₆ alkyl," is defined to include groups having 1, 2, 3, 4, 5, or 6 carbons in a linear or branched arrangement. C₁₋₆ alkyl includes all of the hexyl alkyl and pentyl alkyl isomers as well as *n*-, *iso*-, *sec*- and *t*-butyl, *n*- and isopropyl, ethyl and methyl. As another example, C₁₋₄ alkyl means *n*-, *iso*-, *sec*- and *t*-butyl, *n*- and isopropyl, ethyl and methyl. As another example, C₁-C₁₀ alkyl specifically includes methyl, ethyl, *n*-propyl, *i*-propyl, *n*-butyl, *t*-butyl, *i*-butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, and so on. If no number is specified, 1-10 carbon atoms are intended for linear or branched alkyl groups. Commonly used abbreviations for alkyl groups are used throughout the specification, e.g. methyl may be represented by conventional abbreviations including "Me" or CH₃ or a symbol that is an extended bond without defined terminal group, e.g. "

ξ—

", ethyl may be represented by "Et" or CH₂CH₃, propyl may be represented by "Pr" or CH₂CH₂CH₃, butyl may be represented by "Bu" or CH₂CH₂CH₂CH₃, etc. The term "cycloalkyl" means a monocyclic saturated aliphatic hydrocarbon group having the specified number of carbon atoms. For example, "cycloalkyl" includes cyclopropyl, methyl-cyclopropyl, 2,2-dimethylcyclobutyl, 2-ethyl-cyclopentyl, cyclohexyl, cyclopentenyl, cyclobutenyl and so on.

[0030] "Aryl," unless otherwise indicated, is intended to mean any stable monocyclic or bicyclic carbon ring of up to 7 atoms in each ring, wherein at least one ring is aromatic. Examples of such aryl elements include phenyl, naphthyl, tetrahydronaphthyl, indanyl and biphenyl. In cases where the aryl substituent is bicyclic and one ring is non-aromatic, it is understood that attachment is via the aromatic ring. In an embodiment, aryl is phenyl.

[0031] The term "heteroaryl," as used herein, represents a stable monocyclic or bicyclic ring of up to 7 atoms in each ring, wherein at least one ring is aromatic and contains from 1 to 4 heteroatoms selected from the group consisting of O, N and S. Heteroaryl groups within the scope of this definition include but are not limited to: acridinyl, carbazolyl, cinnolinyl, quinoxalinyl, pyrazolyl, indolyl, benzotriazolyl, furanyl, thienyl, benzothieryl, benzofuranyl, benzimidazolonyl, benzoxazolonyl, quinolinyl, isoquinolinyl, dihydroisoindolonyl, imidazopyridinyl, isoindolonyl, indazolyl, oxazolyl, oxadiazolyl, isoxazolyl, indolyl, pyrazinyl, pyridazinyl, pyridinyl, pyrimidinyl, pyrrolyl, tetrahydroquinoline. As with the definition of heterocycle below, "heteroaryl" is also understood to include the N-oxide derivative of any nitrogen-containing heteroaryl. In cases where the heteroaryl substituent is bicyclic and one ring is non-aromatic or contains no heteroatoms, it is understood that attachment is via the aromatic ring or via the heteroatom containing ring, respectively.

[0032] The term "heterocycle" or "heterocyclyl," as used herein, is intended to mean a 3- to 10-membered aromatic or nonaromatic heterocycle containing from 1 to 4 heteroatoms selected from the group consisting of O, N and S, and includes bicyclic groups. For the purposes of this invention, the term "heterocyclic" is also considered to be synonymous with the terms "heterocycle" and "heterocyclyl" and is understood as also having the definitions set forth herein. "Heterocyclyl" therefore includes the above mentioned heteroaryls, as well as dihydro and tetrahydro analogs thereof. Further examples of "heterocyclyl" include, but are not limited to the following: azetidiny, benzoimidazolyl, benzofuranyl, benzofurazanyl, benzopyrazolyl, benzotriazolyl, benzothiophenyl, benzoxazolyl, carbazolyl, carbolinyl, cinnolinyl, furanyl, imidazolyl, indolinyl, indolyl, indolaziny, indazolyl, isobenzofuranyl, isoindolyl, isoquinolyl, isothiazolyl, isoxazolyl, naphthpyridinyl, oxadiazolyl, oxooxazolidinyl, oxazolyl, oxazoline, oxopiperazinyl, oxopyrrolidinyl, oxomorpholinyl, isoxazoline, oxetanyl, pyranly, pyrazinyl, pyrazolyl, pyridazinyl, pyridopyridinyl, pyridazinyl, pyridyl, pyrimidyl, pyrrolyl, quinazolinyl, quinolyl, quinoxalinyl, tetrahydropyranyl, tetrahydrofuranyl, tetrahydrothiopyranyl, tetrahydroisoquinolinyl, tetrazolyl, tetrazolopyridyl, thiadiazolyl, thiazolyl, thienyl, triazolyl, 1,4-dioxanyl, hexahydroazepinyl, piperazinyl, piperidinyl, pyridin-2-onyl, pyrrolidinyl, morpholinyl, thiomorpholinyl, dihydrobenzoimidazolyl, dihydrobenzofuranyl, dihydrobenzothiophenyl, dihydrobenzoxazolyl, dihydrofuranyl, dihydroimidazolyl, dihydroindolyl, dihydroisooxazolyl, dihydroisothiazolyl, dihydrooxadiazolyl, dihydrooxazolyl, dihydropyrazinyl, dihydropyrazolyl, dihydropyridinyl, dihydropyrimidinyl, dihydropyrrolyl, dihydroquinolinyl, dihydrotetrazolyl, dihydrothiadiazolyl, dihydrothiazolyl, dihydrothienyl, dihydrotriazolyl, dihydroazetidiny, dioxidothiomorpholinyl, methylenedioxybenzoyl, tetrahydrofuranyl, and tetrahydrothienyl, and N-oxides thereof. Attachment of a heterocyclyl substituent can occur via a carbon atom or via a heteroatom.

[0033] "Protein," "polypeptide," and "peptide" are used interchangeably herein to denote a polymer of at least two amino acids covalently linked by an amide bond, regardless of length or post-translational modification (e.g., glycosylation, phosphorylation, lipidation, myristilation, ubiquitination, etc.). Included within this definition are D- and L-amino acids, and mixtures of D- and L-amino acids.

[0034] "Stereoselectivity" refers to the preferential formation in a chemical or enzymatic reaction of one stereoisomer over another. Stereoselectivity can be partial, where the formation of one stereoisomer is favored over the other, or it may be complete where only one stereoisomer is formed. When the stereoisomers are enantiomers, the stereoselectivity is referred to as enantioselectivity, the fraction (typically reported as a percentage) of one enantiomer in the sum of both. It is commonly alternatively reported in the art (typically as a percentage) as the enantiomeric excess (e.e.) calculated there from according to the formula $[\text{major enantiomer} - \text{minor enantiomer}] / [\text{major enantiomer} + \text{minor enantiomer}]$. Where the stereoisomers are diastereoisomers, the stereoselectivity is referred to as diastereoselectivity, the fraction (typically reported as a percentage) of one diastereomer in a mixture of two diastereomers, commonly alternatively reported as the diastereomeric excess (d.e.). Where a mixture contains more than two diastereomers it is common to report the ratio of diastereomers or "diastereomeric ratio" rather than diastereomeric excess. Enantiomeric excess and diastereomeric excess are types of stereomeric excess. "High stereoselectivity," in reference to the process of the present invention, refers the capability of converting a substrate to the asymmetric amine product with at least about 85% stereomeric excess.

[0035] "Transaminase," "transaminase polypeptide" and "transaminase enzyme," as used interchangeably herein, refer to a polypeptide having an enzymatic capability of transferring an amino group (NH_2), a pair of electrons, and a proton from a primary amine of an amino donor to a carbonyl group (C=O ; *i.e.*, a keto group) of an amino acceptor molecule. Transaminases as used herein include naturally occurring (wild-type) transaminases, as well as non-naturally occurring engineered polypeptides generated by human manipulation. In an embodiment of the instant process, a transaminase polypeptide having the amino acid sequence as set forth in SEQ ID NO: 18 or SEQ ID NO: 180 is used. In an embodiment of the instant process, a transaminase polypeptide having a polynucleotide sequence as set forth in SEQ ID NO: 17 or SEQ ID NO: 179 is used.

Transaminase Polypeptides

[0036] Transaminases have been identified from various organisms, such as *Alcaligenes denitrificans*, *Arthrobacter*, *Bordetella bronchiseptica*, *Bordetella parapertussis*, *Brucella melitensis*, *Burkholderia malle*, *Burkholderia pseudomallei*, *Chromobacterium violaceum*, *Oceanicola granulosus* HTCC2516, *Oceanobacter* sp. RED65, *Oceanospirillum* sp. MED92, *Pseudomonas putida*, *Ralstonia solanacearum*, *Rhizobium meliloti*, *Rhizobium* sp. (strain NGR234), *Bacillus thuringiensis*, *Vibrio fluvialis* and *Klebsiella pneumoniae* (see, e.g., Shin et al., 2001, Biosci. Biotechnol. Biochem. 65: 1782-1788). Both R-selective and S-selective

transaminases are known. The wild-type transaminase from *Arthrobacter sp. KNK168* is an R-selective, pyridoxal 5'-phosphate (PLP)-dependent enzyme that produces R-amines from some substrates (see, e.g., Iwasaki et al., 2006, Appl. Microbiol. Biotechnol., 69:499-505; U.S. Pat. No. 7,169,592).

[0037] U.S. application serial no. 12/714,397, filed February 26, 2010 (published as US20100285541), and PCT International application serial no. PCT/US2010/025685, filed February 26, 2010 (published as WO 2010/099501), disclose engineered transaminase polypeptides derived from the naturally occurring transaminase of *Arthrobacter sp. KNK168*. These transaminase polypeptides have increased stability to temperature and/or organic solvent and have been adapted to have enzymatic activity towards structurally different amino acceptor molecules (see also, e.g., Savile et al., 2010, Science 329(5989):305-9). PCT International patent application serial no. PCT/US2011/046932, filed August 8, 2011 (published as WO 2012/024104), further describes non-naturally occurring transaminase polypeptides derived from *Arthrobacter sp. KNK168* engineered to have improved properties, such as increased stereoselectivity. These synthetic variants of the naturally occurring *Arthrobacter sp. KNK168* transaminase comprise amino acid sequences that have one or more residue differences as compared to the wild-type sequence. For example, the residue differences may occur at residue positions that affect one or more functional properties of the enzyme, including but not limited to stereoselectivity, substrate and/or product binding (e.g., resistance to substrate and/or product inhibition), activity (e.g., percent conversion of substrate to product), thermostability, solvent stability, expression, or various combinations thereof.

[0038] In one embodiment of the present invention, the asymmetric synthesis of compounds of formula I from compounds of formula II via biocatalytic transamination utilizes a naturally occurring transaminase polypeptide. In another embodiment, the synthesis reaction of the invention utilizes a synthetic variant of a naturally occurring transaminase. In a further embodiment, the synthetic, engineered transaminase polypeptide is derived from a transaminase of *Arthrobacter sp. KNK168*, including the *Arthrobacter sp. KNK168* transaminase polypeptide as set forth in SEQ ID NO: 2, wherein the synthetic variant comprises an amino acid sequence having one or more residue differences as compared to the wild-type sequence of SEQ ID NO: 2.

[0039] In a further embodiment, the transaminase polypeptide comprises or consists of an engineered transaminase polypeptide as described in PCT International application serial no. PCT/US2011/046932, filed August 8, 2011 (published as WO 2012/024104), having among other things a high stereoselectivity. These engineered polypeptides are non-naturally occurring transaminases engineered to have improved properties, such as increased stereoselectivity, increased activity, increased thermostability, and tolerance of increased substrate and/or product concentration (e.g., decreased product inhibition).

[0040] As described in detail in PCT International application serial no. PCT/US2011/046932, engineered transaminases were previously identified by optimizing the reported wild-type omega transaminase polypeptide from *Arthrobacter sp. KNK168* of SEQ ID NO: 2. First, a

transaminase polypeptide derived from SEQ ID NO: 2 having a single amino acid change relative to the wild-type sequence (I306V) was generated having the amino acid sequence as set forth in SEQ ID NO: 4 (encoded by the polynucleotide sequence as set forth in SEQ ID NO: 3). The synthetic polynucleotide of SEQ ID NO: 3 was optimized for increased expression and thermostability by inserting active and silent mutations which are described in US application Serial No. 12/714,397, filed February 26, 2010, which is incorporated herein by reference. This optimization resulted in the synthetic polynucleotide of SEQ ID NO: 5, which encodes the engineered polypeptide of SEQ ID NO: 6, having the following 24 amino acid differences relative to the naturally occurring transaminase of *Arthrobacter sp. KNK168* (SEQ ID NO: 2): S8P; Y60F; L61Y; H62T; V65A; V69T; D81G; M94I; I96L; F122I; G136F; A169L; V199I; A209L; G215C; G217N; S223P; L269P; L273Y; T282S; A284G; P297S; I306V; and S321P. The engineered transaminase polypeptide of SEQ ID NO: 6 was used as the starting backbone for further optimization to generate polynucleotides encoding additional engineered transaminase polypeptides (see PCT/US2011/046932; *supra*).

[0041] Therefore, in a further embodiment of the present invention, the asymmetric synthesis of compounds of formula I from compounds of formula II via biocatalytic transamination utilizes a transaminase polypeptide that is a synthetic variant of a naturally occurring transaminase and comprises the acid sequence as set forth in SEQ ID NO: 6.

[0042] In another embodiment of the instant process, the transaminase polypeptide comprises an amino acid sequence having at least 80% sequence identity (e.g., at least 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity) to the reference polypeptide of SEQ ID NO: 6.

[0043] In a further embodiment of the present invention, the transaminase polypeptide used in a process of the invention comprises an amino acid sequence having at least 80% sequence identity to the reference polypeptide of SEQ ID NO: 6 and an amino acid residue difference as compared to SEQ ID NO: 6 at one or more of the following positions: X2; X4; X5; X7; X8; X9; X10; X11; X14; X22; X28; X37; X38; X41; X42; X44; X52; X54; X55; X56; X58; X69; X94; X99; X108; X124; X126; X135; X136; X141; X142; X150; X155; X156; X157; X164; X165; X171; X182; X199; X209; X210; X213; X215; X217; X218; X223; X245; X257; X265; X267; X296; and X328. In some embodiments of the instant process, the amino acid residue differences of the transaminase polypeptide as compared to SEQ ID NO: 6 are selected from the following: X2K; X2Q; X2S; X4I; X4L; X5H; X5I; X5L; X5N; X5S; X5T; X5V; X7A; X8T; X9N; X9Q; X9S; X10V; X11K; X14R; X22I; X28P; X37R; X38G; X41F; X42A; X44Q; X44V; X52K; X54K; X54N; X54P; X54R; X55L; X56G; X56L; X56S; X58L; X69C; X69V; X69W; X94L; X99L; X108V; X124F; X124I; X124L; X124R; X124V; X126A; X126T; X135Q; X136W; X141L; X142R; X142T; X150A; X150F; X150N; X155A; X156A; X156F; X156G; X156S; X156T; X157L; X164A; X165N; X171A; X182T; X199F; X199R; X199Y; X209C; X209D; X209E; X210S; X213P; X215F; X215Y; X217S; X218M; X223I; X223L; X223M; X223N; X245S; X257F; X265T; X267V; X296S; and X328I.

[0044] In some embodiments of the instant process, the transaminase polypeptide comprises one or more combinations of amino acid differences as compared to SEQ ID NO: 6 selected

from the following: (a) X124V and X210S; (b) X124V, X136W and X210S; (c) X69V and X136W; (d) X69V and X215Y; (e) X69V and X217S; (f) X69V, X124I and X136W; (g) X69V, X136W and X257F; (h) X44V and X223N; (i) X56S, X69V, X136W and X265T; and (j) X28P, X69V and X136W.

[0045] Exemplary engineered polypeptides having various combinations of amino acid differences resulting in improved properties are provided in the sequence listing incorporated by reference herein and include the polypeptides as set forth in SEQ ID NO: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206. Exemplary polynucleotide sequences encoding these transaminases are provided in the sequence listing incorporated by reference herein and include the polynucleotides as set forth in SEQ ID NO: 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, and 205.

[0046] Thus, in another embodiment, a transaminase polypeptide utilized in the process of the present invention comprises the amino acid sequence as set forth in SEQ ID NOs: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, or 206.

[0047] In a further embodiment of the instant process, a transaminase polypeptide having an amino acid sequence as set forth in SEQ ID NO: 18 is used. SEQ ID NO: 18 has the following amino acid differences relative to SEQ ID NO: 6: T69V, S124I and F136W

[0048] In a further embodiment of the instant process, a transaminase polypeptide having a polynucleotide sequence as set forth in SEQ ID NO: 17 is used.

[0049] In a further embodiment of the instant process, a transaminase polypeptide having an amino acid sequence as set forth in SEQ ID NO: 180 is used. SEQ ID NO: 180 has the following amino acid differences relative to SEQ ID NO: 6: A2S, A5H, T69V, S124I, F136W and C215F.

[0050] In a further embodiment of the instant process, a transaminase polypeptide having a polynucleotide sequence as set forth in SEQ ID NO: 179 is used.

[0051] In addition to the exemplary engineered polypeptides described herein, the process of the present disclosure can be carried out using engineered transaminase polypeptides having improved enzymatic properties (e.g., as disclosed above) and comprising further modifications of the amino acid sequence. Such engineered polypeptides can be derived from the exemplary polypeptides and have amino acid sequences retaining some percent identity to the exemplary engineered polypeptides and one or more of the amino acid differences relative to SEQ ID NO: 6 that are associated with the improved enzymatic property. Techniques and methods for deriving further engineered polypeptides are known in the art and include the methods of directed evolution as described herein. Any of the exemplary engineered polypeptides can be used as the starting amino acid sequence (*i.e.*, the "backbone" sequence) for subsequent rounds of evolution in which a library of genes encoding additional amino acid differences in the backbone is synthesized, expressed, and screened in high-throughput for particular improved properties (e.g., thermostability, total substrate conversion, stereoselectivity, etc.). The design of the libraries can be controlled such that only certain amino acid positions are allowed to change, while others are not. Thus, a backbone set of amino acid differences that are associated with improved properties can be maintained throughout the directed evolution process. The most improved engineered polypeptides from each round could then be used as the parent "backbone" sequence for subsequent rounds of evolution. The resulting engineered transaminase polypeptides, having further improvements in its properties, will retain some or all of the starting backbone amino acid differences and include new amino acid differences, typically while retaining an overall sequence identity to the starting backbone of at least 80%. It is contemplated, however, that one or more of the backbone amino acid differences can be changed during the directed evolution process leading to further improved properties in the engineered polypeptides. Further improvements at later rounds of evolution such as "fine tuning" an engineered polypeptide for certain process conditions (e.g., solvent conditions/concentrations, increased substrate and/or coenzyme loading, pH, and temperature changes) may be generated by including amino acid differences at positions that had been maintained as unchanged throughout earlier rounds of evolution.

