The Claims defining the invention are as follows:

~~CLAIMS~~

~~We claim:~~

1. An engineered enzyme composition, comprising:

a) a polypeptide having xylanase activity; and

b) a polypeptide having Group 1 β-xylosidase activity; and

~~b)~~c) a polypeptide having Group 2 β-xylosidase activity; and ~~selected from a Group 1 or 2 β-xylosidase; and~~

~~c)~~d) a polypeptide having L-α-arabinofuranosidase activity; and

e) a polypeptide having β-glucosidase activity or a whole cellulase enriched with the polypeptide having β-glucosidase activity~~,~~; and

~~d)~~f) a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity;

wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.

~~2. An engineered enzyme composition comprising:~~

~~a) a polypeptide having β-xylosidase activity selected from a Group 1 β-xylosidase; and~~

~~a) a polypeptide having β-xylosidase activity selected from a Group 2 β-xylosidase; and~~

~~b) a polypeptide having L-α-arabinofuranosidase activity; and~~

~~c) a polypeptide having β-glucosidase activity or a whole cellulase enriched with the polypeptide having β-glucosidase activity,~~

~~wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.~~

~~3. An engineered enzyme composition comprising:~~

~~a) a polypeptide having xylanase activity; and~~

~~a) a polypeptide having β-xylosidase activity selected from a Group 1 β-xylosidase; and~~

~~b) a polypeptide having β-xylosidase activity selected from a Group 2 β-xylosidase; and~~

~~c) a polypeptide having β-glucosidase activity or a whole cellulase enriched with the polypeptide having β-glucosidase activity,~~

~~wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.~~

~~An engineered enzyme composition comprising:~~

~~a) a polypeptide having xylanase activity; and~~

~~a) a polypeptide having β-xylosidase activity selected from a Group 1 or 2 β-xylosidase; and~~

b) a polypeptide having β-glucosidase activity or a whole cellulase enriched with the polypeptide having β-glucosidase activity,

wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.

4. The enzyme composition of any one of claims 1-4, further comprising a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity

5. An engineered enzyme composition, comprising:

6. a polypeptide having xylanase activity; and

7. a polypeptide having β-xylosidase activity selected from a Group 1 or 2 β-xylosidase; and

8. a polypeptide having L-α-arabinofuranosidase activity; and

9. a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity,

wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.

10. An engineered enzyme composition comprising:

a) a polypeptide having β-xylosidase activity selected from a Group 1 β-xylosidase; and

b) a polypeptide having β-xylosidase activity selected from a Group 2 β-xylosidase; and

c) a polypeptide having L-α-arabinofuranosidase activity; and

d) a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity,

wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.

11. An engineered enzyme composition comprising:

a) a polypeptide having xylanase activity; and

b) a polypeptide having β-xylosidase activity selected from a Group 1 β-xylosidase; and

c) a polypeptide having β-xylosidase activity selected from a Group 2 β-xylosidase; and

d) a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity,

wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.

12. An engineered enzyme composition comprising:

a) a polypeptide having xylanase activity; and

b) a polypeptide having β-xylosidase activity selected from a Group 1 or 2 β-xylosidase; and

~~c) a polypeptide having GH61/endoglucanase activity or a whole cellulase enriched with the polypeptide having GH61/endoglucanase activity,~~

~~wherein the enzyme composition is capable of hydrolyzing a lignocellulosic biomass material.~~

~~13.~~2. The engineered enzyme composition ~~of any one of claims 1-9~~of ~~claim~~Claim 1, wherein the polypeptide having xylanase activity is~~:~~ selected from a polypeptide comprising an amino acid sequence that has at least 70% identity to SEQ ID NO: 24, 26, 42, or 43, or to a mature sequence thereof; or a polypeptide encoded by a nucleotide having at least 70% identity to SEQ ID NO:23, 25, or 41, or a polypeptide encoded by a nucleotide that is capable of hybridizing under high stringency conditions to SEQ ID NO: 23, 25 or 41, or to a complement thereof.

