CLAIMS

1. A recombinant microorganism comprising ~~a~~ one or more heterologous~~,~~ nucleic acids encoding (a) a stereospecific diol dehydratase ~~enzyme~~of SEQ ID NO: 1.

2. The ~~isolated, recombinant~~ microorganism of claim 1 wherein the ~~enzyme is~~ microorganism further comprises an activase of SEQ ID NO: 2.

A recombinant Clostridium autoethanogenum ~~diol dehydratase.~~

~~3. The isolated, recombinant microorganism of claim 1 wherein the enzyme is Clostridium ljungdahlii diol dehydratase.~~

~~4. The isolated, recombinant microorganism of claim 1 wherein the enzyme is at least 80% identical to Clostridium autoethanogenum diol dehydratase.~~

~~5. The isolated, recombinant microorganism of claim 1 or 4 which does not convert propan-2-one to propan-2-ol.~~

~~6. The isolated, recombinant microorganism of claim 1 or 4 which does not convert propanal to propan-l-ol.~~

~~7. The microorganism of claim 1 or 4 which is a carboxydotrophic acetogenic bacterium.~~

3. ~~8. An isolated,~~ microorganism comprising one or more nucleic acids encoding (a) a stereospecific diol dehydratase ~~enzyme which is genetically modified to express more of said enzyme activity~~of SEQ ID NO: 1 and (b) an activase of SEQ ID NO: 2, wherein the microorganism overexpresses the stereospecific diol dehydratase and/or the activase compared to wild-type *Clostridium autoethanogenum.*

4. The microorganism of claim 3, wherein the microorganism has a higher copy number of the one or more nucleic acids than wild-type Clostridium autoethanogenum ~~or Clostridium ljungdahlii~~.

~~9.~~

The microorganism of claim ~~8 which is genetically modified to have a higher average copy number of a gene encoding said enzyme than wild-type average copy number of the gene.~~

~~10. The microorganism of claim 9 wherein the higher average copy number is 2 or greater.~~

~~11. The microorganism of claim 9 wherein the higher average copy number is 3 or greater.~~

~~12. The microorganism of claim 8 which is genetically modified to have a higher average copy number of a gene encoding a stereospecific diol dehydratase enzyme activase than wild-type average copy number of the gene.~~

~~13. A method of producing at least one of propan-2-one or propan-2-ol, comprising:~~

~~culturing a first microorganism in a fermentation broth comprising propan-1,2- diol, whereby at least one of propan-2-one or propan-2-ol is produced.~~

~~14. The method of claim 13 wherein the propan-l,2-diol is produced in situ in the fermentation broth.~~

~~15. The method of claim 14 wherein the propan-l,2-diol is produced by the first microorganism.~~

~~16. The method of claim 14 wherein the propan-l,2-diol is produced by a second microorganism.~~

~~17. The method of claim 13 wherein the first microorganism is Clostridium autoethanogenum.~~

~~18. The method of claim 13 wherein the first microorganism is Clostridium ljungdahlii.~~

~~19. The method of claim 13 wherein the first microorganism is Escherichia coli.~~

~~20. The method of claim 13 wherein the first microorganism is a carboxydotrophic acetogenic bacterium.~~

~~21. The method of claim 13 wherein the fermentation broth comprises carbon monoxide (CO).~~

~~22. The method of claim 13 wherein the fermentation broth comprises at least one energy source selected from the group consisting of syngas, industrial waste gas, steel mill waste gas.~~

~~The method of claim 13 wherein the fermentation broth comprises at least one energy source selected from the group consisting of sugar, starch, cellulose, biomass hydrolysate, and glycerol.~~

~~24. The method of claim 13 further comprising the step of recovering from the fermentation broth at least one product selected from the group consisting of propionaldehyde, propan-2-one, propan-l-ol, and propan-2-ol.~~

~~25. The method of claim 13 wherein the fermentation broth comprises predominantly (R) entantiomer of propan-l,2-diol.~~

~~26. The method of claim 13 wherein the fermentation broth comprises predominantly (L) entantiomer of propan-l,2-diol.~~

5. ~~27. The method of claim 13~~1, wherein the microorganism produces ~~predominantly~~one or more of propan~~- 2-ol relative to~~-2-one, propan-~~l-~~2-ol, propanal, and propan-1-ol.

~~28.~~

6. The microorganism of claim 1, wherein the microorganism further comprises an endogenous or exogenous alcohol dehydrogenase.