[0052] In some embodiments, the engineered transaminase polypeptides useful in the process of the instant invention comprise an amino acid sequence having at least 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to a reference amino acid sequence selected from any one of SEQ ID NO: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206. The amino acid sequence can include one or more residue differences as compared to SEQ ID NO:6 at the following residue positions: X2; X4; X5; X7; X8; X9; X10; X11; X14; X22; X28; X37; X38; X41; X42; X44; X52; X54; X55; X56; X58; X69; X94; X99; X108; X124; X126; X135; X136; X141; X142; X150; X155; X156; X157; X164; X165; X171; X182; X199; X209; X210; X213; X215; X217; X218; X223; X245; X257; X265; X267; X296; and X328. The amino acid sequence can include one or more residue differences as compared to SEQ ID NO:6 selected from the following: X2K; X2Q; X2S;

X4I; X4L; X5H; X5I; X5L; X5N; X5S; X5T; X5V; X7A; X8T; X9N; X9Q; X9S; X10V; X11K; X14R; X22I; X28P; X37R; X38G; X41F; X42A; X44Q; X44V; X52K; X54K; X54N; X54P; X54R; X55L; X56G; X56L; X56S; X58L; X69C; X69V; X69W; X94L; X99L; X108V; X124F; X124I; X124L; X124R; X124V; X126A; X126T; X135Q; X136W; X141L; X142R; X142T; X150A; X150F; X150N; X155A; X156A; X156F; X156G; X156S; X156T; X157L; X164A; X165N; X171A; X182T; X199F; X199R; X199Y; X209C; X209D; X209E; X210S; X213P; X215F; X215Y; X217S; X218M; X223I; X223L; X223M; X223N; X245S; X257F; X265T; X267V; X296S; and X328I.

[0053] In some embodiments, the engineered transaminase polypeptides useful in the process of the instant invention comprise an amino acid sequence having at least 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to a reference amino acid sequence selected from any one of SEQ ID NO: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206; and further comprises one or more combinations of amino acid differences as compared to SEQ ID NO: 6 selected from the following: (a) X124V and X210S; (b) X124V, X136W and X210S; (c) X69V and X136W; (d) X69V and X215Y; (e) X69V and X217S; (f) X69V, X124I and X136W; (g) X69V, X136W and X257F; (h) X44V and X223N; (i) X56S, X69V, X136W and X265T; and (j) X28P, X69V and X136W. In addition to one or more of the above combinations, the engineered polypeptide amino acid sequence can further comprise one or more amino acid residue differences as compared to SEQ ID NO: 6 selected from the following: X2K; X2Q; X2S; X4I; X4L; X5H; X5I; X5L; X5N; X5S; X5T; X5V; X54K; X54N; X54P; X54R; X56G; X94L; X124I; X126A; X126T; X150A; X150N; X156S; X215F; and X267V.

[0054] In some embodiments, the engineered transaminase polypeptides useful in the process of the instant invention comprise an amino acid sequence having at least 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to a reference amino acid sequence selected from any one of SEQ ID NO: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206; comprises an amino acid difference as compared to SEQ ID NO: 6 at one or more of the following positions: X28; X69; X124; X126; X136; X150; X156; X199; X209; X215; X217; and X223; and further comprises an amino acid difference as compared to SEQ ID NO: 6 at one or more of the following positions: X2; X4; X5; X7; X8; X9; X10; X11; X14; X22; X37; X38; X41; X42; X44; X52; X54; X55; X56; X58; X94; X99; X108; X126; X135; X141; X142; X155; X157; X164; X165; X171; X182; X210; X213; X218; X245; X257; X265; X267; X296; and X328. In some embodiments, the amino acid differences as compared to SEQ ID NO: 6 at positions X28; X69; X124; X126; X136; X150; X156; X199; X209; X215; X217; and/or X223, are selected from the following: X28P; X69C; X69V; X69W;

X124F; X124I; X124L; X124R; X124V; X126A; X126T; X136W; X150A; X150N; X156S; X199F; X199R; X199Y; X209C; X209D; X209E; X215F; X215Y; X217S; X223I; X223L; X223M; and X223N. In other embodiments, the amino acid differences of the transaminase polypeptide as compared to SEQ ID NO: 6 at positions X28; X69; X124; X126; X136; X150; X156; X199; X209; X215; X217; and/or X223 are selected from the following: X28P; X69C; X136W; X150N; X156S; X199F; X199Y; and X217S. In some embodiments of the process, the amino acid differences of the transaminase polypeptide as compared to SEQ ID NO: 6 at positions X2; X4; X5; X7; X8; X9; X10; X11; X14; X22; X37; X38; X41; X42; X44; X52; X54; X55; X56; X58; X94; X99; X108; X135; X141; X142; X155; X157; X164; X165; X171; X182; X210; X213; X218; X245; X257; X265; X267; X296; and X328 are selected from: X2K; X2Q; X2S; X4I; X4L; X5H; X5I; X5L; X5N; X5S; X5T; X5V; X7A; X8T; X9N; X9Q; X9S; X10V; X11K; X14R; X22I; X37R; X38G; X41F; X42A; X44Q; X44V; X52K; X54K; X54N; X54P; X54R; X55L; X56G; X56L; X56S; X58L; X94L; X99L; X108V; X135Q; X141L; X142R; X142T; X155A; X156A; X156F; X156G; X156S; X156T; X157L; X164A; X165N; X171A; X182T; X210S; X213P; X218M; X245S; X257F; X265T; X267V; X296S; and X328I.

[0055] In some embodiments, the instant process uses a non-naturally occurring polypeptide comprising an amino acid sequence having at least 80%, 85%, 86%, 87%, 88%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to SEQ ID NO: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206; and further comprises the set of one or more amino acid residue differences as compared to SEQ ID NO:6 found in any one of SEQ ID NO: 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206.

[0056] Amino acid residue differences at other positions relative to the wild-type sequence of SEQ ID NO: 2 and the affect of these differences on enzyme function are provide by other engineered transaminase polypeptides disclosed in US application Serial No. 12/714,397, filed February 26, 2010. One or more of the amino acid differences as compared to the wild-type sequence of SEQ ID NO: 2, provided in the engineered transaminase polypeptide amino acid sequences of US application Serial No. 12/714,397, filed February 26, 2010 (see e.g., Table 2 of US application Serial No. 12/714,397), could also be introduced into a engineered transaminase polypeptide of the present disclosure.

[0057] The abbreviations used for the genetically encoded amino acids are conventional and are as follows:

Amino Acid	Three-Letter Abbreviation	One-Letter Abbreviation
Alanine	Ala	A
Arginine	Arg	R
Asparagine	Asn	N
Aspartate	Asp	D
Cysteine	Cys	C
Glutamate	Glu	E
Glutamine	Gln	Q
Glycine	Gly	G
Histidine	HIS	H
Isoleucine	Ile	I
Leucine	Leu	L
Lysine	Lys	K
Methionine	Met	M
Phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valine	Val	V

[0058] When the three-letter abbreviations are used, unless specifically preceded by an "L" or a "D" or clear from the context in which the abbreviation is used, the amino acid may be in either the L- or D-configuration about α -carbon (C_α). For example, whereas "Ala" designates alanine without specifying the configuration about the α -carbon, "D-Ala" and "L-Ala" designate D-alanine and L-alanine, respectively. When the one-letter abbreviations are used, upper case letters designate amino acids in the L-configuration about the α -carbon and lower case letters designate amino acids in the D-configuration about the α -carbon. For example, "A" designates L-alanine and "a" designates D-alanine. When polypeptide sequences are presented as a string of one-letter or three-letter abbreviations (or mixtures thereof), the sequences are presented in the amino (N) to carboxy (C) direction in accordance with common convention.

[0059] The abbreviations used for the genetically encoding nucleosides are conventional and are as follows: adenosine (A); guanosine (G); cytidine (C); thymidine (T); and uridine (U). Unless specifically delineated, the abbreviated nucleotides may be either ribonucleosides or 2'-deoxyribonucleosides. The nucleosides may be specified as being either ribonucleosides or 2'-deoxyribonucleosides on an individual basis or on an aggregate basis. When nucleic acid

sequences are presented as a string of one-letter abbreviations, the sequences are presented in the 5' to 3' direction in accordance with common convention, and the phosphates are not indicated. In addition, the following terms are defined as:

"Naturally-occurring" or "wild-type" refers to the form found in nature. For example, a naturally occurring or wild-type polypeptide or polynucleotide sequence is a sequence that can be isolated from a source in nature and which has not been intentionally modified by human manipulation.

[0060] "Derived from" as used herein in the context of engineered transaminase enzymes, identifies the originating transaminase enzyme, and/or the gene encoding such transaminase enzyme, upon which the engineering was based. For example, the engineered transaminase enzyme of SEQ ID NO:34 was obtained by artificially evolving, over multiple generations the gene encoding the *Arthrobacter sp. KNK168* transaminase enzyme of SEQ ID NO:2. Thus, this engineered transaminase enzyme is "derived from" the wild-type transaminase of SEQ ID NO:2.

[0061] "Control sequence" is defined herein to include all components, which are necessary or advantageous for the expression of a polynucleotide and/or polypeptide of the present disclosure. Each control sequence may be native or foreign to the nucleic acid sequence encoding the polypeptide. Such control sequences include, but are not limited to, a leader, polyadenylation sequence, propeptide sequence, promoter, signal peptide sequence, and transcription terminator. At a minimum, the control sequences include a promoter, and transcriptional and translational stop signals. The control sequences may be provided with linkers for the purpose of introducing specific restriction sites facilitating ligation of the control sequences with the coding region of the nucleic acid sequence encoding a polypeptide.

[0062] "Recombinant" or "engineered" or "non-naturally occurring" when used with reference to, e.g., a cell, nucleic acid, or polypeptide, refers to a material, or a material corresponding to the natural or native form of the material, that has been modified in a manner that would not otherwise exist in nature, or is identical thereto but produced or derived from synthetic materials and/or by manipulation using recombinant techniques. Non-limiting examples include, among others, recombinant cells expressing genes that are not found within the native (non-recombinant) form of the cell or express native genes that are otherwise expressed at a different level.

[0063] "Percentage of sequence identity" and "percentage homology" are used interchangeably herein to refer to comparisons among polynucleotides and polypeptides, and are determined by comparing two optimally aligned sequences over a comparison window, wherein the portion of the polynucleotide or polypeptide sequence in the comparison window may comprise additions or deletions (*i.e.*, gaps) as compared to the reference sequence for optimal alignment of the two sequences. The percentage may be calculated by determining the number of positions at which the identical nucleic acid base or amino acid residue occurs in

both sequences to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the window of comparison and multiplying the result by 100 to yield the percentage of sequence identity. Alternatively, the percentage may be calculated by determining the number of positions at which either the identical nucleic acid base or amino acid residue occurs in both sequences or a nucleic acid base or amino acid residue is aligned with a gap to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the window of comparison and multiplying the result by 100 to yield the percentage of sequence identity. Those of skill in the art appreciate that there are many established algorithms available to align two sequences. Optimal alignment of sequences for comparison can be conducted, e.g., by the local homology algorithm of Smith and Waterman, 1981, *Adv. Appl. Math.* 2:482, by the homology alignment algorithm of Needleman and Wunsch, 1970, *J. Mol. Biol.* 48:443, by the search for similarity method of Pearson and Lipman, 1988, *Proc. Natl. Acad. Sci. USA* 85:2444, by computerized implementations of these algorithms (GAP, BESTFIT, FASTA, and TFASTA in the GCG Wisconsin Software Package), or by visual inspection (see generally, *Current Protocols in Molecular Biology*, F. M. Ausubel et al., eds., Current Protocols, a joint venture between Greene Publishing Associates, Inc. and John Wiley & Sons, Inc., (1995 Supplement) (Ausubel)). Examples of algorithms that are suitable for determining percent sequence identity and sequence similarity are the BLAST and BLAST 2.0 algorithms, which are described in Altschul et al., 1990, *J. Mol. Biol.* 215: 403-410 and Altschul et al., 1977, *Nucleic Acids Res.* 3389-3402, respectively. Software for performing BLAST analyses is publicly available through the National Center for Biotechnology Information website. This algorithm involves first identifying high scoring sequence pairs (HSPs) by identifying short words of length W in the query sequence, which either match or satisfy some positive-valued threshold score T when aligned with a word of the same length in a database sequence. T is referred to as, the neighborhood word score threshold (Altschul et al, *supra*). These initial neighborhood word hits act as seeds for initiating searches to find longer HSPs containing them. The word hits are then extended in both directions along each sequence for as far as the cumulative alignment score can be increased. Cumulative scores are calculated using, for nucleotide sequences, the parameters M (reward score for a pair of matching residues; always >0) and N (penalty score for mismatching residues; always <0). For amino acid sequences, a scoring matrix is used to calculate the cumulative score. Extension of the word hits in each direction are halted when: the cumulative alignment score falls off by the quantity X from its maximum achieved value; the cumulative score goes to zero or below, due to the accumulation of one or more negative-scoring residue alignments; or the end of either sequence is reached. The BLAST algorithm parameters W , T , and X determine the sensitivity and speed of the alignment. The BLASTN program (for nucleotide sequences) uses as defaults a wordlength (W) of 11, an expectation (E) of 10, $M=5$, $N=-4$, and a comparison of both strands. For amino acid sequences, the BLASTP program uses as defaults a wordlength (W) of 3, an expectation (E) of 10, and the BLOSUM62 scoring matrix (see Henikoff and Henikoff, 1989, *Proc. Natl. Acad. Sci. USA* 89:10915). Exemplary determination of sequence alignment and % sequence identity can employ the BESTFIT or GAP programs in the GCG Wisconsin Software package (Accelrys, Madison WI), using default parameters provided.

[0064] "Reference sequence" refers to a defined sequence used as a basis for a sequence comparison. A reference sequence may be a subset of a larger sequence, for example, a segment of a full-length gene or polypeptide sequence. Generally, a reference sequence is at least 20 nucleotide or amino acid residues in length, at least 25 residues in length, at least 50 residues in length, or the full length of the nucleic acid or polypeptide. Since two polynucleotides or polypeptides may each (1) comprise a sequence (*i.e.*, a portion of the complete sequence) that is similar between the two sequences, and (2) may further comprise a sequence that is divergent between the two sequences, sequence comparisons between two (or more) polynucleotides or polypeptide are typically performed by comparing sequences of the two polynucleotides or polypeptides over a "comparison window" to identify and compare local regions of sequence similarity. A "reference sequence" can be based on a primary amino acid sequence, where the reference sequence is a sequence that can have one or more changes in the primary sequence. For instance, a "reference sequence based on SEQ ID NO:2 having at the residue corresponding to X9 a threonine" refers to a reference sequence in which the corresponding amino acid residue at X9 in SEQ ID NO:2, which is an alanine, has been changed to threonine.

[0065] "Comparison window" refers to a conceptual segment of at least about 20 contiguous nucleotide positions or amino acids residues wherein a sequence may be compared to a reference sequence of at least 20 contiguous nucleotides or amino acids and wherein the portion of the sequence in the comparison window may comprise additions or deletions (*i.e.*, gaps) of 20 percent or less as compared to the reference sequence (which does not comprise additions or deletions) for optimal alignment of the two sequences. The comparison window can be longer than 20 contiguous residues, and includes, optionally 30, 40, 50, 100, or longer windows.

[0066] "Corresponding to," "reference to" or "relative 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 the reference sequence. In other words, the residue number or residue position of a given polymer is designated with respect to the reference sequence rather than by the actual numerical position of the residue within the given amino acid or polynucleotide sequence. For example, a given amino acid sequence, such as that of an engineered transaminase, can be aligned to a reference sequence by introducing gaps to optimize residue matches between the two sequences. In these cases, although the gaps are present, the numbering of the residue in the given amino acid or polynucleotide sequence is made with respect to the reference sequence to which it has been aligned.

[0067] "Amino acid difference" or "residue difference" refers to a change in the amino acid residue at a position of a polypeptide sequence relative to the amino acid residue at a corresponding position in a reference sequence. The positions of amino acid differences generally are referred to herein as "X_n," where n refers to the corresponding position in the reference sequence upon which the residue difference is based. For example, a "residue difference at position X3 as compared to SEQ ID NO: 2" refers to a change of the amino acid

residue at the polypeptide position corresponding to position 3 of SEQ ID NO:2. Thus, if the reference polypeptide of SEQ ID NO: 2 has a glutamine at position 3, then a "residue difference at position X3 as compared to SEQ ID NO:2" is an amino acid substitution of any residue other than glutamine at the position of the polypeptide corresponding to position 3 of SEQ ID NO: 2. In most instances herein, the specific amino acid residue difference at a position is indicated as "XnY" where "Xn" specified the corresponding position as described above, and "Y" is the single letter identifier of the amino acid found in the engineered polypeptide (*i.e.*, the different residue than in the reference polypeptide). In some instances, the present disclosure also provides specific amino acid differences denoted by the conventional notation "AnB", where A is the single letter identifier of the residue in the reference sequence, "n" is the number of the residue position in the reference sequence, and B is the single letter identifier of the residue substitution in the sequence of the engineered polypeptide. In some instances, a polypeptide can include one or more amino acid residue differences relative to a reference sequence, which is indicated by a list of the specified positions where changes are made relative to the reference sequence. The present process may use engineered polypeptide sequences which comprise one or more amino acid differences that include either/or both conservative and non-conservative amino acid substitutions.

[0068] "Conservative amino acid substitution" refers to a substitution of a residue with a different residue having a similar side chain, and thus typically involves substitution of the amino acid in the polypeptide with amino acids within the same or similar defined class of amino acids. By way of example and not limitation, an amino acid with an aliphatic side chain may be substituted with another aliphatic amino acid, *e.g.*, alanine, valine, leucine, and isoleucine; an amino acid with hydroxyl side chain is substituted with another amino acid with a hydroxyl side chain, *e.g.*, serine and threonine; an amino acids having aromatic side chains is substituted with another amino acid having an aromatic side chain, *e.g.*, phenylalanine, tyrosine, tryptophan, and histidine; an amino acid with a basic side chain is substituted with another amino acid with a basis side chain, *e.g.*, lysine and arginine; an amino acid with an acidic side chain is substituted with another amino acid with an acidic side chain, *e.g.*, aspartic acid or glutamic acid; and a hydrophobic or hydrophilic amino acid is replaced with another hydrophobic or hydrophilic amino acid, respectively. Exemplary conservative substitutions are provided in **Table 1** below:

Table 1

Residue	Possible Conservative Substitutions
A, L, V, I	Other aliphatic (A, L, V, I)
	Other non-polar (A, L, V, I, G, M)
G, M	Other non-polar (A, L, V, I, G, M)
D, E	Other acidic (D, E)
K, R	Other basic (K, R)
N, Q, S, T	Other polar
H, Y, W, F	Other aromatic (H, Y, W, F)

Residue	Possible Conservative Substitutions
C, P	None

[0069] "Non-conservative substitution" refers to substitution of an amino acid in the polypeptide with an amino acid with significantly differing side chain properties. Non-conservative substitutions may use amino acids between, rather than within, the defined groups and affects (a) the structure of the peptide backbone in the area of the substitution (e.g., proline for glycine) (b) the charge or hydrophobicity, or (c) the bulk of the side chain. By way of example and not limitation, an exemplary non-conservative substitution can be an acidic amino acid substituted with a basic or aliphatic amino acid; an aromatic amino acid substituted with a small amino acid; and a hydrophilic amino acid substituted with a hydrophobic amino acid.

[0070] In some embodiments, the present process uses engineered transaminase polypeptides that comprise a polypeptide fragment of any of the engineered transaminase polypeptides described herein that retains the functional activity and/or improved property of that engineered transaminase. A polypeptide fragment that may be capable of asymmetric synthesis of compounds of formula I from compounds of formula II via biocatalytic transamination include fragments comprising at least about 80%, 90%, 95%, 98%, or 99% of a full-length amino acid sequence of an exemplary engineered transaminase polypeptide of SEQ ID NO: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206.

[0071] In some embodiments, the process of the instant invention uses an engineered transaminase polypeptide having an amino acid sequence comprising a deletion as compared to any one of the engineered transaminase polypeptides described herein, such as the exemplary engineered polypeptides of SEQ ID NO: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206. Thus, for each and every embodiment of the engineered transaminase polypeptides of the present process, the amino acid sequence can comprise deletions of one or more amino acids, 2 or more amino acids, 3 or more amino acids, 4 or more amino acids, 5 or more amino acids, 6 or more amino acids, 8 or more amino acids, 10 or more amino acids, 15 or more amino acids, or 20 or more amino acids, up to 10% of the total number of amino acids, up to 20% of the total number of amino acids, or up to 30% of the total number of amino acids of the transaminase polypeptides, where the associated functional activity and/or improved properties of the engineered transaminase is maintained. The deletions can comprise, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9, 1-10, 1-15, 1-20, 1-21, 1-22, 1-

23, 1-24, 1-25, 1-30, 1-35, 1-40, 1-45, 1-50, 1-55, or 1-60 amino acid residues. The number of deletions can be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, 50, 55, or 60 amino acids. In some embodiments, the deletions can comprise deletions of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25 or 30 amino acid residues.