~~14.~~3. The engineered enzyme composition of ~~any one of claims 1-2~~Claim 1 or Claim 2~~10~~, wherein:

a) the polypeptide having β-xylosidase activity of Group 1 comprises an amino acid sequence having at least 70% identity to SEQ ID NO: 2 or 10 or to a mature sequence thereof, and the polypeptide having β-xylosidase activity of Group 2 comprises an amino acid sequence having at least 70% identity to SEQ ID NO: 4, 6, 8, 10, 12, 14, 16, 18, 28, 30, or 45, or to a mature sequence thereof; or

b) the polypeptide having β-xylosidase activity of Group 1 is encoded by a nucleotide and comprises an amino acid sequence having at least 70% identity to SEQ ID NO: 2 or 10 or to a mature sequence thereof, and the polypeptide having β-xylosidase activity of Group 2 comprises an amino acid sequence having at least 70% identity to SEQ ID NO: 4, 6, 8, 10, 12, 14, 16, 18, 28, 30, or 45, or to a mature sequence thereof; or

c) the polypeptide having β-xylosidase activity of Group 1 is encoded by a nucleotide having at least 70% identity to SEQ ID NO:1 or 9; and the polypeptide having β-xylosidase activity of Group 2 is encoded by a nucleotide having at least 70% identity to SEQ ID NO:3, 5, 7, 9, 11, 13, 15, 17, 27, or 29; or

d) the polypeptide having β-xylosidase activity of Group 1 is capable of hybridizing under high stringency conditions to SEQ ID NO:1 or 9, or to a complement thereof; and the polypeptide having β-xylosidase activity of Group 2 is capable of hybridizing under high stringency conditions to SEQ ID NO:3, 5, 7, 9, 11, 13, 15, 17, 27, or 29, or to a complement thereof.

15.4. The engineered enzyme composition of any one of claims 1-3Claims 1 to 311, wherein the polypeptide having L-α-arabinofuranosidase activity is:

a) a polypeptide comprising an amino acid sequence that has at least 70% identity to SEQ ID NO:12, 14, 20, 22 or 32, or to a mature sequence thereof; or

b) a polypeptide encoded by a nucleotide having at least 70% identity to SEQ ID NO:11, 13, 19, 21, or 31, or a nucleotide capable of hybridizing under high stringency conditions to SEQ ID NO: SEQ ID NO:11, 13, 19, 21, or 31.

16.5. The engineered enzyme composition of any one of claims 1-4Claims 1 to 412, wherein the polypeptide having β-glucosidase activity is:

a) a polypeptide comprising an amino acid sequence having at least about 60% identity to SEQ ID NO: 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 79, 93, and 95; or

b) a hybrid polypeptide comprising 2 two or more β-glucosidase sequences, wherein the first sequence derived from a first β-glucosidase is at least 200 amino acid residues in length and comprises one or more or all of SEQ ID NOs: 96 to 108, and the second sequence derived from a second β-glucosidase is at least 50 amino acid residues in length and comprises one or more or all of SEQ ID NOs: 109 to 116, and optionally a third sequence derived from a third β-glucosidase of 3, 4, 5, 6, 7, 8, 9, 10, or 11 amino acid residues in length encoding a loop sequence comprising SEQ ID NO: 204 or 205; or

c) a polypeptide encoded by a nucleotide that has at least about 60% identity to SEQ ID NO: 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 92 or 94, or one that is capable of hybridizing under high stringency conditions to SEQ ID NO: 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 92 or 94, or to a complement thereof.

17.6. The engineered enzyme composition of any one of claims 1-5Claims 1 to 513, wherein the polypeptide having GH61/endoglucanase activity is:

a) a polypeptide comprising an amino acid sequence having at least 70% sequence identity to any one of SEQ ID NOs:52, 80 to 81, 206 to 207, over a region of at least 100 residues; or

b) a polypeptide that is at least 200 residues in length, having GH61/endoglucanase activity, and comprising one or more sequence selected from the group consisting of: (1) SEQ ID NOs:84 and 88; (2) SEQ ID NOs:85 and 88; (3) SEQ ID NO:86; (4) SEQ ID NO:87; (5) SEQ ID NOs:84, 88 and 89; (6) SEQ ID NOs:85, 88, and 89; (7) SEQ ID NOs: 84, 88, and 90; (8) SEQ ID NOs: 85, 88 and 90; (9) SEQ ID NOs:84, 88 and 91; (10) SEQ ID NOs: 85, 88 and 91; (11) SEQ ID NOs: 84, 88, 89 and 91; (12) SEQ ID NOs: 84, 88, 90 and 91; (13) SEQ ID NOs: 85, 88, 89 and 91: and (14) SEQ ID NOs: 85, 88, 90 and 91; or

c) a polypeptide encoded by a nucleotide having at least 70% sequence identity to SEQ ID NO:51, or is capable of hybridizing under high stringency conditions to SEQ ID NO:51 or to a complement thereof.