7. The method of claim ~~13~~5, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

8. The microorganism of claim 3, wherein the microorganism further comprises attenuation or knockout of an endogenous alcohol dehydrogenase.

9. The method of claim 8, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

10. A method of producing a product comprising culturing the microorganism of claim 1 in the presence of a substrate and propane-1,2-diol whereby the microorganism produces ~~predominantly~~one or more of propan~~-l-ol relative to~~-2-one, propan-2-ol, propanal, and propan-1-ol.

~~29.~~

11. The method of claim ~~13~~10, wherein the propane-1,2-diol is one or both of (*R*)-propane-1,2-diol and (*S*)-propane-1,2-diol.

12. The method of claim 10, wherein the substrate comprises one or more of sugar, starch, cellulose, biomass, syngas, glycerol, and CO-containing gas.

13. The microorganism of claim 3, wherein the microorganism produces ~~predominantly propionaldehyde relative to propan-2-~~one~~.~~ or more of propan-2-one, propan-2-ol, propanal, and propan-1-ol.

~~30.~~

14. The microorganism of claim 3, wherein the microorganism further comprises an endogenous or exogenous alcohol dehydrogenase.

15. The method of claim ~~13~~14, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

16. The microorganism of claim 3, wherein the microorganism further comprises attenuation or knockout of an endogenous alcohol dehydrogenase.

17. The method of claim 16, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

A method of producing a product comprising culturing the microorganism of claim 3 in the presence of a substrate and propane-1,2-diol whereby the microorganism produces ~~predominantly propan-2-one relative to propionaldehyde.~~

~~31. The method of claim 13 wherein the microorganism does not convert propan-2-~~one ~~to~~ or more of propan~~-~~-2~~-ol.~~

18. ~~32. The method of claim 13 wherein the microorganism converts propan-2-~~-one ~~to,~~ propan-~~-~~2-ol, propanal, and propan-1-ol.

~~33.~~

19. The method of claim ~~13~~18, wherein the ~~fermentation broth~~propane-1,2-diol is one or both of (*R*)-propane-1,2-diol and (*S*)-propane-1,2-diol.

20. The method of claim 18, wherein the substrate comprises ~~at least 1 g/L propan-l,2-diol.~~ one or more of sugar, starch, cellulose, biomass, syngas, glycerol, and CO-containing gas.

We claim:

1. An isolated, recombinant microorganism comprising a heterologous, stereospecific diol dehydratase enzyme.

2. The isolated, recombinant microorganism of claim 1 wherein the enzyme is *Clostridium autoethanogenum* diol dehydratase.

3. The isolated, recombinant microorganism of claim 1 wherein the enzyme is *Clostridium ljungdahlii* diol dehydratase.

4. The isolated, recombinant microorganism of claim 1 wherein the enzyme is at least 80% identical to *Clostridium autoethanogenum* diol dehydratase.

5. The isolated, recombinant microorganism of claim 1 or 4 which does not convert propan-2-one to propan-2-ol.

6. The isolated, recombinant microorganism of claim 1 or 4 which does not convert propanal to propan-1-ol.

7. The microorganism of claim 1 or 4 which is a carboxydotrophic acetogenic bacterium.

8. An isolated, microorganism comprising a stereospecific diol dehydratase enzyme which is genetically modified to express more of said enzyme activity than wild-type *Clostridium autoethanogenum* or *Clostridium ljungdahlii.*

9. The microorganism of claim 8 which is genetically modified to have a higher average copy number of a gene encoding said enzyme than wild-type average copy number of the gene.

10. The microorganism of claim 9 wherein the higher average copy number is 2 or greater.

11. The microorganism of claim 9 wherein the higher average copy number is 3 or greater.

12. The microorganism of claim 8 which is genetically modified to have a higher average copy number of a gene encoding a stereospecific diol dehydratase enzyme activase than wild-type average copy number of the gene.

13. A method of producing at least one of propan-2-one or propan-2-ol, comprising:

culturing a first microorganism in a fermentation broth comprising propan-1,2-diol, whereby at least one of propan-2-one or propan-2-ol is produced.

14. The method of claim 13 wherein the propan-1,2-diol is produced *in situ* in the fermentation broth.

15. The method of claim 14 wherein the propan-1,2-diol is produced by the first microorganism.

16. The method of claim 14 wherein the propan-1,2-diol is produced by a second microorganism.

17. The method of claim 13 wherein the first microorganism is *Clostridium autoethanogenum.*

18. The method of claim 13 wherein the first microorganism is *Clostridium ljungdahlii.*

19. The method of claim 13 wherein the first microorganism is *Escherichia coli.*

20. The method of claim 13 wherein the first microorganism is a carboxydotrophic acetogenic bacterium.

21. The method of claim 13 wherein the fermentation broth comprises carbon monoxide (CO).

22. The method of claim 13 wherein the fermentation broth comprises at least one energy source selected from the group consisting of syngas, industrial waste gas, steel mill waste gas.