[0072] In some embodiments, the process uses an engineered transaminase polypeptide having an amino acid sequence comprising an insertion as compared to any one of the engineered transaminase polypeptides described herein, such as the exemplary engineered polypeptides of SEQ ID NO: 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, and 206. Thus, for each embodiment of the transaminase polypeptides utilized in the instant process, the insertions can comprise one or more amino acids, 2 or more amino acids, 3 or more amino acids, 4 or more amino acids, 5 or more amino acids, 6 or more amino acids, 8 or more amino acids, 10 or more amino acids, 15 or more amino acids, or 20 or more amino acids, where the associated functional activity and/or improved properties of the engineered transaminase described herein is maintained. The insertions can be to amino or carboxy terminus of the transaminase, or internal portions of the transaminase polypeptide.

[0073] "Deletion" refers to modification to the polypeptide by removal of one or more amino acids from the reference polypeptide. Deletions can comprise removal of 1 or more amino acids, 2 or more amino acids, 5 or more amino acids, 10 or more amino acids, 15 or more amino acids, or 20 or more amino acids, up to 10% of the total number of amino acids, or up to 20% of the total number of amino acids making up the reference enzyme while retaining enzymatic activity and/or retaining the improved properties of an engineered transaminase enzyme or polypeptide. Deletions can be directed to the internal portions and/or terminal portions of the polypeptide. The deletion can comprise a continuous segment or can be discontinuous.

[0074] "Insertion" refers to modification to the polypeptide by addition of one or more amino acids from the reference polypeptide. The improved engineered transaminase enzymes comprise insertions of one or more amino acids to the naturally occurring transaminase polypeptide as well as insertions of one or more amino acids to other improved transaminase polypeptides. Insertions can be in the internal portions of the polypeptide, or to the carboxy or amino terminus. Insertions as used herein include fusion proteins as is known in the art. The insertion can be a contiguous segment of amino acids or separated by one or more of the amino acids in the naturally occurring polypeptide.

[0075] "Fragment" as used herein refers to a polypeptide that has an amino-terminal and/or carboxy-terminal deletion, but where the remaining amino acid sequence is identical to the corresponding positions in the sequence. Fragments can be at least 14 amino acids long, at

least 20 amino acids long, at least 50 amino acids long or longer, and up to 70%, 80%, 90%, 95%, 98%, and 99% of the full-length transaminase polypeptide, for example the polypeptide of SEQ ID NO:2 or an engineered transaminase.

[0076] In some embodiments, the transaminase polypeptides of the instant process can be in the form of fusion polypeptides in which the engineered polypeptides are fused to other polypeptides, such as, by way of example and not limitation, antibody tags (*e.g.*, myc epitope), purification sequences (*e.g.*, His-tags for binding to metals), and cell localization signals (*e.g.*, secretion signals). Thus, the engineered polypeptides described herein can be used with or without fusions to other polypeptides.

[0077] The engineered transaminase polypeptides described herein are not restricted to the genetically encoded amino acids. In addition to the genetically encoded amino acids, the polypeptides described herein may be comprised, either in whole or in part, of naturally-occurring and/or synthetic non-encoded amino acids. Certain commonly encountered non-encoded amino acids of which the polypeptides described herein may be comprised include, but are not limited to: the D-stereoisomers of the genetically-encoded amino acids; 2,3-diaminopropionic acid (Dpr); α -aminoisobutyric acid (Aib); ϵ -aminohexanoic acid (Aha); δ -aminovaleric acid (Ava); N-methylglycine or sarcosine (MeGly or Sar); ornithine (Orn); citrulline (Cit); t-butylalanine (Bua); t-butylglycine (Bug); N-methylisoleucine (Melle); phenylglycine (Phg); cyclohexylalanine (Cha); norleucine (Nle); naphthylalanine (Nal); 2-chlorophenylalanine (Ocf); 3-chlorophenylalanine (Mcf); 4-chlorophenylalanine (Pcf); 2-fluorophenylalanine (Off); 3-fluorophenylalanine (Mff); 4-fluorophenylalanine (Pff); 2-bromophenylalanine (Obf); 3-bromophenylalanine (Mbf); 4-bromophenylalanine (Pbf); 2-methylphenylalanine (Omf); 3-methylphenylalanine (Mmf); 4-methylphenylalanine (Pmf); 2-nitrophenylalanine (Onf); 3-nitrophenylalanine (Mnf); 4-nitrophenylalanine (Pnf); 2-cyanophenylalanine (Ocf); 3-cyanophenylalanine (Mcf); 4-cyanophenylalanine (Pcf); 2-trifluoromethylphenylalanine (Otf); 3-trifluoromethylphenylalanine (Mtf); 4-trifluoromethylphenylalanine (Ptf); 4-aminophenylalanine (Paf); 4-iodophenylalanine (Pif); 4-aminomethylphenylalanine (Pamf); 2,4-dichlorophenylalanine (Opef); 3,4-dichlorophenylalanine (Mpcf); 2,4-difluorophenylalanine (Opff); 3,4-difluorophenylalanine (Mpff); pyrid-2-ylalanine (2pAla); pyrid-3-ylalanine (3pAla); pyrid-4-ylalanine (4pAla); naphth-1-ylalanine (1nAla); naphth-2-ylalanine (2nAla); thiazolylalanine (taAla); benzothienylalanine (bAla); thienylalanine (tAla); furylalanine (fAla); homophenylalanine (hPhe); homotyrosine (hTyr); homotryptophan (hTrp); pentafluorophenylalanine (5ff); styrylalanine (sAla); authrylalanine (aAla); 3,3-diphenylalanine (Dfa); 3-amino-5-phenylpentanoic acid (Afp); penicillamine (Pen); 1,2,3,4-tetrahydroisoquinoline-3-carboxylic acid (Tic); β -2-thienylalanine (Thi); methionine sulfoxide (Mso); N(w)-nitroarginine (nArg); homolysine (hLys); phosphonomethylphenylalanine (pmPhe); phosphoserine (pSer); phosphothreonine (pThr); homoaspartic acid (hAsp); homoglutamic acid (hGlu); 1-aminocyclopent-(2 or 3)-ene-4 carboxylic acid; pipecolic acid (PA), azetidine-3-carboxylic acid (ACA); 1-aminocyclopentane-3-carboxylic acid; allylglycine (aOly); propargylglycine (pgGly); homoalanine (hAla); norvaline (nVal); homoleucine (hLeu), homovaline (hVal); homoisoleucine (hIle); homoarginine (hArg); N-acetyl lysine (AcLys); 2,4-diaminobutyric acid (Dbu); 2,3-diaminobutyric acid (Dab); N-methylvaline (MeVal);

homocysteine (hCys); homoserine (hSer); hydroxyproline (Hyp) and homoproline (hPro). Additional non-encoded amino acids of which the polypeptides described herein may be comprised will be apparent to those of skill in the art (see, e.g., the various amino acids provided in Fasman, 1989, CRC Practical Handbook of Biochemistry and Molecular Biology, CRC Press, Boca Raton, FL, at pp. 3-70 and the references cited therein, all of which are incorporated by reference). These amino acids may be in either the L- or D-configuration. Those of skill in the art will recognize that amino acids or residues bearing side chain protecting groups may also comprise the polypeptides described herein. Non-limiting examples of such protected amino acids, which in this case belong to the aromatic category, include (protecting groups listed in parentheses), but are not limited to: Arg(tos), Cys(methylbenzyl), Cys (nitropyridinesulfenyl), Glu(δ -benzylester), Gln(xanthyl), Asn(N- δ -xanthyl), His(bom), His(benzyl), His(tos), Lys(fmoc), Lys(tos), Ser(O-benzyl), Thr (O-benzyl) and Tyr(O-benzyl).

[0078] Non-encoding amino acids that are conformationally constrained of which the polypeptides described herein may be composed include, but are not limited to, N-methyl amino acids (L-configuration); 1-aminocyclopent-(2 or 3)-ene-4-carboxylic acid; pipercolic acid; azetidine-3-carboxylic acid; homoproline (hPro); and 1-aminocyclopentane-3-carboxylic acid. As described above the various modifications introduced into the naturally occurring polypeptide to generate an engineered transaminase enzyme can be targeted to a specific property of the enzyme.

[0079] In some embodiments, the transaminase polypeptides used in the instant process are bound to a substrate. The transaminase polypeptide can be bound non-covalently or covalently. Various methods for conjugation to substrates, e.g., membranes, beads, glass, etc. are described in, among others, Hermanson, G.T., Bioconjugate Techniques, Second Edition, Academic Press; (2008), and Bioconjugation Protocols: Strategies and Methods, In Methods in Molecular Biology, C.M. Niemeyer ed., Humana Press (2004). The polynucleotides encoding the exemplary engineered transaminases useful in the present process are selected from SEQ ID NO: 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, and 205. These polynucleotides may be manipulated in a variety of ways well-known in the art to provide for expression of the engineered polypeptides, including further sequence alteration by codon-optimization to improve expression, insertion in a suitable expression with or without further control sequences, and transformation into a host cell suitable for expression and production of the polypeptide, as further described in detail in PCT International application serial no. PCT/US2011/046932, *supra*.

[0080] To make the transaminase polynucleotides and polypeptides for use in the present process, the naturally-occurring transaminase enzyme that catalyzes the transamination reaction can be obtained (or derived) from *Arthrobacter sp. KNK168*. In some embodiments, the parent polynucleotide sequence is codon optimized to enhance expression of the

transaminase in a specified host cell. The parental polynucleotide sequence encoding the wild-type polypeptide of *Arthrobacter sp. KNK168* has been described (see e.g., Iwasaki et al., Appl. Microbiol. Biotechnol., 2006, 69: 499-505). Preparation of engineered transaminases based on this parental sequence are also described in US application Serial No. 12/714,397, filed February 26, 2010 and International application PCT/US2010/025685, filed February 26, 2010.

[0081] The engineered transaminases can be obtained by subjecting the polynucleotide encoding the naturally occurring transaminase to mutagenesis and/or directed evolution methods, as discussed above. An exemplary directed evolution technique is mutagenesis and/or DNA shuffling as described in Stemmer, 1994, Proc Natl Acad Sci USA 91:10747-10751; WO 95/22625; WO 97/0078; WO 97/35966; WO 98/27230; WO 00/42651; WO 01/75767 and U.S. Pat. 6,537,746. Other directed evolution procedures that can be used include, among others, staggered extension process (StEP), in vitro recombination (Zhao et al., 1998, Nat. Biotechnol. 16:258-261), mutagenic PCR (Caldwell et al., 1994, PCR Methods Appl. 3:S136-S140), and cassette mutagenesis (Black et al., 1996, Proc Natl Acad Sci USA 93:3525-3529). Mutagenesis and directed evolution techniques useful for the purposes herein are also described in e.g., Ling, et al., 1997, Anal. Biochem. 254(2):157-78; Dale et al., 1996, Methods Mol. Biol. 57:369-74; Smith, 1985, Ann. Rev. Genet. 19:423-462; Botstein et al., 1985, Science 229:1193-1201; Carter, 1986, Biochem. J. 237:1-7; Kramer et al., 1984, Cell, 38:879-887; Wells et al., 1985, Gene 34:315-323; Minshull et al., 1999, Curr Opin Chem Biol 3:284-290; Christians et al., 1999, Nature Biotech 17:259-264; Crameri et al., 1998, Nature 391:288-291; Crameri et al., 1997, Nature Biotech 15:436-438; Zhang et al., 1997, Proc Natl Acad Sci USA 94:45-4-4509; Crameri et al., 1996, Nature Biotech 14:315-319; Stemmer, 1994, Nature 370:389-391; Stemmer, 1994, Proc Natl Acad Sci USA 91:10747-10751; PCT Publ. Nos. WO 95/22625, WO 97/0078, WO 97/35966, WO 98/27230, WO 00/42651, and WO 01/75767; and U.S. Pat. No. 6,537,746.

[0082] The clones obtained following mutagenesis treatment can be screened for engineered transaminases having a desired improved enzyme property. Measuring enzyme activity from the expression libraries can be performed using the standard biochemistry techniques, such as HPLC analysis following OPA derivatization of the product amine (see, e.g., PCT/US2011/046932; *supra*).

[0083] Where the improved enzyme property desired is thermostability, enzyme activity may be measured after subjecting the enzyme preparations to a defined temperature and measuring the amount of enzyme activity remaining after heat treatments. Clones containing a polynucleotide encoding a transaminase are then isolated, sequenced to identify the nucleotide sequence changes (if any), and used to express the enzyme in a host cell.

[0084] "Improved enzyme property" refers to a transaminase polypeptide that exhibits an improvement in any enzyme property as compared to a reference transaminase. For the engineered transaminase polypeptides, the comparison is generally made to the wild-type transaminase enzyme, although in some embodiments, the reference transaminase can be another improved engineered transaminase. Enzyme properties for which improvement is

desirable include, but are not limited to, enzymatic activity (which can be expressed in terms of percent conversion of the substrate), thermostability, solvent stability, pH activity profile, coenzyme requirements, refractoriness to inhibitors (e.g., substrate or product inhibition), stereospecificity, and stereoselectivity (including enantioselectivity).

[0085] "Increased enzymatic activity" refers to an improved property of the engineered transaminase polypeptides, which can be represented by an increase in specific activity (e.g., product produced/time/weight protein) or an increase in percent conversion of the substrate to the product (e.g., percent conversion of starting amount of substrate to product in a specified time period using a specified amount of transaminase) as compared to the reference transaminase enzyme. Any property relating to enzyme activity may be affected, including the classical enzyme properties of K_m , V_{max} or k_{cat} , changes of which can lead to increased enzymatic activity. Improvements in enzyme activity can be from about 1.1 times the enzymatic activity of the corresponding wild-type transaminase enzyme, to as much as 2 times, 5 times, 10 times, 20 times, 25 times, 50 times, 75 times, 100 times, or more enzymatic activity than the naturally occurring transaminase or another engineered transaminase from which the transaminase polypeptides were derived. It is understood by the skilled artisan that the activity of any enzyme is diffusion limited such that the catalytic turnover rate cannot exceed the diffusion rate of the substrate, including any required coenzymes. The theoretical maximum of the diffusion limit, or k_{cat}/K_m , is generally about 10^8 to 10^9 ($M^{-1} s^{-1}$). Hence, any improvements in the enzyme activity of the transaminase will have an upper limit related to the diffusion rate of the substrates acted on by the transaminase enzyme.

[0086] Transaminase activity can be measured by any one of standard assays, such as by monitoring changes in spectrophotometric properties of reactants or products. The amount of products produced can be measured by High-Performance Liquid Chromatography (HPLC) separation combined with UV absorbance or fluorescent detection following o-phthaldialdehyde (OPA) derivatization. Comparisons of enzyme activities are made using a defined preparation of enzyme, a defined assay under a set condition, and one or more defined substrates, as further described in detail herein. Generally, when lysates are compared, the numbers of cells and the amount of protein assayed are determined as well as use of identical expression systems and identical host cells to minimize variations in amount of enzyme produced by the host cells and present in the lysates.

[0087] "Conversion" refers to the enzymatic conversion of the substrate(s) to the corresponding product(s). "Percent conversion" refers to the percent of the substrate that is converted to the product within a period of time under specified conditions. Thus, the "enzymatic activity" or "activity" of a transaminase polypeptide can be expressed as "percent conversion" of the substrate to the product.

[0088] "Thermostable" refers to a transaminase polypeptide that maintains similar activity (more than 60% to 80% for example) after exposure to elevated temperatures (e.g., 40-80°C) for a period of time (e.g., 0.5-24 hrs) compared to the wild-type enzyme.

[0089] "Solvent stable" refers to a transaminase polypeptide that maintains similar activity (more than *e.g.*, 60% to 80%) after exposure to varying concentrations (*e.g.*, 5-99%) of solvent (ethanol, isopropyl alcohol, dimethylsulfoxide (DMSO), tetrahydrofuran, 2-methyltetrahydrofuran, acetone, toluene, butyl acetate, methyl tert-butyl ether, etc.) for a period of time (*e.g.*, 0.5-24 hrs) compared to the wild-type enzyme.

[0090] "Thermo- and solvent stable" refers to a transaminase polypeptide that is both thermostable and solvent stable.

[0091] Where the sequence of the engineered polypeptide is known, the polynucleotides encoding the enzyme can be prepared by standard solid-phase methods, according to known synthetic methods. In some embodiments, fragments of up to about 100 bases can be individually synthesized, then joined (*e.g.*, by enzymatic or chemical ligation methods, or polymerase mediated methods) to form any desired continuous sequence. For example, polynucleotides and oligonucleotides of the disclosure can be prepared by chemical synthesis using, *e.g.*, the classical phosphoramidite method described by Beaucage et al., 1981, Tet Lett 22:1859-69, or the method described by Matthes et al., 1984, EMBO J. 3:801-05, *e.g.*, as it is typically practiced in automated synthetic methods. According to the phosphoramidite method, oligonucleotides are synthesized, *e.g.*, in an automatic DNA synthesizer, purified, annealed, ligated and cloned in appropriate vectors. In addition, essentially any nucleic acid can be obtained from any of a variety of commercial sources.

Reaction Conditions

[0092] As described further below, and illustrated in the Examples, the present process contemplates ranges of suitable reaction conditions that can be used in the enzymatic process disclosed, including but not limited to ranges of pH, temperature, buffer, solvent system, substrate loading, transaminase polypeptide loading, coenzyme loading, atmosphere, and reaction time. Further suitable reaction conditions for carrying out the method for the transaminase-catalyzed DKR of a compound formula II to form an asymmetric compound of formula I can be readily optimized by routine experimentation that includes contacting a transaminase polypeptide and substrate (compound of formula II) under experimental reaction conditions of concentration, pH, temperature, solvent conditions, and detecting the production of the compound of formula I using the methods described in the Examples provided herein.

[0093] "Suitable reaction conditions" refers to those conditions in the biocatalytic reaction solution (*e.g.*, ranges of enzyme loading, substrate loading, coenzyme loading, temperature, pH, buffers, co-solvents, etc.) under which a transaminase polypeptide is capable of converting a compound of formula II to a compound of formula I. Exemplary "suitable reaction conditions" are provided in the present disclosure and illustrated by the Examples.

[0094] "Substrate" in the context of a biocatalyst mediated process refers to the compound or

molecule acted on by the biocatalyst. An exemplary substrate for the transaminase biocatalyst in the processes disclosed herein is a compound of formula II.

[0095] The use of a lower concentration of transaminase polypeptide in a process of the invention may reduce the amount of residual protein that may need to be removed in subsequent steps for purification of the compound of formula I. In some embodiments of the process, the suitable reaction conditions comprise a transaminase polypeptide concentration of about 0.1 to about 15 g/L, about 0.5 to about 10 g/L, about 1.0 to about 5 g/L, about 2 to about 5 g/L, about 15 g/L, about 10 g/L, about 5, g/L, about 3 g/L, about 2 g/L, about 1.5 g/L, about 1.0 g/L, about 0.75 g/L, or even lower concentration.

[0096] In some embodiments of the process, the amino donor is isopropylamine (also referred to herein as "IPM" or "iPrNH₂"), putrescine, L-lysine, α -phenethylamine, D-alanine, L-alanine, or D,L-alanine, or D,L-ornithine. In some embodiments, the amino donor is IPM, putrescine, L-lysine, D- or L-alanine. In some embodiments, the amino donor is IPM. In some embodiments, the suitable reaction conditions comprise the amino donor at a concentration of at least about 0.5 M, at least about 1.0 M, at least about 2.5 M, at least about 5.0 M, at least about 7.5 M, at least about 10.0 M, or more.