~~18.~~7. The engineered enzyme composition of any one of ~~claims 1-6~~Claims 1 to 6~~14~~, wherein the polypeptide having β-glucosidase activity is a hybrid polypeptide comprising ~~2~~ two or more β-glucosidase sequences, wherein the first sequence derived from a first β-glucosidase is at least 200 amino acid residues in length and comprises one or more or all of SEQ ID NOs: 197 to ~~-~~202, and the second sequence derived from a second β-glucosidase is at least 50 amino acid residues in length and comprises SEQ ID NO:203, and optionally a third polypeptide sequence of 3 to ~~-~~11 amino acid residues in length comprising SEQ ID NO:204 or SEQ ID NO:205.

~~19.~~8. ~~-~~The engineered enzyme composition of any one of ~~claims 1-7~~Claims 1 to 7~~15~~, which is a culture mixture, a fermentation broth of a host cell expressing one or more of the polypeptides, or a whole broth formulation of the fermentation broth.

~~20.~~9. The engineered enzyme composition of ~~claim~~ Claim 8~~16~~, wherein the host cell is one of a bacterium or a fungus.

~~21.~~10. The engineered enzyme composition of ~~claim~~ Claim ~~1~~9~~7~~, wherein the bacterium is a *Bacillus,* or an *E.coli.*

~~22.~~11. The engineered enzyme composition of ~~claim~~ Claim ~~17~~10, wherein the fungus is a yeast, an *Aspergillus*, a *Chrysosporium,* or a *Trichoderma*.

~~23.~~12. The engineered enzyme composition of any one of ~~claims 1-11~~Claims 1 to 11~~19~~, further comprising a polypeptide having cellolubiohydrolase activity and/or a polypeptide having endoglucanase activity.

~~24.~~13. The engineered enzyme composition of any one of ~~claims 1-12~~Claims 1 to 12~~19~~, further comprising a whole cellulase.

~~25. The engineered enzyme composition of any one of claims 1-21, wherein the amount of xylanase relative to the total amount of proteins in the enzyme composition is about 10 wt.% to about 20 wt.%.~~

~~26. The engineered enzyme composition of any one of claims 1-21, wherein the amount of β-xylosidase relative to the total amount of proteins in the enzyme composition is about 5 wt.% to about 20 wt.%.~~

~~27. The engineered enzyme composition of any one of claims 1-23, wherein the amount of β-glucosidase relative to the total amount of proteins in the enzyme composition is about 18 wt.% to about 30 wt.%.~~

~~28. The engineered enzyme composition of any one of claims 1-24, wherein the amount of L-a-arabinofuranosidase relative to the total amount of proteins in the enzyme composition is about 0.2 wt.% to about 2 wt.%.~~

~~29. The engineered enzyme composition of any one of claims 1-25, wherein the amount of polypeptides having GH61/endoglucanase activity relative to the total amount of proteins in the enzyme composition is about 6 wt.% to about 20 wt.%.~~

~~30. The engineered enzyme composition of any one of claims 1-26, wherein the amount of polypeptides having cellobiohydrolase activity relative to the total amount of proteins in the enzyme composition is about 15 wt.% to about 25 wt.%.~~

~~31. The engineered enzyme composition of any one of claims 2-5, 7-8, and 10-27, wherein the ratio of the weight of Group 1 β-xylosidase to the weight of Group 2 β-xylosidase is 1:10 to 10:1, 1:9 to 9:1, 1:8 to 8:1, 1:7 to 7:1, 1:6 to 6:1, 1:5 to 5:1, 1:4 to 4:1, 1:3 to 3:1, 1:2 to 2:1, or 1:1.~~

~~32.~~14. The engineered enzyme composition of any one of ~~claims 1-28~~13Claims 1 to 13, wherein at least ~~1~~one, ~~2~~two, or ~~3~~ three of the polypeptides are heterologous to the host cell engineered to express the polypeptides.