23. The method of claim 13 wherein the fermentation broth comprises at least one energy source selected from the group consisting of sugar, starch, cellulose, biomass hydrolysate, and glycerol.

24. The method of claim 13 further comprising the step of recovering from the fermentation broth at least one product selected from the group consisting of propionaldehyde, propan-2-one, propan-1-ol, and propan-2-ol.

25. The method of claim 13 wherein the fermentation broth comprises predominantly (R) entantiomer of propan-1,2-diol.

26. The method of claim 13 wherein the fermentation broth comprises predominantly (L) entantiomer of propan-1,2-diol.

27. The method of claim 13 wherein the microorganism produces predominantly propan-2-ol relative to propan-1-ol.

28. The method of claim 13 the microorganism produces predominantly propan-1-ol relative to propan-2-ol.

29. The method of claim 13 wherein the microorganism produces predominantly propionaldehyde relative to propan-2-one.

30. The method of claim 13 the microorganism produces predominantly propan-2-one relative to propionaldehyde.

31. The method of claim 13 wherein the microorganism does not convert propan-2-one to propan-2-ol.

32. The method of claim 13 wherein the microorganism converts propan-2-one to propan-2-ol.

33. The method of claim 13 wherein the fermentation broth comprises at least 1 g/L propan-1,2-diol.

CLAIMS

1. A recombinant microorganism comprising one or more heterologous nucleic acids encoding (a) a stereospecific diol dehydratase of SEQ ID NO: 1.

2. The microorganism of claim 1 wherein the microorganism further comprises an activase of SEQ ID NO: 2.

3. A recombinant *Clostridium autoethanogenum* microorganism comprising one or more nucleic acids encoding (a) a stereospecific diol dehydratase of SEQ ID NO: 1 and (b) an activase of SEQ ID NO: 2, wherein the microorganism overexpresses the stereospecific diol dehydratase and/or the activase compared to wild-type *Clostridium autoethanogenum.*

4. The microorganism of claim 3, wherein the microorganism has a higher copy number of the one or more nucleic acids than wild-type *Clostridium autoethanogenum*.

5. The microorganism of claim 1, wherein the microorganism produces one or more of propan-2-one, propan-2-ol, propanal, and propan-1-ol.

6. The microorganism of claim 1, wherein the microorganism further comprises an endogenous or exogenous alcohol dehydrogenase.

7. The method of claim 5, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

8. The microorganism of claim 3, wherein the microorganism further comprises attenuation or knockout of an endogenous alcohol dehydrogenase.

9. The method of claim 8, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

10. A method of producing a product comprising culturing the microorganism of claim 1 in the presence of a substrate and propane-1,2-diol whereby the microorganism produces one or more of propan-2-one, propan-2-ol, propanal, and propan-1-ol.

11. The method of claim 10, wherein the propane-1,2-diol is one or both of (*R*)-propane-1,2-diol and (*S*)-propane-1,2-diol.

12. The method of claim 10, wherein the substrate comprises one or more of sugar, starch, cellulose, biomass, syngas, glycerol, and CO-containing gas.

13. The microorganism of claim 3, wherein the microorganism produces one or more of propan-2-one, propan-2-ol, propanal, and propan-1-ol.

14. The microorganism of claim 3, wherein the microorganism further comprises an endogenous or exogenous alcohol dehydrogenase.

15. The method of claim 14, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

16. The microorganism of claim 3, wherein the microorganism further comprises attenuation or knockout of an endogenous alcohol dehydrogenase.

17. The method of claim 16, wherein the alcohol dehydrogenase is a secondary alcohol dehydrogenase.

18. A method of producing a product comprising culturing the microorganism of claim 3 in the presence of a substrate and propane-1,2-diol whereby the microorganism produces one or more of propan-2-one, propan-2-ol, propanal, and propan-1-ol.

19. The method of claim 18, wherein the propane-1,2-diol is one or both of (*R*)-propane-1,2-diol and (*S*)-propane-1,2-diol.

20. The method of claim 18, wherein the substrate comprises one or more of sugar, starch, cellulose, biomass, syngas, glycerol, and CO-containing gas.