[0097] Suitable reaction conditions for the process of the instant invention require a coenzyme. Engineered transaminases, as disclosed herein, may require far less coenzyme than reactions catalyzed with wild-type transaminase enzymes. Coenzymes useful in the disclosed methods include, but are not limited to, pyridoxal-5'-phosphate (also known as pyridoxal-phosphate, PLP, P5P). In some embodiments, the coenzyme is a member of the vitamin B6 family, selected from PLP, pyridoxine (PN), pyridoxal (PL), pyridoxamine (PM), and their phosphorylated counterparts; pyridoxine phosphate (PNP), and pyridoxamine phosphate (PMP). In some embodiments, the coenzyme is PLP. In some embodiments, the coenzyme is present naturally in the cell extract and does not need to be supplemented. In some embodiments of the methods, the suitable reaction conditions comprise coenzyme added to the enzyme reaction mixture. In some embodiments, the coenzyme is added either at the beginning of the reaction and/or additional coenzyme is added during the reaction.

[0098] In some embodiments of the process, the suitable reaction conditions can further comprise the presence of the reduced coenzyme, nicotinamide adenine dinucleotide (NADH), which can act to limit the inactivation of the transaminase enzyme (see, e.g., van Ophem et al., 1998, *Biochemistry* 37(9):2879-88). In such embodiments where NADH is present, a coenzyme regeneration system, such as glucose dehydrogenase (GDH) and glucose or formate dehydrogenase and formate can be used to regenerate the NADH in the reaction medium.

[0099] In some embodiments of the process, the suitable reaction conditions comprise a substrate compound of formula II loading of at least 5 g/L, at least 10 g/L, at least 15 g/L, at least 20 g/L, at least 30 g/L, at least 50 g/L, at least 75 g/L, at least 100 g/L, or even greater.

[0100] In certain embodiments of the process, the temperature of the suitable reaction conditions can be chosen to maximize the reaction rate at higher temperatures while maintaining the activity of the enzyme for sufficient duration for efficient synthesis. Where higher temperatures are used, polypeptides with increased thermostability can be selected to carry out the process. For example, the engineered polypeptides of the present disclosure have increased thermal stability relative to naturally occurring transaminase polypeptide *e.g.*, the wild type polypeptide of SEQ ID NO: 2. In some embodiments of the method the suitable reaction conditions comprise a temperature of between 25°C and 75°C, between 35°C and 65°C, between about 40°C and about 60°C, at least about 30°C, at least about 35°C, at least about 40°C, at least 45°C, or at least 50°C, or 60°C, or more. In certain embodiments, the temperature during the enzymatic reaction can be maintained at a temperature throughout the course of the reaction. In some embodiments, the temperature during the enzymatic reaction can be adjusted over a temperature profile during the course of the reaction.

[0101] The methods for preparing compounds of formula I of the present disclosure are generally carried out in a solvent. Suitable solvents include water, aqueous buffer solutions, organic solvents, and/or co-solvent systems, which generally comprise aqueous solvents and organic solvents. The aqueous solvent (water or aqueous co-solvent system) may be pH-buffered or unbuffered.

[0102] In certain embodiments, the process for preparing compounds of formula I of the present invention can be carried out with the pH of the reaction mixture and may be maintained at a desired pH or within a desired pH range by the addition of an acid or a base during the course of the reaction. In certain embodiments of the process, the pH of the reaction mixture may be allowed to change, or be changed during the course of the reaction. Thus, it is contemplated that in some embodiments the pH may be controlled by using an aqueous solvent that comprises a buffer. In some embodiments of the method, the suitable reaction conditions comprise a solution pH of between pH 8.5 and pH 11.5, between pH 9.0 and pH 11.5, between pH 9.5 and pH 11.0, at least pH 8.5, at least pH 9.0, at least pH 9.5, at least pH 10.0, or at least pH 10.5. Suitable buffers to maintain desired pH ranges are known in the art and include, for example, phosphate buffer, triethanolamine buffer, and the like. Combinations of buffering and acid or base addition may also be used. In some embodiments, the buffer is TEA (0.025 M to 0.25 M TEA). In some embodiments of the process the suitable reaction conditions comprise a buffer solution of 0.05 M borate to 0.25 M borate, or 0.1 M borate. In some embodiments, the reaction conditions comprise water as a suitable solvent with no buffer present.

[0103] In some embodiments, the process for preparing compounds of formula I are generally carried out in an aqueous co-solvent system comprising an organic solvent (ethanol, isopropanol (IPA), dimethyl sulfoxide (DMSO), ethyl acetate, butyl acetate, 1-octanol, heptane, octane, methyl t-butyl ether (MTBE), toluene, and the like), ionic liquids (*e.g.*, 1-ethyl 4-methylimidazolium tetrafluoroborate, 1-butyl-3-methylimidazolium tetrafluoroborate, 1-butyl-3-methylimidazolium hexafluorophosphate, and the like). The organic solvent component of an aqueous co-solvent system may be miscible with the aqueous component, providing a single

liquid phase, or may be partly miscible or immiscible with the aqueous component, providing two liquid phases. Exemplary aqueous co-solvent systems comprises water and one or more organic solvent. In general, an organic solvent component of an aqueous co-solvent system is selected such that it does not completely inactivate the transaminase enzyme. Appropriate co-solvent systems can be readily identified by measuring the enzymatic activity of the specified engineered transaminase enzyme with a defined substrate of interest in the candidate solvent system, utilizing an enzyme activity assay, such as those described herein. In some embodiments of the process, the suitable reaction conditions comprise an aqueous co-solvent comprising DMSO at a concentration of at least 5% (v/v), at least 10% (v/v), at least 20% (v/v), at least 30% (v/v), or at least 40% (v/v).

[0104] In carrying out the transamination reactions described in the process of the instant invention, the transaminase polypeptide may be added to the reaction mixture in the form of a purified enzyme, whole cells transformed with gene(s) encoding the enzyme, and/or as cell extracts and/or lysates of such cells. Whole cells transformed with gene(s) encoding the transaminase enzyme or cell extracts, lysates thereof, and isolated enzymes may be employed in a variety of different forms, including solid (e.g., lyophilized, spray-dried, and the like) or semisolid (e.g., a crude paste). The cell extracts or cell lysates may be partially purified by precipitation (ammonium sulfate, polyethyleneimine, heat treatment or the like, followed by a desalting procedure prior to lyophilization (e.g., ultrafiltration, dialysis, and the like). Any of the cell preparations may be stabilized by crosslinking using known crosslinking agents, such as, for example, glutaraldehyde or immobilization to a solid phase (e.g., Eupergit C, and the like). In some embodiments where the transaminase polypeptide can be expressed in the form of a secreted polypeptide and the culture medium containing the secreted polypeptides can be used in the disclosed method.

[0105] In some embodiments, solid reactants (e.g., enzyme, salts, etc.) may be provided to the reaction in a variety of different forms, including powder (e.g., lyophilized, spray dried, and the like), solution, emulsion, suspension, and the like. The reactants can be readily lyophilized or spray dried using methods and equipment that are known to those having ordinary skill in the art. For example, the protein solution can be frozen at -80°C in small aliquots, then added to a prechilled lyophilization chamber, followed by the application of a vacuum.

[0106] In some embodiments, the order of addition of reactants is not critical. The reactants may be added together at the same time to a solvent (e.g., monophasic solvent, biphasic aqueous co-solvent system, and the like), or alternatively, some of the reactants may be added separately, and some together at different time points. The coenzyme, transaminase, and transaminase substrate may be added first to the solvent. For improved mixing efficiency when an aqueous co-solvent system is used, the transaminase, and coenzyme may be added and mixed into the aqueous phase first. The organic phase may then be added and mixed in, followed by addition of the transaminase substrate. Alternatively, the transaminase substrate may be premixed in the organic phase, prior to addition to the aqueous phase.

[0107] The quantities of reactants used in the transamination reaction will generally vary

depending on the quantities of product desired, and concomitantly the amount of transaminase substrate employed. Those having ordinary skill in the art will readily understand how to vary these quantities to tailor them to the desired level of productivity and scale of production. Transformation of substrate to product can be monitored using known methods by detecting substrate and/or product. Suitable methods include gas chromatography, HPLC. In some embodiments, the process can further comprise a step of removal of the carbonyl by-product formed from the amino group donor when the amino group is transferred to the transaminase substrate. Such removal in situ can reduce the rate of the reverse reaction such that the forward reaction dominates and more substrate is then converted to product. Removal of the carbonyl by-product can be carried in a number of ways. Where the amino group donor is an amino acid, such as alanine, the carbonyl by-product, a keto acid, can be removed by reaction with a peroxide (see US2008/0213845). Peroxides which can be used include, among others, hydrogen peroxide; peroxyacids (peracids) such as peracetic acid ($\text{CH}_3\text{CO}_3\text{H}$), trifluoroperacetic acid and metachloroperoxybenzoic acid; organic peroxides such as t-butyl peroxide ($(\text{CH}_3)_3\text{COOH}$), or other selective oxidants such as tetrapropylammonium perruthenate, MnO_2 , KMnO_4 , ruthenium tetroxide and related compounds. Alternatively, pyruvate removal can be achieved via its reduction to lactate by employing lactate dehydrogenase to shift equilibrium to the product amine (see, e.g., Koszelewski et al., 2008, Adv. Syn. Catal. 350:2761-2766). Pyruvate removal can also be achieved via its decarboxylation to carbon dioxide acetaldehyde by employing pyruvate decarboxylase (see, e.g., Höhne et al., 2008, Chem BioChem 9:363-365).

[0108] In some embodiments of the process, where the choice of the amino donor results in a carbonyl by-product that has a vapor pressure higher than water (e.g., a low boiling co-product such as a volatile organic carbonyl compound), the carbonyl by-product can be removed by sparging the reaction solution with a non-reactive gas or by applying a vacuum to lower the reaction pressure and removing the carbonyl by-product present in the gas phase. A non-reactive gas is any gas that does not react with the reaction components. Various non-reactive gases include nitrogen and noble gases (e.g., inert gases). In some embodiments, the non-reactive gas is nitrogen gas.

[0109] In some embodiments, the amino donor used in the process is isopropylamine (IPM), which forms the carbonyl by-product acetone upon transfer of the amino group to the amino group acceptor. The acetone can be removed by sparging with nitrogen gas at elevated temperatures or applying a vacuum to the reaction solution and removing the acetone from the gas phase by an acetone trap, such as a condenser or other cold trap. Alternatively, the acetone can be removed by reduction to isopropanol using a ketoreductase. A nitrogen sweep can also be used to prevent formation of a ketone side product, ensuring that the reaction remains inert at all times.

[0110] In some embodiments of the process where the carbonyl by-product is removed, the corresponding amino group donor can be added during the transamination reaction to replenish the amino group donor and/or maintain the pH of the reaction. Replenishing the amino group donor also shifts the equilibrium towards product formation, thereby increasing

the conversion of substrate to product. Thus, in some embodiments wherein the amino group donor is IPM and the acetone product is removed in situ, the method can further comprise a step of adding IPM to the reaction solution to replenish the amino group donor lost during the acetone removal and to maintain the pH of the reaction (e.g., at about 8.5).

[0111] Alternatively, in embodiments where an amino acid is used as amino group donor, the keto acid carbonyl by-product can be recycled back to the amino acid by reaction with ammonia and NADH using an appropriate amino acid dehydrogenase enzyme, thereby replenishing the amino group donor.

[0112] In some embodiments, the process of the instant invention can further comprise extraction, isolation, purification, and/or crystallization of the compound of formula I, each of which can be carried out under a range of conditions.

[0113] These and other aspects of the invention will be apparent from the teachings contained herein.

EXAMPLES

[0114] Examples provided are intended to assist in a further understanding of the invention.

[0115] Certain starting materials and reagents are either commercially available or known in the chemical scientific or patent literature. Purification procedures include, for example, distillation, crystallization, and normal or reverse phase high performance liquid chromatography.

[0116] The abbreviations used herein have the following tabulated meanings (see Table 2). Abbreviations not tabulated below have their meanings as commonly used unless specifically stated otherwise.

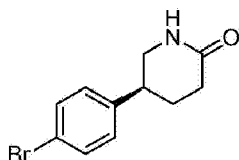
Table 2

NaOH =	Sodium hydroxide
AlCl ₃ =	Aluminum chloride
H ₂ SO ₄ =	Sulfuric acid
IPA =	Isopropyl alcohol
Na ₂ CO ₃ =	Sodium carbonate
MgSO ₄ =	Magnesium sulfate
Me ₃ SOI =	Trimethyl sulfoxonium iodide
KOt-Bu _(s) =	Potassium tert-butoxide
DMSO =	Dimethyl sulfoxide

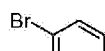
THF =	Tetrahydrofuran
Na ₂ SO ₄ =	Sodium sulfate
ZnBr ₂ =	Zinc bromide
NaHSO ₃ =	Sodium bisulfite
PhMe =	Toluene
NaCl =	Sodium chloride
iPrNH ₂ =	Isopropylamine
MeCN =	Acetonitrile
PLP =	Pyridoxal-phosphate
NaBH ₄ =	Sodium borohydride
EtOH =	Ethanol
BF ₃ ·THF =	Boron trifluoride tetrahydrofuran complex
MeOH =	Methanol
NH ₄ OH =	Ammonium hydroxide
LCAP =	Liquid chromatography area percent
MeLi =	Methyl lithium
DBU =	1,8-Diazabicyclo[5.4.0]undec-7-ene
DIBAL =	Diisobutylaluminium hydride
MsCl =	Methanesulfonyl chloride
Et ₃ N =	Triethylamine
CH ₂ Cl ₂ =	Dichloromethane
DMF =	Dimethylformamide

EXAMPLE 1

[0117] The following Example 1 describes synthesis of the chiral lactam **7** using DKR transamination:



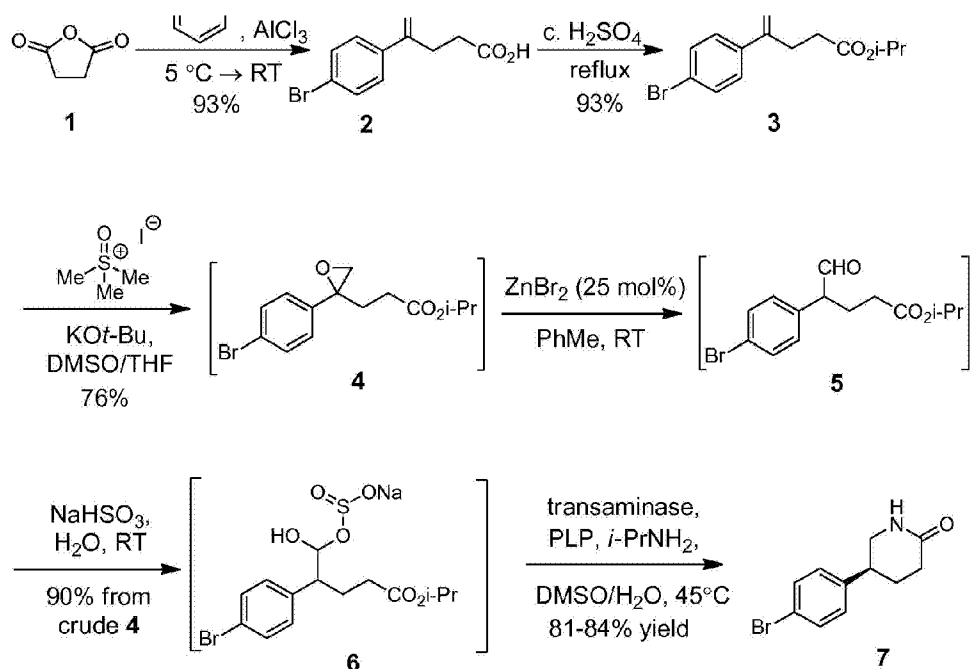
(S)-5-(4-bromophenyl)piperidin-2-one

Scheme

O

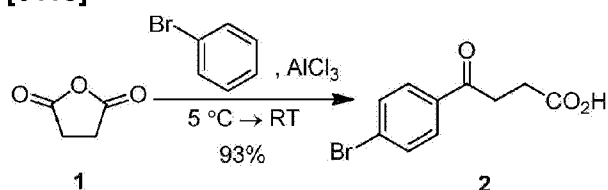
IPA,

O



1.1 Acylation

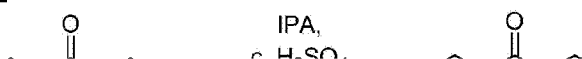
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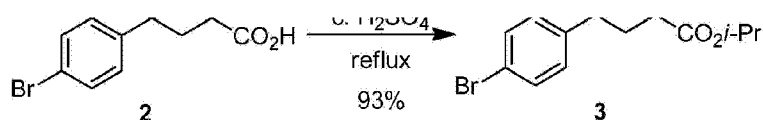


[0119] A mixture of succinic anhydride 1 (110 g) and bromobenzene (695 mL) was cooled to $2\text{--}5^\circ\text{C}$ then added AlCl_3 (294 g). The slurry was allowed to warm to RT and then aged until the reaction was complete judged by HPLC. The reaction mixture was then transferred slowly into a cold HCl solution resulting in the formation of a white precipitate. The white slurry was filtered through a fritted funnel rinsing with H_2O . To the off-white product was added MTBE and extracted with aq. NaOH. The aqueous layer was cooled in an ice bath. Concentrated HCl was added drop wise to adjust the solution pH to 1, resulting in the formation of a white slurry. The slurry was collected on a fritted funnel, rinsed with H_2O , and dried under vacuum with a N_2 sweep at RT to give the target compound (265 g, 93% corrected yield) as a white powder.

1.2 Esterification

[0120]

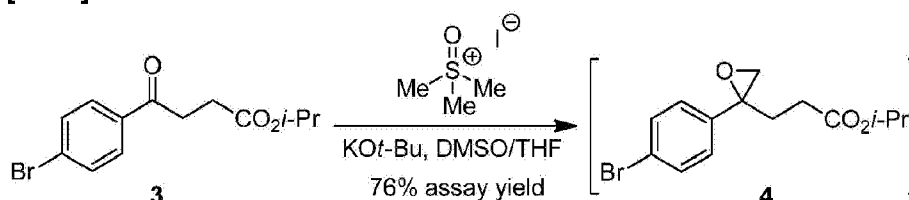




[0121] A mixture of the acid **2** (205 g), IPA (4 L) and conc. H_2SO_4 (2.13 mL / 3.91 g) was heated to a gentle reflux until the reaction was complete judged by HPLC. The solution was then cooled to RT and concentrated to a volume of 350-400 mL. The residue was dissolved in MTBE (1.2 L), washed with aq. Na_2CO_3 followed by water. After dried over MgSO_4 , the filtrate was solvent-switched into heptane. The slurry was then filtered, and the cake was washed with cold heptane. After drying under vacuum, the target compound (223.5 g, 93% corrected yield) was obtained as a white powder.

1.3 Epoxidation

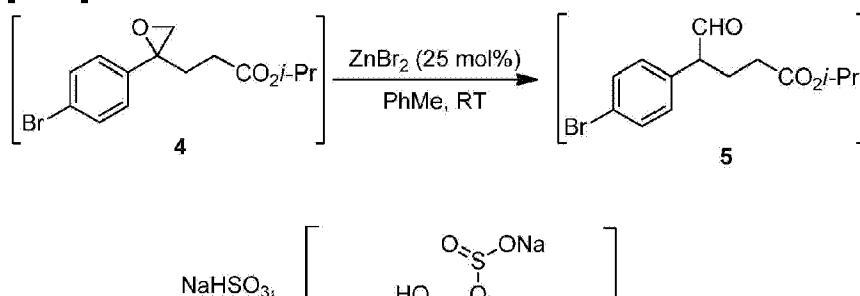
[0122]

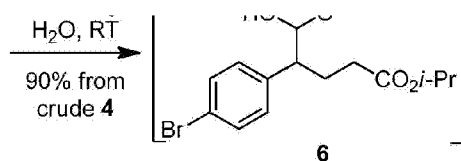


[0123] A mixture of Me_3SOI (230 g) and DMSO (300 mL) was added $\text{KO}^t\text{-Bu}$ (113 g) followed by DMSO (300 mL). The mixture was aged for a further 1.5 hr. In a separate flask, ketone **3** (230 g) was dissolved in a mixture of THF (250 mL) and DMSO (150 mL), and the resulting solution was added drop wise to the ylide solution. The mixture was aged for 2 hr at RT, added hexanes (1 L), and then quenched by the addition of ice-water (600 mL). The layers were cut, and the organic layer was washed with water then with brine. The slightly cloudy yellow organic layer was dried over Na_2SO_4 and filtered through a fritted funnel. Product solution assay was 176.1 g (76% assay yield). This solution was carried forward into the rearrangement step.