~~33.~~15. The engineered enzyme composition of any one of ~~claims 1-14~~Claims 1 to 14~~28~~, wherein at least ~~2~~ two of the polypeptides are derived from different microorganisms.

~~34.~~16. The engineered enzyme composition of ~~claim~~ Claim ~~30~~15, wherein at least one of the polypeptides ~~are~~ is from a *Fusasrium,* or a *Trichoderma.*

~~35.~~17. A method of hydrolyzing or digesting a lignocellulosic biomass material comprising hemicelluloses, cellulose, or both cellulose and hemicelluloses, comprising contacting the enzyme composition of any one of ~~claims 1-31~~ 16Claims 1 to 16 with the lignocellulosic biomass mixture.

~~36.~~18. The method of ~~claim~~ Claim 17~~32~~, wherein the lignocellulosic biomass mixture comprises an agricultural crop, a byproduct of a food/feed production, a lignocellulosic waste product, a plant residue, or waste paper.

~~37.~~19. The method of ~~claim~~ Claim 18~~33~~, wherein the plant reside is selected from grain, seeds, ~~sternsstems~~, leaves, hulls, husks, corncobs, corn stover, potatos, soybean, barley, rye, oats, wheat, beats, sugarcane bagasse, sorghum, straw, grasses, canes, reeds, wood, wood chips, wood pulp, or sawdust.

~~38.~~20. The method of ~~claim~~ Claim 19~~33~~, wherein the grass is selected from Indian grass or switchgrass.

~~39.~~21. The method of any one of ~~claim~~ Claims ~~10~~17 to 20~~32~~, wherein the biomass material in the lignocellulosic biomass mixture is subjected to pretreatment.

~~40.~~22. The method of any one of ~~claims~~ Claims 17 to ~~21~~32~~-36~~, wherein the lignocellulosic biomass mixture further comprises a fermentable sugar.

~~41.~~23. The method of ~~claim~~ Claim 21~~36~~, wherein the pretreatment is an acidic or a basic pretreatment.

~~42.~~24. The method of Claim ~~claim~~ ~~21~~38~~38~~, wherein the basic pretreatment is with a dilute ammonia,

43.25. The method of Claim claim 21338, wherein the acidic pretreatment is with a dilute acid.

44.26. A method of producing ethanol comprising contacting a lignocellulosic biomass material with an enzyme composition of any one of claims 1-1631Claims 1 to 16 to produce one or more fermentable sugar, followed by fementing the fermentable sugar into ethanol using an ethanologen microorganism.

45.27. The method of claim Claim 2641, wherein the lignocellulosic biomass material is subjected to pretreatment before it contacts the enzyme composition.

46. The method of claim 41 or 42, wherein the ethanologen microorganism is a yeast, or a Zymomonas mobilis.

47.28. The method of any one of claims 27-27Claim 2732-43, wherein the enzyme composition comprises about 2 g to about 20 g of polypeptide having xylanase activity per kilogram of hemicelluloses in the biomass material.

29. 45The method of any one of claims 32-4417-28Claims 17 to 28, wherein the enzyme composition comprises about 2 g to about 40 g of polypeptide having β-xylosidase activity per kilogram of hemicelluloses in the biomass material.

48.30. The method of any one of claims 32-45217-29Claims 17 to 29, wherein the enzyme composition comprises about 3 g to about 50 g of polypeptide having cellulase activity per kilogram of cellulose in the biomass material.

49.31. The method of claim Claim 4630, wherein the amount of polypeptide having β-glucosidase acitivityactivity constitutes up to about 50% of the total weight of polypeptide having cellulase activity.

50. The method of any one of claims Claims 17 to 3117-3132-47, wherein the enzyme composition is used in an amount, and under conditions and for a duration sufficient to convert 60% to 90% of the xylan in the biomass material into xylose.

~~51.~~32. ~~A method of using the enzyme composition of any one of claims 1-31 in an industrial or commercial setting following a merchant enzyme supply model strategy or a on-site biorefinery model strategy~~