1.4 Epoxide rearrangement and bisulfite formation

[0124]

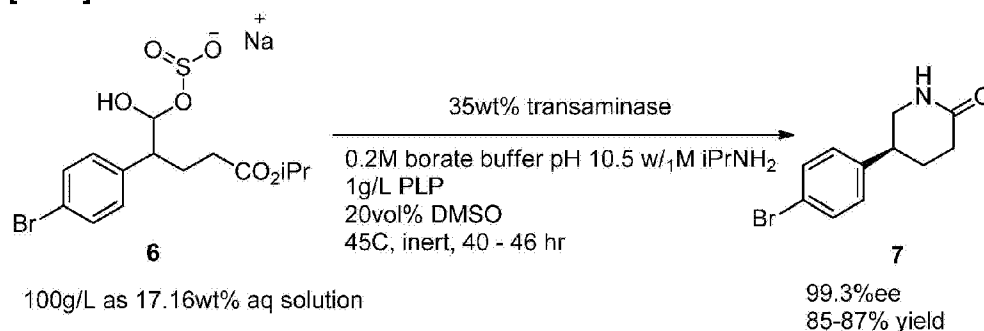




[0125] A solution of crude epoxide **4** (assay 59.5 g) in hexanes was solvent switched into PhMe, and added ZnBr_2 (10.7 g). When the rearrangement was complete judged by HPLC, the slurry was filtered through a fritted funnel. The clear filtrate was washed with 10% aq. NaCl and then stirred with a solution of sodium bisulfite (NaHSO_3 , 24.7 g) in H_2O (140 mL) vigorously at RT for 3 hr. The cloudy aqueous layer was separated and washed with heptanes. By $^1\text{H-NMR}$ assay, the aqueous solution contained 71.15 g bisulfite adduct **6** (30.4 wt % solution, 90% yield from crude epoxide **4**). This solution was used directly in the subsequent transaminase step.

1.5 Transaminase DKR

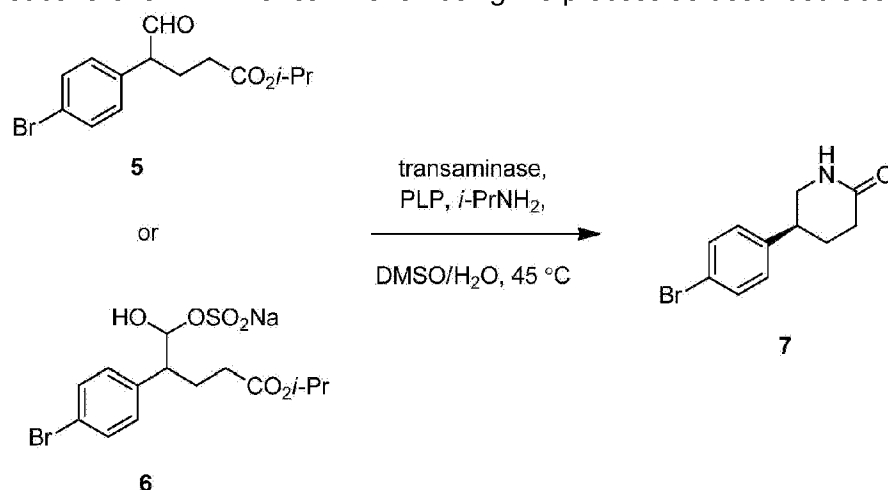
[0126]



[0127] To a cylindrical Labfors reactor was charged pyridoxal-5-phosphate (1.4 g, 5.66 mmol), 452 ml 0.2 M borate buffer pH 10.5 containing 1M iPrNH_2 , 52 g transaminase (SEQ ID NO: 180), and 75 ml DMSO, and the resulting mixture was warmed to 45°C. The pH was controlled at pH 10.5 using 8 M aq iPrNH_2 . To this was added dropwise a mixture of 17.16 wt% aq solution of ester bi-sulfite **6** (147.2 g, 353 mmol) and 219 ml DMSO under N_2 atmosphere. When the reaction was complete judged by HPLC, the reaction mixture was cooled and extracted with 1 volume of 3:2 IPA:IPAc. The aq/rag layer was extracted again with 1 volume of 3:7 IPA:IPAc. The organic layer was washed with brine at pH >9. Assay yield in solution was 78 g (87%); 99.3% ee. After dried over MgSO_4 , and filtered through a fritted funnel, the crude solution was concentrated under vacuum flushing with IPAc to remove IPA. The resulting slurry was concentrated to a final volume of ~200 mL, cool to below 0°C, and filtered to collect the solid. The cake was washed with ice-cold IPAc and dried at RT under vacuum to give the desired product (84% corrected yield, 99.3 LCAP) as a white powder.

Alternative substrates

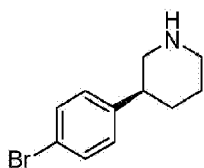
[0128] While the DKR transaminase reaction described above was performed using the bisulfite adduct of ester aldehyde **5**, it was also determined that aldehyde **5** itself is a good substrate for DKR transamination using the process as described above.



[0129] When screening two transaminases, SEQ ID NO: 18 and SEQ ID NO: 180, using either the ester aldehyde **5** or its bisulfite adduct **6**, the enantiomeric excess of each reaction was found to be 99% or greater.

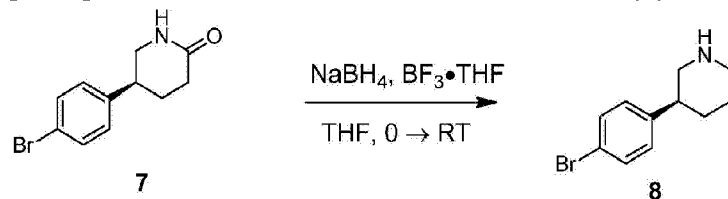
1.6. Reduction of amide

[0130]



(S)-3-(4-bromophenyl)piperidine

[0131] The lactam **7** can be reduced to form the piperidine **8** as described below:



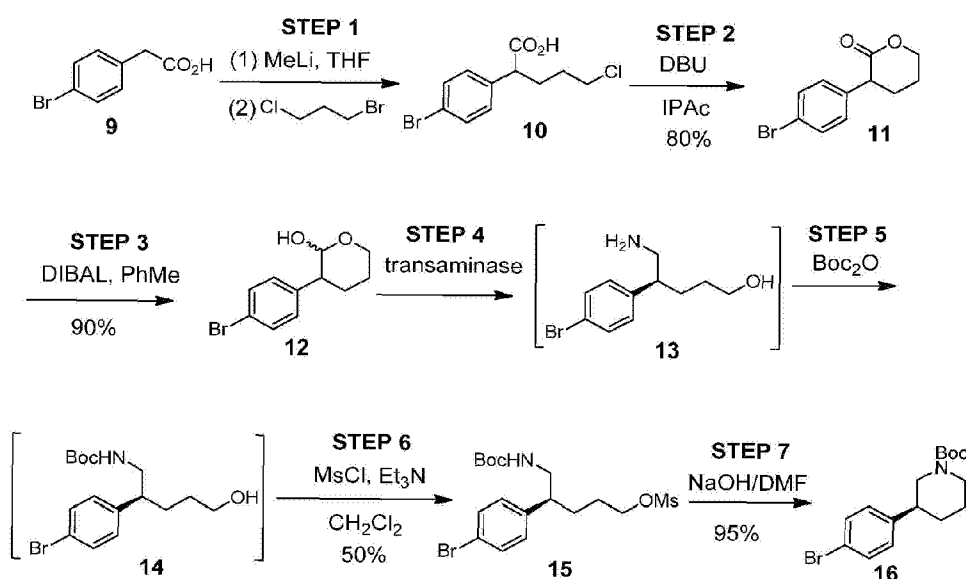
[0132] A mixture of lactam **7** (10.25 g at 97.5 wt %) in THF (100 mL) was cooled to < 10 °C, and added NaBH₄ (4.47 g). EtOH (6.89 mL) was then added slowly over 20 min. The slurry

was aged for an additional 1 hr at 2°C after which $\text{BF}_3 \cdot \text{THF}$ (13.03 mL) was added over 1 hr. The slurry was slowly warmed to RT and aged until complete conversion judged by HPLC. The reaction was then cooled to < 5°C then slowly quenched with MeOH (7.96 mL), added HCl (9.69 mL), then the reaction was heated to 45°C until decomplexation of product-borane complex was complete, as indicated by LC assay. The reaction was cooled, diluted with IPAc (75 mL) and water (80 mL), and then pH was adjusted with aqueous NH_4OH to pH 8. The organic layer was separated, added 75 mL water, then pH adjusted to 10.5 with 50 wt % NaOH. The layers were separated and the organic layer was washed with brine. After solvent-switched to IPAc, LC Assay yield was 9.1g; 95.9%.

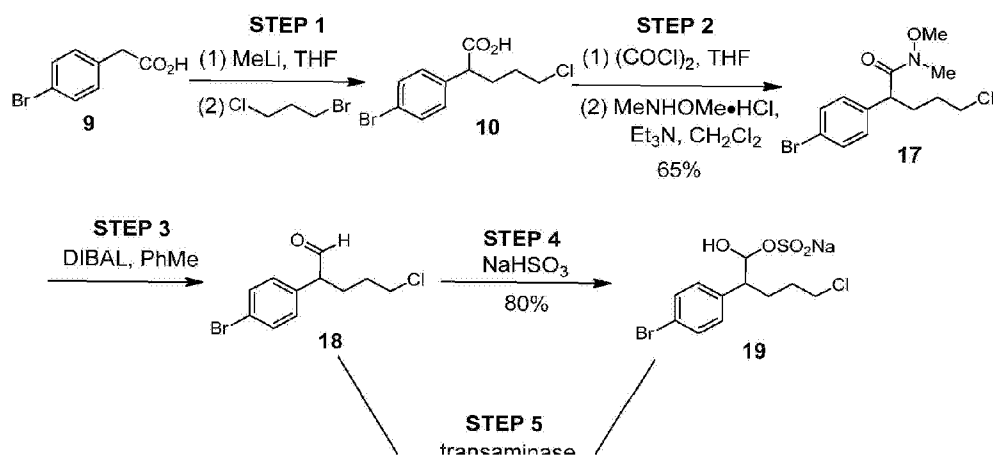
EXAMPLE 2

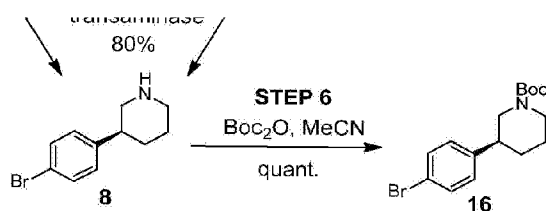
[0133] The DKR transaminase reaction described in Example 1 can be performed using related substrates, yielding similar products. For example, the following schemes can also be used to generate the key intermediate described as part of the present invention.

Alternate scheme 1:

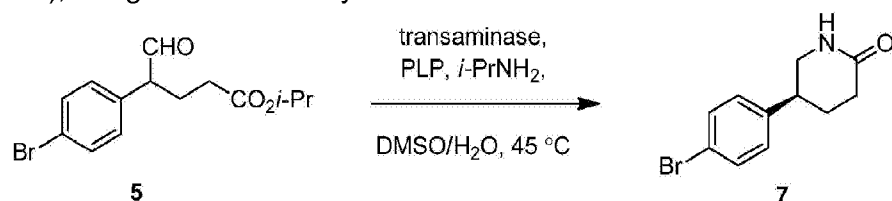


Alternate scheme 2:



**EXAMPLE 3**

[0134] Different transaminases were tested in the reaction as described in Example 1 (section 1.5), using the ester aldehyde **5** as the substrate to form the lactam **7** by DKR transamination.



[0135] Pyridoxal-5-phosphate (1 mg; 4.05 μmol) was dissolved in water 0.2M borate buffer pH 10.5 (400 μl) containing isopropylamine hydrochloride (50 mg, 0.523 mmol). The respective transaminase (2 mg), 0.663 mmol) was added and slowly dissolved. Then a solution of ester aldehyde **5** (2 mg, 6.39 μmol) in DMSO (100 μl) was added and the reactions aged at 45°C. As control, ester aldehyde **5** (2 mg, 6.39 μmol) was incubated in water 0.2M borate buffer pH 10.5 (400 μl) and DMSO (100 μl) with and without the isopropylamine hydrochloride (50 mg, 0.523 mmol).

[0136] The enantiomeric excess was determined for the transaminases tested in this reaction, the results shown in the table below:

	Transaminase Sequence	% e.e.
1	SEQ ID NO: 18	99
2	SEQ ID NO: 207	75
3	SEQ ID NO: 208	59
4	SEQ ID NO: 209	66
5	SEQ ID NO: 210	44
6	SEQ ID NO: 211	45

SEQUENCE LISTING

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<110> Merck Sharp & Dohme Corp.

Bulger, Paul Gerard

Kosjek, Birgit

Rivera, Nelo

<120> Biocatalytic Transamination Process

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gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtgggtt cgagttatcg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgccctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 8

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 8

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Val Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Ser Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu

Pro Val Thr Ser Ser Leu Leu Thr Pro Val Gln Tyr 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 9

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 9

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atggcctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg ccttgactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gcgatcgttt ctgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatt cctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 10

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 10

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn

20	25	30
Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro		
35	40	45
Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp		
50	55	60
Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu		
65	70	75
Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu		
85	90	95
Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu		
100	105	110
Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr		
115	120	125
Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg		
130	135	140
Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe		
145	150	155
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg		
165	170	175
Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp		
180	185	190
Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu		
195	200	205
Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly		
210	215	220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg		
225	230	235
Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu		
245	250	255
Phe Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu		
260	265	270
Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp		
275	280	285
Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly		
290	295	300
Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu		
305	310	315
Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr		
325	330	

<210> 11

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 11

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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatactttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gogatcgttt ctgtttctat caccgtgggt tactcttcta ccccatggga gogtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgccggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 12

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 12

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Pro Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 13

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 13

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatctccga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtctg      300
accaggacag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgttt ctgtttctat caccctgggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggctccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac      780
gaagctatcc tgactgacat caccctgggt gaactgtacg acgcagacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 14

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 14

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Ser Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Thr Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 15
<211> 990
<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 15

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atggccttct cagctgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcgcgtg      300
accagggaag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcgttt ctgtttctat caccgtggtt tactcttcta cccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg accgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggctccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 16

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 16

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 17

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 17

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctccta gcggaatcta ttogtttgat cccgccgctg      300
acccaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcggtta tcgtttctat caccgtgggt tactcttcta ccccatggga gcgtgacatc      420
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gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgccggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 18

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 18

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 19

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 19

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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatota ttctgttgat ccgcgcgtg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcatcgcttt ctgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc      420
acaaacatc gtccgcaggt ttacatgat gctgttcgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgat gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgtgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccag gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

```

<210> 20

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 20

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Gly Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

      80      90      95
Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
      100      105      110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
      115      120      125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
      130      135      140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
      145      150      155      160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
      165      170      175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
      180      185      190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
      195      200      205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
      210      215      220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
      225      230      235      240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
      245      250      255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
      260      265      270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
      275      280      285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
      290      295      300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
      305      310      315      320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
      325      330

```

<210> 21

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 21

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atcacctact ctgactacga actggaccgc gctaaccgc tggctggtgg tgetgcttgg    120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt    180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg    240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg    300
accaggacg aagtcaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcgttt ctgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc    420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt    480
gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagtccgtcg tacaccgcgt    540
agctctatcg acccgaggt taaaaacttc cagtgggttg acctgatccg tgcaattcag    600
gaaacccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct    660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt    720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac    780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt    840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac    900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa    960
ccttcttctc tgctgacccc ggtacgtac      990

```

<210> 22

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 22

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Val Val Tyr Thr Arg Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 23

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 23

atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat 60
 atcacctact ctgactagca actgagccg gctaaccggc tagctgctga tctgacttga 120

```

ccccccccc cggacacaga acgggacccg gccacccgc cggccggggy cggccggggy
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt 180
tatacttctg acgtaccta caccaccttc caggtttgga acggtaacgc tttccgtctg 240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg 300
accaggacag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa 360
gcgatcgta tcgtttctat cacccggtgt tactcttcta ccccatggga gcgtgacatc 420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt 480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct 540
ggctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag 600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct 660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt 720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac 780
gaagctatcc tggtgacat cccccggct gaactgtacg acgtgacga agttctgggt 840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac 900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgctgacccc ggtacagtac 990

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<210> 24

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 24

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Gly Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 25

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 25

atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat 60

atcacctact ctgactacga actggacccg gctaaccocg tggctggtgg tgctgcttgg 120

atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatat ctatcttcga ccagggtttt 180

```

tatacttctg acgctaccta caccgtcttc cacgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttogtttgat cccgccgctg      300
accaggaacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgttt ctgtttctat caccgtgggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgctg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacac accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggt      660
gaagggtccg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt      720

gctgctctgc cgggcatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tgactgacat cccccgggt gaactgtaag acgctgacga agttctgggt      840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 26

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 26

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115         120         125

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Thr Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 27

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 27

atggcctttct cagctgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatactttctg acgctaccta caccaccttc cactgttgga acggtaacgc tttccgtctg	240

```

ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360

gcgatcgta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgctg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggtgacat caccocggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacctc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgcagacccc ggtacgtac      990

```

<210> 28

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 28

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg

```

```

--g 130 135 140
Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175
Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190
Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205
Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240
Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255
Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270
Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285
Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300
Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320
Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

```

<210> 29

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 29

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atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc caccgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgctgctg      300

```

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accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtaga 360
gogatcgttt ctgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc 420
accagacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt 480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgctg tacaccgctg 540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag 600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct 660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt 720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac 780
gaagctatcc tggctgacat caccggtggt gaactgtacg acgctgacga agttctgggt 840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac 900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgcagacccc ggtacgtac 990

```

<210> 30

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 30

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25          30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40          45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55          60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70          75          80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90          95

```

```

Ile Pro Leu Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Arg His Arg
130          135          140

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr

325 330

<210> 31

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 31

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atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gcctgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360

gogatcgta tcgtttctat caccctgtgt tactcttcta cccattcga gogtgacatc 420
 accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt 480
 gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgctg tacaccgcgt 540
 agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag 600
 gaaacccacg accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct 660
 gaaggtccgg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt 720
 gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac 780
 gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt 840
 tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acgtaactc tatctctgac 900
 ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
 ccttcttctc tgctgacccc ggtacgtac 990

<210> 32

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 32

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

```

170          175          180          185          190
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180          185          190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195          200          205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210          215          220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225          230          235          240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245          250          255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260          265          270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275          280          285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290          295          300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305          310          315          320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325          330

```

<210> 33

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 33

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggacccg gctaaccgcc tggtctgttg tgcgtcttgg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctacctc caccaccttc caggtttgga acggtaacgc tttcgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacg aagtaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gcgatcgttg tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc      420

```

```

accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacac accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggctccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgtgacccc ggtacagtac      990

```

<210> 34

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 34

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Val Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 35

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 35

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accagggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgttt ctgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc	420

```

accaaacatc gtccgcaggt ttacatgtat gctgttcogt accagtggat cgtaccgttt      480
gaccgcatcc gtgacgggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtgggtt cgagttatcg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttgttatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt      840

tgctcaaccg gtggtgggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac                                     990

```

<210> 36

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 36

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Ser Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 37

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 37

atggcctttct cagctgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggacccg gctaaccgcg tggttggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgttt ctgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc	420

```

accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtgggtt cgaggaatcg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tgggtgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtgggtgggt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 38

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 38

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg

```

130

135

140

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe

```

145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Glu Ser Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 39

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 39

atggctttct cagctgacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttcgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
cccatcttc tctttctat caccgtact tactcttata cccatttga ccttcacata	420

```

ggagccgctg cggctctat caccgctgtt caccctctca cccattcga gggtgacac 720
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt 480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg 540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag 600
gaaaccacag accgtggttt cgagctgtcg ctgctgctgg actgcgacaa cctgctggct 660
gaaggctccg gtttcaacgt tgttgttatc aaagacggtg ttgttcgttc tccgggtcgt 720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac 780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt 840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac 900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgctgacccc ggtacagtac 990

```

<210> 40

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 40

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Val Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe

```

145	150	155	160
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg	165	170	175
Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp	180	185	190
Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu	195	200	205
Leu Ser Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly	210	215	220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg	225	230	235
Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu	245	250	255
Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu	260	265	270
Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp	275	280	285
Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly	290	295	300
Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu	305	310	315
Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr	325	330	

<210> 41

<211> 990

<212> DNA

<213> Artificial Sequence

 $\langle 220 \rangle$

<223> Engineered variant of Arthrobacter transaminase

<400> 41

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atcgaaggtg	ctttcgttcc	gccgtctgaa	gctcgtatct	ctatcttcga	ccagggtttt	180
tatacttctg	acgctaccta	caccgttttc	cacgttttga	acggtaacgc	tttccgtctg	240
ggggaccaca	tcgaacgtct	gttctctaata	gcggaatcta	ttcgtttgat	cccgccgctg	300
accagggacg	aagttaaaga	gatcgcctctg	gaactgggtg	ctaaaaccga	actgcgtgaa	360
gcgatcgttt	ctgtttctat	caccctgtgt	tactcttcta	cccatctcga	gcgtgacatc	420

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accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 42

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 42

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 43

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 43

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgttttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgttt ctgtttctat caccggtggt tactcttcta cccatttga gcgtagacac	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480

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gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actacgacaa cctgctggct      660
gaaggctccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 44

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 44

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115         120         125

```

```

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130         135         140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

```

165

170

175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Tyr Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 45

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 45

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggacccg gctaaccgcg tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgtaa	360
gcgatcgttt ctgtttctat caccggtggt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggtat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg accgcaggt taaaaactc cagtgggtg acctgatcg tccaattcag	600

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gggccccccg acccgagggg ccccccccc cggggggggg acccgcccc gggccccccg    ...
gaaacccacg accgtggttt cgaggagccg ctgctgctgg actgcgacaa cctgctggct    660
gaaggtcccg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt    720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac    780
gaagctatcc tggtgacat cccccgggt gaactgtacg acgctgacga agttctgggt    840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac    900
ggtgttcccg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa    960
ccttcttctc tgctgacccc ggtacgtac                                     990

```

<210> 46

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 46

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Glu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 47

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 47

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggtggtgg tgetgcttg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgttttc caccgtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgtctctg gaactggttg ctaaaaccga actgcgtgaa	360
gogatcgttt ctgtttctat caccgcgtgt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600

```

gaaacccacg accgtggttt cgagctgccg ctgctgctgg actgcgacag cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 48

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 48

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130        135        140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145        150        155        160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165        170        175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180        185        190

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Ser Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 49

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 49

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttgg	120
atcgaaggtg ttttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgtctct gaactgggtg ctaaaaccga actgctgaa	360
gogatcgttt ctgtttctat caccctgtgt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgtttcgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660

```

gaaggtaatg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 50

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 50

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Val Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Asn Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 51

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 51

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcgttt ctgtttctat caccgcgtgt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtaatg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
actactctac caaatatcac ccataaaacc attctaaaaa tcactaaatc tctaatcac	780

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gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtgggtgggt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 52

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 52

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
          20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
          35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
          50           55           60

```

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
          85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
          100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
          115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
          130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
          145          150          155          160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
          165          170          175

```

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
          180          185          190

```

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
          195          200          205

```

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Asn Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 53

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 53

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcggtt ctgtttctat caccggtggt tactcttota cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtctgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccggtgct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac	900

gggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
 ccttcttctc tgctgacccc ggtacagtag 990

<210> 54

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 54

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Leu Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg

225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 55

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 55

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atggctttct cagctgacac cctgaaatc gtttacaccc acgacaccgg totggactat      60
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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcctcga ccagggtttt      180
tatacttctg acgtaccta caccaccttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa      360
gcgatcgta ttgtttctat caccggtggt tactcttcta cccattcga gctgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg accgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc totgggtcac      780
gaagctatcc tggtgacat caccgcggt gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990
  
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<210> 56

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 56

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Leu Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 57

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 57

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atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accagggaag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgttt ctgtttctat caccggtggt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg	540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggatttg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccgcggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 58

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 58

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Ile Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 59

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 59

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atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgtaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttggtttgat cccgccgctg	300
accaggacgc aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgctt ttgtttctat cacccggtgt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg	540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacgc accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc totgggtcac	780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 60

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 60

Met Ala Phe Ser Ala Asp Ala Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Leu Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 61

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 61

atggcctttct cagctgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gogatcgttt ctgtttctat caccggtggt tactcttota cccattcga gogtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcataatcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840
tgtcacaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgcctgaccc ggtacagtac	990

<210> 62

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 62

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Tyr Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 63

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 63

atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta cacctggttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accagggaag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcggtt ctgtttctat caccggtggt tactcttcta cccattcga gcgtgacatc	420
accaaaccatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 64

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 64

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Trp Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

415

480

485

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 65

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 65

atggcctttct cagctgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggttggtgg tgcgtgcttg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcatcgcttt ctgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420
accaaaccatc gtccgcaggt ttacatgtat gctgttcgt accagtggat cgtaccgttt	480
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agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
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gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840
tgtctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgcgtacccc ggtacgtac	990

<210> 66

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 66

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Ala Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 67

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 67

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcgcgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa	360
gcgatcgttt ttgtttctat caccgcgtgt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg accgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgagtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccgcggct gaactgtacg acgctgacga agttctgggt	840
tgtcacaacg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 68

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 68

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15
 Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30
 Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Phe Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Ser Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 69

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 69

atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtcgttg tgctgcttg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgtaccta caccaccttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcggtt ctgtttctat caccctgggt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgaggatccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggtgacat caccocggct gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccgggtac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 70

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 70

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr	
1 5 10 15	

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Asp Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 71

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 71

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gcgatcgttt ttgtttctat caccggtggt tactcttcta cccattcga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgccgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 72

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 72

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Glu Leu Asn Tyr Ile Thr Tyr Ser Asn Tyr Glu Leu Asn Pro Ala Asn

20 25 30
 Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Phe Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Pro Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr

325

330

<210> 73

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 73

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggtctgtgg tgtctgttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc cactgttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcgcgtg	300
accaggacg aagttaaaga gatcgtctctg gaactggttg ctaaaaccga actgctgaa	360
gogatcgttt ctgtttctat caccgcgtgt tactcttcta cccaattcga gctgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctctcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgctgacga agttctgggt	840
tgctcgaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 74

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 74

Met	Ala	Phe	Ser	Ala	Asp	Thr	Pro	Glu	Ile	Val	Tyr	Thr	His	Asp	Thr
1				5					10					15	
Gly	Leu	Asp	Tyr	Ile	Thr	Tyr	Ser	Asp	Tyr	Glu	Leu	Asp	Pro	Ala	Asn
		20						25					30		

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Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35                      40                      45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50                      55                      60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65                      70                      75                      80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
                        85                      90                      95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
                100                      105                      110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
                115                      120                      125

Arg Gly Tyr Ser Ser Thr Gln Phe Glu Arg Asp Ile Thr Lys His Arg
 130                      135                      140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145                      150                      155                      160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
                165                      170                      175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
                180                      185                      190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195                      200                      205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210                      215                      220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225                      230                      235                      240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
                245                      250                      255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
                260                      265                      270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
                275                      280                      285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290                      295                      300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305                      310                      315                      320

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Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 75

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 75

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atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta cacctgtttc cacgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg      300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa      360
gcgatcgttt ctgtttctat caccggtggt tactcttcta cccattcga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 76

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 76

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Cys Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 77

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 77

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtgggtgg tgtgcttg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccaccttc cagctttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgtctct gaactgggtg ctaaaaccga actgctgaa	360
gcgatcgttt ctgtttctat caccctgggt tactcttcta cccattcga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagtgtccg ctgctgctgg actgcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gtactctgc cgggtatcac ccgtaaaacc gttctggaaa tcgtgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 78

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 78

Met	Ala	Phe	Ser	Ala	Asp	Thr	Pro	Glu	Ile	Val	Tyr	Thr	His	Asp	Thr
1				5					10					15	

Gly	Leu	Asp	Tyr	Ile	Thr	Tyr	Ser	Asp	Tyr	Glu	Leu	Asp	Pro	Ala	Asn
			20					25						30	

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Cys Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Thr Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 79

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 79

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atcacctact ctgactacga actggaccgg gctaaccggc tggtggtgg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg      300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgctt tggtttctat caccggtggt tactcttcta cccattcga gctgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480

gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgtgaatc tctgggtcac      780
gaagctatcc tggtgacat caccocggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 80

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 80

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
          20           25           30

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Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Leu Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 81

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 81

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atggcctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggttggtgg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccaccttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtcg      300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgttt ctgtttctat cacccggtgt tactcttcta ccccatggga gcgtgacatc      420
accaaaccac gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtgacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtgggtgg acctgatccg tgcaattcag      600
gaaaccacac accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tggtgttatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 82

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 82

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 83

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 83

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atggcctttct cagctgacac cccgtgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgttg tggttttctat caccgctggt tactcttcta cccattcga gctgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtccgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990
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<210> 84

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 84

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro

35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Val Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 85

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 85

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggacccg gctaaccgcg tggctggtgg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc cacgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacag aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gcgatcgttt ctgtttctat cacccggtgt tactcttcta cccattcga gcgtgacatc      420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcatttcag      600
gaaaccacag accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggtg gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttcagg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 86

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 86

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Phe Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 87

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 87

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atggcctttct cagctgacac cctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcatcgttt ctgtttctat caccgcgtgt tactcttcta cccattcga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg accgcaggt taaaaacttc cagtgggtg acctgatccg tgcaaggcag      600
gaaaccacg accgtgggtt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

```

<210> 88

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 88

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asn Gln Glu Phe Tyr Thr Ser Asn

```

Ser Ser Thr Arg Thr Ser Thr Thr Asp Ser Gly Thr Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Arg Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 89

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 89

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atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccaccttc cactgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgtg      300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcgttt ctgtttctat caccctggtt tactcttcta cccattcga gcgtgacatc      420
accaaacatc gtcgcaggtt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540

agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagctgccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtatgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccctggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

```

<210> 90

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 90

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Met Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 91

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 91

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atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180

tatacttctg acgctaccta caccgtcttc cagcttttga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacag aagtgaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gogatcgta tcgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc      420
accaaaccatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttcac tgctgacccc ggtacagtac      990

```

<210> 92

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 92

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 93

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 93

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atggccttct cagctgacac cccgtgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa      360
gogatcggtta tcgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtcgat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgaggtt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaacccaag accgtggttt cgagttaccg ctgttgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacgt caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 94

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 94

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Ser Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Val Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 95

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 95

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atggctttct cagctgacac cctgaaatc gtttacacc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg    120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt    180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg    240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg    300
accagggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa    360
gcgatcggtta tcgttactat caccgctggt tactcttcta ccccatggga gctgacatc    420
accaaacatc gtcgcgaggt ttacatgaat gctgttccgt accagtggat cgtaccgttt    480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg    540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcaattcag    600
gaaaccacac accgtggttt cgagttaccg ctgctgctgg actgcgacaa cctgctggct    660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt    720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac    780
gaagctatcc tggctgacat caccgcggct gaactgtaag acgctgacga agttctgggt    840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac    900
ggtgttcagg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa    960
ccttcttctc tgctgacccc ggtacagtac                                990

```

<210> 96

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 96

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asn Glu Val Lys Glu Ile Ala Leu Glu Leu

```

```

100      105      110
Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Thr Ile Thr
115      120      125
Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130      135      140
Pro Gln Val Tyr Met Asn Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145      150      155      160
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165      170      175
Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180      185      190
Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195      200      205
Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210      215      220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225      230      235      240
Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245      250      255
Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260      265      270
Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275      280      285
Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290      295      300
Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305      310      315      320
Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325      330

```

<210> 97

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 97

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atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tgctggtgq tgctgcttgg      120

```

```

- - - - -
atcgaagggtg ctttcggtcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt 180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg 240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg 300
accagggaag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa 360
gcgatcgtaa tcgtttctat caccgtggtt tactcttota ccccatggga gcgtgacatc 420
accaaacatc gtccgcaggt ttacatggcg gctgttccgt accagtggat cgtaccgttt 480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtccgtcg tacaccgctg 540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag 600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg actgcgacaa cctgctggct 660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt 720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc totgggtcac 780
gaagctatcc tggctgacat cccccggct gaactgtacg acgtgacga agttctgggt 840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac 900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgcagacccc ggtacgtac 990

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<210> 98

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 98

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15
Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30
Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45
Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60
Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80
Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95
Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Ala Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 99

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 99

atggctttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat 60

atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg 120

atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt 180

```

tatacttctg acgctaccta caccgtcttc cacgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gogattgtta ttgttaccat caccgcgtgt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtgacgggtg tcacctgatg gttgctcagt cagttcgctg tacaccgcgt      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg actgcgacaa cctgctggct      660

gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 100

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 100

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Thr Ile Thr
115         120         125

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 101

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 101

atggccttct cagctgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat 60

atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg 120

atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt 180

tatacttctg acgctaccta caccgtcttc caccgtttgga acggtaacgc tttcgtctg 240

```

ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgta tcgttgctat caccggtggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtgggtt cgagttaccg ctgctgctgg actgcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 102

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 102

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ala Ile Thr
115         120         125

Arg Glu Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg

```

```

-----
130                               135                               140
Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145                               150                               155                               160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165                               170                               175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180                               185                               190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195                               200                               205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210                               215                               220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225                               230                               235                               240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245                               250                               255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260                               265                               270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275                               280                               285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290                               295                               300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305                               310                               315                               320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325                               330

```

<210> 103

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 103

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atggcggttct cagcggacac cctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg      120
ttcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300

```

```

accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gcgatcgta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccggtggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttccg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 104

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 104

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Phe Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 105

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 105

atggcggttct tagcggacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttcag acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcggtta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420

```

accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtaacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaatacag      600
gaaacccacg accgtgggtt cgagttaccg ctgctgctgg acttcgacaa cctgttggt      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtgggtgggt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaatt gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 106

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 106

```

Met Ala Phe Leu Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

Asp Arg Ile Arg Asn Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 107

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 107

atggcggttct cagcggacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccactttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gogatcggtta tcgtttctat caccctgtgt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgtttcgt accagtggtat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540

```

agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac                                     990

```

<210> 108

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 108

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 109

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 109

atggcggtct cagcgacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggttggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgtaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gogatcgta tcgtttctat caccgtggt tactcttcta cccatggga gogtgacatc	420
ctgaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgat gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg accgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600

```

gaaacccacg accgtgggtt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgccggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 110

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 110

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Leu Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

```

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180          185          190

```

<211> 990

<213> Artificial Sequence

<223> Engineered variant of *Arthrobacter* transaminase

atggcggttct	cagcggacac	ccctgaaatc	gtttacaccc	acgacaccgg	tctggactat	60
atcacctact	ctgactacga	actggaccgg	gctaaccggc	tggctggtgg	tgtgtgttgg	120
atcgaaggtg	ctttcgttcc	gccgtctgaa	gctcgtatct	ctatcttcga	ccagggtttt	180
tatacttctg	acgtaccta	caccgtcttc	cacgtttgga	acggtaacgc	tttcggtctg	240
ggggaccaca	tcgaacgtct	gttctctaata	gcggaatcta	ttogtttgat	ccgcccgctg	300
accagggacg	aagttaaaga	gatcgtctctg	gaactgggtg	ctaaaaccga	actgcgtgaa	360
gcgatcggtta	tcgtttctat	caccgctggt	tactcttcta	ccccatggga	gcgtgacatc	420
accacgcac	gtccgcaggt	ttacatgtat	gctgttccgt	accagtggtat	cgtaccggtt	480
gaccgcaccc	gtgacgggtg	tcacctgatg	gttgctcagt	cagttcgtcg	tacaccgcgt	540
agctctatcg	accgcaggt	taaaaacttc	cagtgggggtg	acctgatccg	tgcaattcag	600
gaaacccacg	accgtgggtt	cgagttaccg	ctgctgctgg	acttcgacaa	cctgctggct	660

```

gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 112

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 112

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Thr His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 113

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 113

atggcggttct cagcggacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcgggga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gogatcggtta tcgtttctat caccggtggt tactcttcta cccatggga gctgacatc	420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720

```

gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaactc tatctctgac      900
ggtgttcagg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 114

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 114

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Gly Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195         200         205

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr

325 330

<210> 115

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 115

atggcgttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctttgttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cacgtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatota ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780

```

gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtgggtgggt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttcocg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 116

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 116

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

```

Ser Glu Ala Arg Ile Ser Leu Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130        135        140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145        150        155        160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165        170        175

```

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180        185        190

```

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195        200        205

```

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly

```

```

      210              215              220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225                  230                235                240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245                  250                255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260                  265                270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275                  280                285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290                  295                300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305                  310                315                320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325                  330
```

<210> 117

<211> 990

<212> DNA

<213> Artificial Sequence

 $\langle 220 \rangle$

<223> Engineered variant of *Arthrobacter* transaminase

<400> 117

atg'gcgttct	cagcggacac	ccctgaaatc	gtttacacc	acgacaccgg	tctggactat	60
atcacctact	ctgactacga	actggacccg	gctaaccgcg	tggctggtg	tgctgcttg	120
atcgaaggtg	ctttcgttcc	gccgtctgaa	gctcgtatct	ctatcttcga	ccagggtttt	180
tatacttctg	acgtaccta	caccgtcttc	cacgtttgga	acggtaacgc	tttccgtctg	240
ggggaccaca	tcgaacgtct	gttctcta	atgcgaatctc	ttcgtttgat	cccgcgcgtg	300
acccaggacg	aagttaaaga	gatcgcctctg	gaactgggtg	ctaaaaccga	actgcgtgaa	360
gcgatcgtta	tcgtttctat	caccgcgtgg	tactcttcta	cccctggtga	gcgtgacatc	420
accaaacatc	gtccgcaggt	ttacatgtat	gctgttccgt	accagtggtg	cgtaccgttt	480
gaccgcaccc	gtgacggtgt	tcacctgatg	gttgctcagt	cagttcgtcg	tacaccgcgt	540
agctctatcg	acccgcaggt	taaaaacttc	cagtgggggtg	acctgatccg	tgcaattcag	600
gaaacccacg	acgctgggtt	cgagttaccg	ctgctgctgg	acttcgacaa	cctgctggct	660
gaaggtccgg	gtttcaacgt	tgttggtatc	aaagacgggtg	ttgttcgttc	tccgggtcgt	720
gctgctctgc	cgggtatcac	ccgtaaaacc	gttctggaaa	tcgctgaatc	tctgggtcac	780
gaagctatcc	tggtcgacat	caccccggt	gaactgtacg	acgctgacga	agttctgggt	840

```

tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttcogg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 118

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 118

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1          5          10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20        25        30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35        40        45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50        55        60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65        70        75        80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Leu Arg Leu
85        90        95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100       105       110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115       120       125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130       135       140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145       150       155       160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165       170       175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180       185       190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195       200       205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210       215       220

```

210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 119

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 119

atggcggtct cagcggacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtctggtg tgcgtcttgg	120
atcgaaggtg ctttctgtcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcgtta tcgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agcagatcg acccgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840

```

tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaactc tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcggt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac                                     990

```

<210> 120

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 120

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Thr Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195         200         205

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 121

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 121

atggcgttct cagcggacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtctggtg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga cttgggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg	300
accagggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gogatcgtaa tcgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgctg	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840

```

tgc tca accg gtg gtggtgt ttggccgttc gtttctgttg acg gta actc tatctctgac      900
ggtgttccgg gtccgggttac ccagtcctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac                                          990

```

<210> 122

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 122

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Leu Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180          185          190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195          200          205

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 123

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 123

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatcc ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcggtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttcogt accagtggtat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt	840

```

tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 124

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 124

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
          20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
          35           40           45

Ser Glu Ala Arg Ile Pro Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
          50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
          85           90           95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
          100          105          110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
          115          120          125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
          130          135          140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
          145          150          155          160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
          165          170          175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
          180          185          190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
          195          200          205

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 125

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 125

atggcggtct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatca ggatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gogatcgtta tcgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtgggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900

```

- - - - -
gggtgttccgg gtccggttac ccagttctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac                                     990

```

<210> 126

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 126

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

```

Ser Glu Ala Arg Ile Arg Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

```

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

```

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

```

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195         200         205

```

```

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210         215         220

```

210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 127

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 127

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatca atatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caccgtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gcgatcgtta tcgtttctat caccgttgtt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg accgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tggtgttatc aaagacgggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acggtaacct tatctctgac	900
aatattccaa atccaatcacc caactctatc atccatcatt actaaact aaacattgaa	960

 ccttcttctc tgctgacccc ggtacagtac 990

<210> 128

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 128

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Asn Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 129

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 129

atggcggtct cagcggacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtggtgg tctgcttg	120
atcgaagggtg ctttctgtcc gccgtctgaa gctcgtatca agatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttcgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg	300
accaggacg aagttaaaga gatcgtctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgtta tcgtttctat caccgtggt tactctcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttcctg accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg accgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggtgacat caccgggt gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 130

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 130

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Lys Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 131

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 131

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgtaa tcgtttctat caccogtggg tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtac gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacgt gaccccggt gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 132

<211> 330

<212> PRT

<213> Artificial Sequence

 $\langle 220 \rangle$

<223> Engineered variant of Arthrobacter transaminase

<400> 132

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

6 **7** **8** **9** **10** **11** **12** **13** **14** **15** **16** **17** **18** **19** **20**

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Val Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 133

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 133

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtctggtg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaat gcggaatcta ttctgttgat ccggccgctg	300
accaggagcg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcggtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtcgat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg	540
agctctatcg acccgcaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag	600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa catgctggct	660
gaagggtccgg gtttcaacgt tggtgttata aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tgggtgacat caccgcggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtgggtggtg ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 134

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 134

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Ser Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Met Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 135

<211> 990

<212> DNA

<213> Artificial Sequence

 $\langle 220 \rangle$

<223> Engineered variant of Arthrobacter transaminase

<400> 135

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atcgaaggtc	aattcgcttc	gccgtctgaa	gctcgatat	ctatcttcga	ccagggttt	180
tatacttctg	acgctaccta	caccgtcttc	cacgtttgga	acggtaacgc	tttccgtctg	240
ggggaccaca	tcgaacgtct	gttctcta	gcggaatcta	ttcgtttgat	ccgccgctg	300
accagggacg	aagttaaaga	ggtagctctg	gaactgggtg	ctaaaaccga	actgctgtaa	360
gcgatcgta	tcgttgctat	caccgctggt	tactcttcta	cccatggga	gcgtgacatc	420
accaaacatc	gtccgcaggt	ttacatggct	gctgttccgt	accagtggat	cgtaccgttt	480
gaccgcatcc	gtgacgggtg	tcacctgatg	gttgctcagt	cagttcgctg	tacaccgcgt	540
agctctatcg	acccgcaggt	taaaaacttc	cagtgggggtg	acctgatccg	tgcaattcag	600
gaaaccacg	accgtggttt	cgagttaccg	ctgctgctgg	acttcgacaa	catgctggct	660
gaagggtccg	gtttcaacgt	tggtgttatc	aaagacgggtg	ttgttcgttc	tcggggtcgt	720
gctgctctgc	cgggtatcac	cgtaaaaacc	gttctggaaa	tcgctgaatc	tctgggtcac	780
gaagctatcc	tggctgacat	caccccggt	gaactgtacg	acgctgacga	agttctgggt	840
tgtctaaccc	gtgggtggtg	ttggccgttc	gtttctgttg	acggtaaact	tatctctgac	900
ggtgttccg	gtccggttac	ccagtcctatc	atccgtcgtt	actgggaact	gaacgttgaa	960
ccttcttctc	tgtgacccc	gatccagta				990

<210> 136

$\langle 211 \rangle$ 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 136

Met Ala Phe Ser Asn Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Gln Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Val Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ala Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Ala Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Met Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu

260

265

270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Ile Gln Tyr
 325 330

<210> 137

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 137

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcggtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcagggt ttacatgtat gctgttccgt accagtttat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg acccgcagggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggt	660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttcggg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 138

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 138

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1      5      10      15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20      25      30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35      40      45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50      55      60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65      70      75      80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85      90      95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100     105     110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115     120     125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130     135     140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Phe Ile Val Pro Phe
145     150     155     160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165     170     175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180     185     190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195     200     205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210     215     220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225     230     235     240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245     250     255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260     265     270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275     280     285

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Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 139

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 139

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgetgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg	300
accaggacg aagttaaaga gatcgcctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcgtta tcgtttctat caccgcgtgt tactcttcta ccccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgtttcgt accagacgat cgtaccgttt	480
gaccgcaccc gtgacggtgt tcacctgatg gttgcgcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
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gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 140

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 140

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Thr Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Glu Asp Ser Ile Ser Asp Gly Val Pro Gly

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Phe Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 141

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 141

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atgaaattct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgcgtgcttg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggagcg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcggtta tcgtttctat caccgcgtgt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggtat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660

gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 142

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 142

Met Iys Phe Ser Ala Asp Thr Pro Gly Ile Val Tyr Thr His Asp Thr

```

Met Lys Phe Ser Ala Asp Thr Phe Glu Ile Val Tyr Thr His Asp Thr
1      5      10      15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20      25      30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35      40      45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50      55      60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65      70      75      80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85      90      95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100     105     110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115     120     125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130     135     140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145     150     155     160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165     170     175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180     185     190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195     200     205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210     215     220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225     230     235     240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245     250     255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260     265     270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275     280     285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290     295     300

```

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 143

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 143

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atcacctact ctgactacga actggacccg gctaaccgcg tggtctggtg tgtctgttgg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacg aagtaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcgtta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccgggt gaactgtacg acgtgacga agttctgggt      840
tgtcacaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 144

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 144

Met Gln Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asp Val Glu

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Asp Glu Met Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 145

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 145

atgtcattct cagcggacac cctgaaatc gtttacacc acgacaccgg tctggactat	60
atcacctact ctgactacga actggacccg gctaaccgcg tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgtaccta caccgtcttc cactgttga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa	360
gcgatcgta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctgaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 146

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 146

Met Ser Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn

20	25	30
Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro		
35	40	45
Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp		
50	55	60
Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu		
65	70	75
Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu		
85	90	95
Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu		
100	105	110
Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr		
115	120	125
Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg		
130	135	140
Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe		
145	150	155
Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg		
165	170	175
Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp		
180	185	190
Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu		
195	200	205
Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly		
210	215	220
Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg		
225	230	235
Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu		
245	250	255
Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu		
260	265	270
Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp		
275	280	285
Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly		
290	295	300
Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu		
305	310	315
Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr		
325	330	

343

350

<210> 147

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 147

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atgcaattct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggtggtgg tgetgcttg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc cactgttgga acggtaacgc ttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcgcgtg      300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa      360
gogatcgtaa tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagtccgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgtgacga agttctgggt      840
tgetcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaaact tatctctgac      900
ggtgttccg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgetgacccc ggtacagtac      990

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<210> 148

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 148

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Met Gln Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 149

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 149

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atggcgttct catccgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg      120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cagctttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcgtta tcgtttctat caccgctggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
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tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 150

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 150

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Met Ala Phe Ser Ser Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 151

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 151

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atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc cactgttga acggtaacgc tttccgtctg      240
ggggaccaca tcgagcgtct gttctctaata gcggaatcta ttctgttgat ccgcgcgtg      300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcatcggtta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgatcc gtgacggtgt tcacctgatg gttgctcagt cagtctctcg tacaccgct      540
agctctatcg accgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggt gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 152

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 152

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Met Ala Phe Ser Thr Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175
 Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 153

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 153

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atggcggttct caatcgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgtttgga acggtaacgc ttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccggccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360

gcgatcgtta tcgtttctat caccgctgggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacgggtg tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtgggtggtg ttggccgttc gtttctgttg acggtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 154

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 154

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Met Ala Phe Ser Ile Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 155

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 155

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atggcggttct cacatgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc caccgtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat ccgcccgtg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa      360
gcatcggtta tctgtttctat caccgtggt tactcttota ccccatggga gctgacatc      420
accaaacatc gtcgcaggt ttacatgat gctgttcctg accagtggat cgtaccgttt      480
gaccgatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tctctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgggt gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tctgacccc ggtacgtac      990

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<210> 156

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 156

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Met Ala Phe Ser His Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

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Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr

325

330

<210> 157

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 157

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg      300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa      360
gcgatcggtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 158

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 158

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Met Ala Phe Ser Leu Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 159

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 159

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga tcagggtttt      180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct cttctccta gcggaatcta ttcgcttgat cccgccgctg      300
accagggaag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcggtt tcgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccacaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat cccccggctt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgcagacccc ggtacagtac      990

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<210> 160

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 160

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Met Ala Phe Ser Val Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1          5          10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
      100                      105                      110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
      115                      120                      125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
      130                      135                      140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
      145                      150                      155                      160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
      165                      170                      175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
      180                      185                      190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
      195                      200                      205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
      210                      215                      220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
      225                      230                      235                      240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
      245                      250                      255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
      260                      265                      270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
      275                      280                      285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
      290                      295                      300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
      305                      310                      315                      320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
      325                      330

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<210> 161

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 161

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atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg      120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgtta tcgtttctat caccggtggt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgcggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acgtaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 162

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 162

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Met Ala Phe Ser Leu Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 163

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 163

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atggcgcttct cagcggacac ccctcaaata gtttacaccc acgacaccgg tctggactat      60
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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgtaccta caccgtcttc cactgttga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgta tcgtttctat caccgtgggt tactcttcta ccccatggga gcgtagacac      420
accaaacata gtcgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480

gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct      540
agctctatcg accgcaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag      600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccgccggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtagctc tatctctgac      900
ggtgttccgg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

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<210> 164

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 164

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Met Ala Phe Ser Ala Asp Thr Pro Gln Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

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Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Ser Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 165

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 165

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg      300
accaggacag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgtaa      360
gcgatcgtaa tcgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc      420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt      540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaaccacag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
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tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
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ccttcttctc tgctgacccc ggtacagtac      990

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<210> 166

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 166

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Met Ala Phe Ile Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu

```

85										90					95						
Ile	Pro	Pro	Leu	Thr	Gln	Asp	Glu	Val	Lys	Glu	Ile	Ala	Leu	Glu	Leu						
			100					105					110								
Val	Ala	Lys	Thr	Glu	Leu	Arg	Glu	Ala	Ile	Val	Ile	Val	Ser	Ile	Thr						
		115					120					125									
Arg	Gly	Tyr	Ser	Ser	Thr	Pro	Trp	Glu	Arg	Asp	Ile	Thr	Lys	His	Arg						
	130					135					140										
Pro	Gln	Val	Tyr	Met	Tyr	Ala	Val	Pro	Tyr	Gln	Trp	Ile	Val	Pro	Phe						
145					150						155				160						
Asp	Arg	Ile	Arg	Asp	Gly	Val	His	Leu	Met	Val	Ala	Gln	Ser	Val	Arg						
				165					170					175							
Arg	Thr	Pro	Arg	Ser	Ser	Ile	Asp	Pro	Gln	Val	Lys	Asn	Phe	Gln	Trp						
			180					185					190								
Gly	Asp	Leu	Ile	Arg	Ala	Ile	Gln	Glu	Thr	His	Asp	Arg	Gly	Phe	Glu						
		195					200					205									
Leu	Pro	Leu	Leu	Leu	Asp	Phe	Asp	Asn	Leu	Leu	Ala	Glu	Gly	Pro	Gly						
	210					215					220										
Phe	Asn	Val	Val	Val	Ile	Lys	Asp	Gly	Val	Val	Arg	Ser	Pro	Gly	Arg						
225					230					235					240						
Ala	Ala	Leu	Pro	Gly	Ile	Thr	Arg	Lys	Thr	Val	Leu	Glu	Ile	Ala	Glu						
				245					250					255							
Ser	Leu	Gly	His	Glu	Ala	Ile	Leu	Ala	Asp	Ile	Thr	Pro	Ala	Glu	Leu						
			260					265					270								
Tyr	Asp	Ala	Asp	Glu	Val	Leu	Gly	Cys	Ser	Thr	Gly	Gly	Gly	Val	Trp						
	275						280					285									
Pro	Phe	Val	Ser	Val	Asp	Gly	Asn	Ser	Ile	Ser	Asp	Gly	Val	Pro	Gly						
	290					295					300										
Pro	Val	Thr	Gln	Ser	Ile	Ile	Arg	Arg	Tyr	Trp	Glu	Leu	Asn	Val	Glu						
305					310					315					320						
Pro	Ser	Ser	Leu	Leu	Thr	Pro	Val	Gln	Tyr												
				325					330												

<210> 167

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of *Arthrobacter* transaminase

<400> 167

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt      180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg      240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttctgttgat cccgccgctg      300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcggtt tcgtttctat caccgtggtt tactcttcta ccccatggga gcgtgacatc      420
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gaaacccaag accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
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ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

```

<210> 168

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 168

```

Met Ala Phe Ser Ala Asp Thr Pro Ser Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

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Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
      100                      105                      110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
      115                      120                      125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
      130                      135                      140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
      145                      150                      155                      160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
      165                      170                      175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
      180                      185                      190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
      195                      200                      205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
      210                      215                      220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
      225                      230                      235                      240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
      245                      250                      255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
      260                      265                      270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
      275                      280                      285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
      290                      295                      300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
      305                      310                      315                      320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
      325                      330

```

<210> 169

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 169

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atggcggtct cagcggacac cacagaaatc gtttacaccc acgacaccgg tctggactat      60
atcacctact ctgactacga actggacccg gctaaccgcg tggctggtgg tgetgcttgg      120
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gcgatcgtaa tcgtttctat caccgtggtt tactcttota ccccatggga gcgtgacatc      420
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gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctgtcg tacaccgcgt      540
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tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac      990

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<210> 170

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 170

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Met Ala Phe Ser Ala Asp Thr Thr Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 171

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 171

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atcacctact ctgactacga actggaccgg gctaaccggc tggctggtgg tgcgtgcttg 120

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accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa 360
gcgatcgta tcgtttctat caccgtggt tactctteta ccccatggga gcgtgacatc 420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt 480
gaccgcatcc gtgacgtgtg tcacctgatg gttgctcagt cagttcgtcg tacaccgct 540
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gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttogacaa cctgctggct 660
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gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgtgaatc tctgggtcac 780
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ccttcttctc tgctgacccc ggtacgtac 990

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<210> 172

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of *Arthrobacter* transaminase

<400> 172

```

Met Ala Phe Ser Ala Asp Thr Pro Asn Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 173

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 173

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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt 180

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tatacttctg acgtaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg      240
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accaggacag aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa      360
gcgatcgtaa tcgtttctat caccgctggt tactcttcta ccccatggga gcgtgacatc      420
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ccttcttctc tgctgacccc ggtacagtac      990

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<210> 174

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 174

```

Met Ala Phe Leu Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10          15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

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tatacttctg acgctaccta caccgtcttc cactgttga acggtaacgc ttccgtctg      240
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<210> 176

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 176

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Lys Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Glu Tyr Ser Ser Thr Pro Thr Glu Arg Asp Ile Thr Tyr His Arg

```

Arg Gly Tyr Ser Ser Thr Phe Asp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 177

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 177

atgagcttct cacaatgacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgetgcttg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300

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accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa 360
gogatcgtaa tcgttgctat caccggtggt tactcttota ccccatggga gogtgacatc 420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtcgat cgtaccgttt 480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt 540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag 600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct 660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt 720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac 780
gaagctatcc tggctgacgt cccccggct gaactgtacg acgctgacga agttctgggt 840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acgtaactc tatctctgac 900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgctgacccc ggtacgtac 990

```

<210> 178

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 178

```

Met Ser Phe Ser His Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ala Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Ser Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Val Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 179

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 179

atgagcttct cacatgacac ccttgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gogatcgtaa tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420

```

accaaacatc gtcgcgaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt      480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg      540
agctctatcg acccgaggtt taaaaacttc cagtggggtg acctgatccg tgcaattcag      600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct      660
gaagggtcgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 180

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 180

```

Met Ser Phe Ser His Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg

```

[illegible]

<210> 181

<211> 990

<212> DNA

<213> Artificial Sequence

 $\langle 220 \rangle$

<223> Engineered variant of *Arthrobacter* transaminase

<400> 181

atgagcttct	caaacgcac	cctgaaatc	gtttacacc	acgacaccg	tctggactat	60
atcacctact	ctgactacga	actggaccog	gctaaccgc	tggctggtg	tgctgcttgg	120
atcgaaggtc	aattcgttcc	gccgtctgaa	gctcgtatct	ctatcttcga	ccagggtttt	180
tatacttctg	acgctaccta	caccgtcttc	cacgtttgga	acggtaacgc	tttccgtctg	240
ggggaccaca	tcgaacgtct	gttctctaata	gcggaatcta	ttcgtttgat	cccgcgcgtg	300
accaggagc	aagttaaaga	ggtagctctg	gaactggttg	ctaaaaccga	actgcgtgaa	360
gcgatcgta	tcgttgctat	caccgcgtgt	tactcttcta	ccccatggga	gcgtgacatc	420
accaaacatc	gtccgcaggt	ttacatggct	gctgttccgt	accagtggat	cgtaccgttt	480
gaccgcaccc	gtgacgggtg	tcacctgatg	gttgctcagt	cagttcgtcg	tacaccgcgt	540
agctctatcg	accggcaggt	taaaaacttc	cagtcgggtg	acctgatccg	tgcatttcag	600

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gggtccacg accgctgggt caggttaccg ctgctgctgg acttcgacaa catgctggct    660
gaaggtccgg gtttcaacgt tgttggtatc aaagacgggt ttgttcgttc tccgggtcgt    720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac    780
gaagctatcc tggctgacat cccccggct gaactgtacg acgctgacga agttctgggt    840
tgctcaaccg gtggtgggtg ttggccgttc gtttctgttg acggttaactc tatctctgac    900
ggtgttcogg gtcgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa    960
cattcttctc tgctgacccc gatccagtac    990

```

<210> 182

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 182

```

Met Ser Phe Ser Asn Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

```

```

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

```

```

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Gln Phe Val Pro Pro
35           40           45

```

```

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

```

```

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

```

```

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

```

```

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Val Ala Leu Glu Leu
100          105          110

```

```

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ala Ile Thr
115          120          125

```

```

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

```

```

Pro Gln Val Tyr Met Ala Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145          150          155          160

```

```

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

```

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Met Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Ile Gln Tyr
325 330

<210> 183

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 183

atggcggtct cagcggacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggctggtag ggctgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttggtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgctgaa	360
gcgatcggtta tcgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc	420
accaaaccatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660

```

gaaggtccgg gtttcaacgt tgttggtatc aaagacgggtg ttgttcgttc tccgggtcgt      720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocgggt gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacgtac                                          990

```

<210> 184

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 184

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Arg Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

```

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 185

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 185

atggcggtct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tcttgactat	60
atcatctact ctgactacga actggaccgg gctaaccggc tggtggtgg tgtgcttg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caccgttgga acggtaacgc tttcgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gcgatcgtta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtgcgtcg tacaccgctg	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
caagtcggg gtttgaacgt tttttttatg aaagacgtg ttttcttcg tccggtgat	720

```

gaaggccggg gctccaaagt cgtgcctacc aagagggggt cgtcccgccc ccggggccgc      720
gtgtgtctgc cgggtatcac ccgtaaaacc gttctggaaa tcgtgaatc tctgggtcac      780
gaagctatcc tggctgacat caccocggct gaactgtacg acgtgacga agttctgggt      840
tgctcaaccg gtgggtgggt ttggccgttc gtttctgttg acggtaacct tatctctgac      900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 186

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 186

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Ile Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu

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Gly Asp Leu Ile Arg Ala Ile Gln Gln Thr His Asp Arg Gly Phe Gln
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 187

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 187

atggcggtct cagcgacac cctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgg gctaaccggc tggtgtgttg tgctgcttgg	120
atcgcggtg ctttctgtcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgtaccta caccgtcttc cactgttggg acggtaacgc tttcgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gcgatcgtta tcgtttctat caccgtgggt tactcttcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctctcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780

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gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt      840
tgctcaaccg gtgggtggtgt ttggccgttc gtttctgttg acggttaactc tatctctgac      900
ggtgttccgg gtccggttac ccagtctatc atccgtcggt actgggaact gaacggtgaa      960
ccttcttctc tgctgacccc ggtacagtac      990

```

<210> 188

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 188

```

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20          25          30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Ala Gly Ala Phe Val Pro Pro
35          40          45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50          55          60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65          70          75          80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85          90          95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100         105         110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115         120         125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130         135         140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145         150         155         160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165         170         175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180         185         190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195         200         205

Leu Pro Leu Leu Leu Leu Arg Phe Arg Arg Leu Leu Ala Glu Glu Pro Glu

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Leu Phe Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Phe Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 189

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 189

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atcgaaggtg ctttcgttcc gccgtctgaa gctaagatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc cactgttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gogatcgta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtccgtcg tacaccgctg	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtgggtggtgt ttggccgttc gtttctgttg acggtaaactc tatctctgac	900

...

gggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa 960
ccttcttctc tgctgacccc ggtacagtac 990

<210> 190

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 190

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Lys Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 191

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 191

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atcacctact ctgactacga actggaccgg gctaaccggc tggctgggtg tgctgcttgg	120
atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttogtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gcgatcggtt tcgtttctat caccgtggt tactcttcta ccccatggga gcgtgacatc	420
accaaaccatc gtccgcaggt ttacatgtat gctgttccgt accagtggat cgtaccgttt	480
gaccgcatcg ctgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgctg	540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccocggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtgggtggtg ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 192

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 192

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Ala Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Glu Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu

Ala Ala Ser Phe Gly Ile Thr Arg Lys Thr Val Ser Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 193

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 193

atggcggttct cagcggacac ccctgaaatc gtttacaccc acgacaccgg tctggactat	60
atcacctact ctgactacga actggaccgc gctaaccgcg tggttggtgg tgctgcttgg	120
atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctccta gcggaatcta ttctgttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgtctct gaactggttg ctaaaaccga actgctgaa	360
gcgatcgtta tcgtttctat caccgtggt tactcttcta cccatggga gcgtgacatc	420
accaaaccatc gtccgcaggt ttacatgtat gctgttccgt acgttggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagtctctcg tacaccgct	540
agctctatcg acccgaggt taaaaacttc cagtgggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaaggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggtgacat caccocggct gaactgtacg acgtgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 194

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 194

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Ala Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 195

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 195

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atcgaagggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat ccgcccgtg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgcgtgaa	360
gcgatcgta tcgtttctat caccgtgggt tactcttcta ccccatggga gcgtagacac	420
accaaacatc gtccgcaggt ttacatgttt gctgttccgt accagtggtat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtgggtt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tgttggtatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggttgacat caccocggct gaactgtacg acgctgacga agttctgggt	840
tgtcacaacg gtggtggtgt ttggccgttc gtttctgttg acggtaacac tatctctgac	900
ggtgttccgg gtccggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacagtac	990

<210> 196

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 196

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Phe Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
 325 330

<210> 197

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 197

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caccgttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactgggtg ctaaaaccga actgctgaa	360
gcgatcgta tcgtttctat caccggtggt tactcttcta cccatggga gcgtgacatc	420
accaaacatc gtccgcaggt ttacatgtat gctgttccgt accaggggat cgtaccgttt	480
gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgcgt	540
agctctatcg acccgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaacccacg accgtgggtt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
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tgctcaaccg gtgggtggtg ttggccgttc gtttctgttg acggtaacct tatctctgac	900
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ccttcttctc tgctgacccc ggtacagtac	990

<210> 198

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 198

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1           5           10           15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20           25           30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35           40           45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50           55           60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65           70           75           80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85           90           95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100          105          110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115          120          125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130          135          140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Gly Ile Val Pro Phe
145          150          155          160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165          170          175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180          185          190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195          200          205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210          215          220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225          230          235          240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245          250          255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260          265          270

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Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr

325

330

<210> 199

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 199

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atcgaaggtg ctttcgttcc gccgtctgaa gctcgtatct ctatcttcga ccagggtttt	180
tatacttctg acgctaccta caccgtcttc caggtttgga acggtaacgc tttccgtctg	240
ggggaccaca tcgaacgtct gttctctaata gcggaatcta ttcgtttgat cccgccgctg	300
accaggacg aagttaaaga gatcgctctg gaactggttg ctaaaaccga actgcgtgaa	360
gogatcgta tcgtttctat caccgtggt tactctcta cccatggga gogtgacatc	420
accaaacatc gtccgcaggt ttacatgat gctgttccgt accaggcgat cgtaccgttt	480
gaccgcaccc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
agctctatcg accgcaggt taaaaacttc cagtggggtg acctgatccg tgcaattcag	600
gaaaccacg accgtggttt cgagttaccg ctgctgctgg acttcgacaa cctgctggct	660
gaagggtccgg gtttcaacgt tggtgttatc aaagacggtg ttgttcgttc tccgggtcgt	720
gctgctctgc cgggtatcac ccgtaaaacc gttctggaaa tcgctgaatc tctgggtcac	780
gaagctatcc tggctgacat caccgggct gaactgtacg acgctgacga agttctgggt	840
tgctcaaccg gtggtggtgt ttggccgttc gtttctgttg acggtaacct tatctctgac	900
ggtgttccgg gtccgggttac ccagtctatc atccgtcgtt actgggaact gaacgttgaa	960
ccttcttctc tgctgacccc ggtacgtac	990

<210> 200

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 200

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Ala Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp

275

280

285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 201

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 201

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tatacttctg acgctaccta caccgtcttc cactgttggg acggtaacgc tttccgtctg	240
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gaccgcatcc gtgacggtgt tcacctgatg gttgctcagt cagttcgtcg tacaccgct	540
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<210> 202

<211> 330

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<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 202

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Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
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Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20      25      30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35      40      45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50      55      60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65      70      75      80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85      90      95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100     105     110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115     120     125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130     135     140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Ser Ile Val Pro Phe
145     150     155     160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165     170     175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180     185     190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195     200     205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210     215     220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225     230     235     240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245     250     255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260     265     270

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Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
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Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
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<210> 203

<211> 990

<212> DNA

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 203

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<211> 330

<212> PRT

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<223> Engineered variant of Arthrobacter transaminase

<400> 204

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1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Leu Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp

180

185

190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
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Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
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<212> DNA

<213> Artificial Sequence

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<223> Engineered variant of Arthrobacter transaminase

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<210> 206

<211> 330

<212> PRT

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<223> Engineered variant of Arthrobacter transaminase

<400> 206

Met Ala Phe Ser His Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45

Ser Glu Ala Arg Ile Ser Ile Gly Asp Gln Gly Phe Tyr Thr Ser Asp
 50 55 60

Ala Thr Tyr Thr Val Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Leu Arg Leu
 85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ile Val Ser Ile Thr
 115 120 125

Arg Gly Tyr Ser Ser Thr Pro Trp Glu Arg Asp Ile Thr Lys His Arg
 130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205

Leu Pro Leu Leu Leu Asp Phe Asp Asn Leu Leu Ala Glu Gly Pro Gly
 210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
 260 265 270

200 205 210
 Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
 290 295 300
 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
 305 310 315 320
 Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
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<210> 207

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<212> PRT

<213> Artificial Sequence

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<223> Engineered variant of Arthrobacter transaminase

<400> 207

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
 1 5 10 15
 Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
 20 25 30
 Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Tyr Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Asp Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Ile
 85 90 95
 Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
 100 105 110
 Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
 115 120 125
 Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
 130 135 140
 Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
 145 150 155 160
 Asp Arg Ile Arg Asp Gly Val His Ala Met Val Ala Gln Ser Val Arg
 165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
 180 185 190
 Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
 195 200 205
 Leu Pro Leu Leu Leu Asp Cys Asp Gly Leu Leu Ala Glu Gly Pro Gly
 210 215 220
 Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
 225 230 235 240
 Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
 245 250 255
 Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Leu Ala Glu Leu
 260 265 270
 Leu Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
 275 280 285
 Pro Phe Val Ser Val Asp Gly Asn Pro Ile Ser Asp Gly Val Pro Gly
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 Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
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 Ser Ser Ser Leu Leu Thr Pro Val Gln Tyr
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 <400> 208
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 20 25 30
 Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
 35 40 45
 Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Tyr Tyr Thr Ser Asp
 50 55 60
 Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
 65 70 75 80
 Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Leu Arg Leu
 85 90 95

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Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
      100                      105                      110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val Ser Val Ser Ile Thr
      115                      120                      125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
      130                      135                      140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
      145                      150                      155                      160

Asp Arg Ile Arg Asp Gly Val His Ala Met Val Ala Gln Ser Val Arg
      165                      170                      175

Arg Ser Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
      180                      185                      190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
      195                      200                      205

Leu Pro Leu Leu Leu Asp Cys Asp Gly Leu Leu Ala Glu Gly Pro Gly
      210                      215                      220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
      225                      230                      235                      240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
      245                      250                      255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
      260                      265                      270

Leu Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
      275                      280                      285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
      290                      295                      300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
      305                      310                      315                      320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
      325                      330

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<210> 209

<211> 330

<212> PRT

<213> Artificial Sequence

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<223> Engineered variant of Arthrobacter transaminase

<400> 209

Met Ala Phe Ser Ala Asp Thr Pro Glu Ile Val Tyr Thr His Asp Thr
1 5 10 15

Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Ile Val His Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
325 330

<210> 210

<211> 330

<212> PRT

<213> Artificial Sequence

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<223> Engineered variant of Arthrobacter transaminase

<400> 210

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Gly Leu Asp Tyr Ile Thr Tyr Ser Asp Tyr Glu Leu Asp Pro Ala Asn
20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

Val Ala Lys Thr Glu Leu Arg Glu Ala Met Val Asn Val Ser Ile Thr
115 120 125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
130 135 140

Pro Gln Val Tyr Met Tyr Ala Val Pro Tyr Gln Trp Ile Val Pro Phe
145 150 155 160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
165 170 175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
180 185 190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
195 200 205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
210 215 220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
225 230 235 240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
245 250 255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
260 265 270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
275 280 285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
290 295 300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
305 310 315 320

Pro Ser Ser Leu Leu Thr Pro Val His Tyr
325 330

<210> 211

<211> 330

<212> PRT

<213> Artificial Sequence

<220>

<223> Engineered variant of Arthrobacter transaminase

<400> 211

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20 25 30

Pro Leu Ala Gly Gly Ala Ala Trp Ile Glu Gly Ala Phe Val Pro Pro
35 40 45

Ser Glu Ala Arg Ile Ser Ile Phe Asp Gln Gly Phe Tyr Thr Ser Asp
50 55 60

Ala Thr Tyr Thr Thr Phe His Val Trp Asn Gly Asn Ala Phe Arg Leu
65 70 75 80

Gly Asp His Ile Glu Arg Leu Phe Ser Asn Ala Glu Ser Ile Arg Leu
85 90 95

Ile Pro Pro Leu Thr Gln Asp Glu Val Lys Glu Ile Ala Leu Glu Leu
100 105 110

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Val Ala Lys Thr Glu Leu Arg Glu Ala Met Val Thr Val Thr Ile Thr
    115                                120                        125

Arg Gly Tyr Ser Ser Thr Pro Phe Glu Arg Asp Ile Thr Lys His Arg
    130                                135                        140

Pro Gln Val Tyr Met Ser Ala Cys Pro Tyr Gln Trp Ile Val Pro Phe
    145                                150                        155                        160

Asp Arg Ile Arg Asp Gly Val His Leu Met Val Ala Gln Ser Val Arg
                                165                                170                        175

Arg Thr Pro Arg Ser Ser Ile Asp Pro Gln Val Lys Asn Phe Gln Trp
                                180                                185                        190

Gly Asp Leu Ile Arg Ala Ile Gln Glu Thr His Asp Arg Gly Phe Glu
    195                                200                        205

Leu Pro Leu Leu Leu Asp Cys Asp Asn Leu Leu Ala Glu Gly Pro Gly
    210                                215                        220

Phe Asn Val Val Val Ile Lys Asp Gly Val Val Arg Ser Pro Gly Arg
    225                                230                        235                        240

Ala Ala Leu Pro Gly Ile Thr Arg Lys Thr Val Leu Glu Ile Ala Glu
                                245                                250                        255

Ser Leu Gly His Glu Ala Ile Leu Ala Asp Ile Thr Pro Ala Glu Leu
                                260                                265                        270

Tyr Asp Ala Asp Glu Val Leu Gly Cys Ser Thr Gly Gly Gly Val Trp
    275                                280                        285

Pro Phe Val Ser Val Asp Gly Asn Ser Ile Ser Asp Gly Val Pro Gly
    290                                295                        300

Pro Val Thr Gln Ser Ile Ile Arg Arg Tyr Trp Glu Leu Asn Val Glu
    305                                310                        315                        320

Pro Ser Ser Leu Leu Thr Pro Val Gln Tyr
                                325                                330

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REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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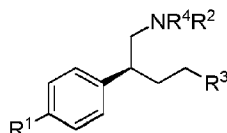
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BIOKATALYTISK TRANSAMINERINGSFREMANGSMÅDE

PATENTKRAV

1. Fremgangsmåde til fremstilling af en asymmetrisk forbindelse med formlen I:

**I**

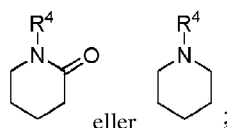
5 hvor:

R^1 er en fraspaltelig gruppe, en beskyttet aminogruppe, NO_2 , eller OH eller dens beskyttede form;

R^2 er hydrogen;

R^3 er $(C=O)OR^5$, CH_2R^6 eller et beskyttet aldehyd; eller

R^2 og R^3 kombineres for at danne et nitrogenholdigt heterocycl, der er udvalgt fra



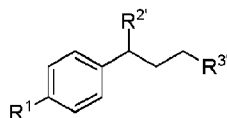
10

R^4 er hydrogen eller en aminobeskyttelsesgruppe;

R^5 er C_{1-6} alkyl, C_{3-10} -cycloalkyl, C_{4-10} -heterocycl, aryl eller heteroaryl; og

R^6 er en fraspaltelig gruppe eller OH eller dens beskyttede form;

der omfatter en biokatalytisk transaminering af en forbindelse med formlen II:

**II**

15

hvor:

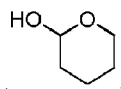
R^1 er som defineret ovenfor;

$R^{2'}$ er et aldehyd eller en aldehydækvivalent; og

$R^{3'}$ er R^3 ; eller

20

$R^{2'}$ og $R^{3'}$ kombineres for at danne



i nærvær af et transaminasepolypeptid, et coenzym og en aminodonor.

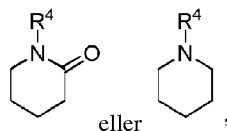
2. Fremgangsmåde ifølge krav 1, hvor transaminasepolypeptidet er udvalgt fra SEQ ID NO: 18 eller SEQ ID NO: 180.

25 3. Fremgangsmåde ifølge krav 2, hvor transaminasepolypeptidet er SEQ ID NO: 180.

4. Fremgangsmåde ifølge krav 1, hvor coenzymet er pyridoxal-phosphat (PLP).

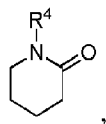
- 2 -

5. Fremgangsmåde ifølge krav 1, hvor aminodonoren er isopropylamin.
6. Fremgangsmåde ifølge krav 1, hvor transaminasepolypeptidet er SEQ ID NO: 180, coenzymet er PLP og aminodonoren er isopropylamin.
7. Fremgangsmåde ifølge krav 1, hvor R^1 er Br.
- 5 8. Fremgangsmåde ifølge krav 1, hvor R^2 og R^3 kombineres for at danne et nitrogenholdigt heterocyclyl udvalgt fra



og R^4 er hydrogen.

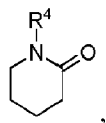
9. Fremgangsmåde ifølge krav 8, hvor R^2 og R^3 kombineres for at danne



10

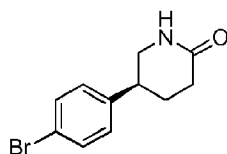
og R^4 er hydrogen.

10. Fremgangsmåde ifølge krav 1, hvor R^1 er Br, R^2 og R^3 kombineres for at danne



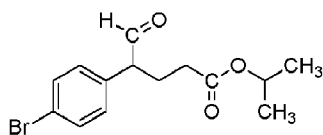
og R^4 er hydrogen.

- 15 11. Fremgangsmåde ifølge krav 1, hvor R^2 er hydrogen, R^3 er CH_2R^5 , R^4 er hydrogen og R^5 er OH.
12. Fremgangsmåde til fremstilling af en asymmetrisk forbindelse med formlen III:

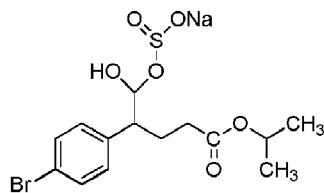


III

der omfatter en biokatalytisk transaminering af en forbindelse med formlen IV eller en forbindelse med formlen V:



IV



V

20

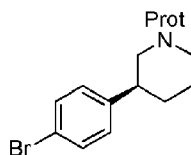
i nærvær af et transaminasepolypeptid, et coenzym og en aminodonor.

- 3 -

13. Fremgangsmåde ifølge krav 12, hvor transaminasepolypeptidet er udvalgt fra SEQ ID NO: 18 eller SEQ ID NO: 180.

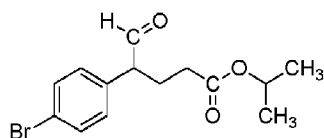
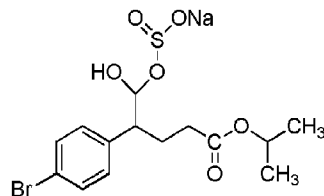
14. Fremgangsmåde ifølge krav 13, hvor transaminasepolypeptidet er SEQ ID NO: 180, coenzymet er PLP og aminodonoren er isopropylamin.

5 15. Fremgangsmåde til fremstilling af en asymmetrisk forbindelse med formel VI:

**VI**

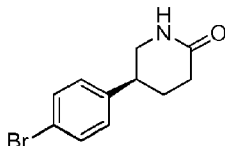
der omfatter:

(a) en biokatalytisk transaminering af en forbindelse med formel IV eller en forbindelse med formel V:

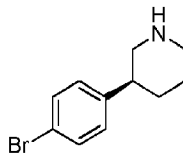
**IV****V**

10

i nærvær af et transaminasepolypeptid, et coenzym og en aminodonor, hvorved forbindelsen med formel III dannes:

**III** ;

15 (b) reduktion af lactam i forbindelsen med formel III, hvorved forbindelsen med formel VII dannes:

**VII** ; og

(c) beskyttelse af piperidinnitrogenet i forbindelsen med formel VII for at danne forbindelsen med formel VI.