CLAIMS:

1. An integrated process for the production of at least one fermentation product from a gaseous stream, the process comprising:
   a) obtaining a first gaseous stream comprising hydrogen and a second gaseous stream comprising CO_2;
   b) passing at least a portion of the first gaseous stream and at least a portion of the second gaseous stream to a reverse water gas shift CO_2 to CO conversion system operated under conditions to produce a CO enriched exit stream;
   c) passing the CO enriched exit stream to a bioreactor having a culture of one or more C1 fixing bacterium and fermenting to produce at least one fermentation product stream and a bioreactor tail gas stream comprising CO_2;
   d) compressing the bioreactor tail gas stream to generate a compressed bioreactor tail gas stream;
   e) passing at least a first portion of the compressed bioreactor tail gas stream, in any order, to:
      i) a gas desulfurization and or acid gas removal unit; or
      ii) a gas component removal unit; or
      iii) both the gas desulfurization and or acid gas removal unit and the gas component removal unit;

      to generate a compressed treated bioreactor tail gas stream;
   f) recycling the compressed treated bioreactor tail gas stream:
      i) to combine with the first gaseous stream, the second gaseous stream, or a combination thereof; or
      ii) to the reverse water gas shift CO_2 to CO conversion system; or
      iii) any combination thereof; and
   g) optionally recycling a second portion of the compressed bioreactor tail gas stream to combine with the CO enriched exit stream or to the bioreactor.
2. The process of claim 1 further comprising combining at least a second portion of the first gaseous stream, at least a second portion of the second gaseous stream, or a combination thereof, with the CO enriched exit stream.

3. The process of claim 1 further comprising passing at least at least a second portion of the first gaseous stream, at least a second portion of the second gaseous stream, or a combination thereof, to the bioreactor.
4. The process of claim 1 further comprising compressing any portions of the first gaseous stream, the second gaseous stream, or combinations thereof.
5. The process of claim 1 further comprising controlling the relative amounts of the first portion of the compressed tail gas stream and the second portion of the compressed tail gas stream using a control valve.
6. The process of claim 1, wherein the CO enriched exit stream comprises a H_2:CO:CO_2 molar ratio of about 5:1:1, about 4.5:1:1, about 4.33:1:1, about 3:1:1, about 2:1:1, about 1:1:1; or about 1:3:1.
7. The process of claim 1, wherein:
    a) the at least one fermentation product is selected from ethanol, acetate, butanol, butyrate, 2,3-butanediol, lactate, butene, butadiene, methyl ethyl ketone, ethylene, acetone, isopropanol, lipids, 3-hydroxypropionate, isoprene, fatty acids, 2-butanol, 1,2-propanediol, hexanol, octanol, or 1-propanol; or
    b) the first gaseous stream comprising hydrogen is produced by a hydrogen production source comprising at least one of a water electrolyser, a hydrocarbon reforming source, a hydrogen purification source, a solid biomass gasification source, a solid waste gasification source, a coal gasification source, a hydrocarbon gasification source, a methane pyrolysis source, a refinery tail gas production source, a plasma reforming reactor, partial oxidation reactor, or any combination thereof; or
    c) wherein the second gaseous stream comprising CO_2 is produced by a gas production source comprising at least one of a sugar-based ethanol production source, a first generation corn-ethanol production source, a second generation corn-ethanol production source, a sugarcane ethanol production source, a cane sugar ethanol production source, a sugar beet ethanol production source, a molasses ethanol production source, a wheat ethanol production source, a grain based ethanol production source, a starch based ethanol production source, a cellulosic based ethanol production source, a cement production source, a methanol synthesis source, an olefin production source, a steel production source, a ferroalloy production source, a refinery tail gas production source, a

post combustion gas production source, a biogas production source, a landfill production source, an ethylene oxide production source, a methanol production source, an ammonia production source, mined CO_2 production source, natural gas processing production source, a gasification source, an organic waste gasification source, direct air capture, or any combination thereof; or

d) any combination thereof.

8. The process of claim 1, wherein at least one C1 fixing bacterium is selected from *Clostridium autoethanogenum, Clostridium ljungdahlii,* or *Clostridium ragsdalei.*

9. An integrated process for the production of at least one fermentation product from a gaseous stream, the process comprising:

a) obtaining a first gaseous stream comprising hydrogen and a second gaseous stream comprising CO_2;

b) optionally compressing, in a first compressor, at least a portion of the first gaseous stream, at least a portion of the second gaseous stream, or any combination thereof to generate a compressed first gaseous stream, a compressed second gaseous stream, and or a compressed combination first gaseous stream and second gaseous stream;

c) treating:

i) at least a portion of the first gaseous stream or the compressed first gaseous stream, or both; and at least a portion of the second gaseous stream or the compressed second gaseous stream, or both; or

ii) the compressed combination first gaseous stream and second gaseous stream;

in a gas treatment zone comprising a gas component removal unit, a gas desulfurization/acid gas removal unit, or both to generate a treated stream;

d) converting CO_2 in at least a first portion of the treated stream to form CO in a reverse water gas shift CO_2 to CO conversion system operated under conditions to produce a CO enriched exit stream;

e) passing the CO enriched exit stream to a bioreactor having a culture of one or more C1 fixing bacterium and fermenting to produce at least one fermentation product stream and a bioreactor tail gas stream; and

f) recycling the tail gas stream to the first compressor, the gas treatment zone, the reverse water gas shift CO_2 to CO conversion system, the first gaseous stream, the second

gaseous stream, or the combination of the first gaseous stream and the second gaseous stream.

10. The process of claim 9 further comprising, combining with the CO enriched exit stream, at least a portion of:
    a) the treated stream; or
    b) the first gaseous stream; or
    c) the second gaseous stream; or
    d) the combination of the first gaseous stream and the second gaseous stream; or
    e) the compressed first gaseous stream; or
    f) the compressed second gaseous stream; or
    g) the compressed combination first gaseous stream and second gaseous stream; or
    h) any combination thereof.
11. The process of claim 9, wherein the CO enriched exit stream further comprises hydrogen and CO_2 and comprises a H_2:CO:CO_2 molar ratio of about 5:1:1, about 4.5:1:1, about 4.33:1:1, or about 3:1:1, about 2:1:1, about 1:1:1; or about 1:3:1.
12. The process of claim 9, wherein the gas treatment zone further comprises a deoxygenation unit, a catalytic hydrogenation unit, an adsorption unit, a thermal oxidizer, or any combination thereof.
13. The process of claim 9, wherein the at least one fermentation product is selected from ethanol, acetate, butanol, butyrate, 2,3-butanediol, lactate, butene, butadiene, methyl ethyl ketone, ethylene, acetone, isopropanol, lipids, 3-hydroxypropionate, isoprene, fatty acids, 2-butanol, 1,2-propanediol, hexanol, octanol, or 1-propanol.
14. The process of claim 9, wherein:
    a) the first gaseous stream comprising hydrogen is produced by a hydrogen production source comprising at least one of a water electrolyser, a hydrocarbon reforming source, a hydrogen purification source, a solid biomass gasification source, a solid waste gasification source, a coal gasification source, a hydrocarbon gasification source, a methane pyrolysis source, a refinery tail gas production source, a plasma reforming reactor, partial oxidation reactor, or any combination thereof; or
    b) the second gaseous stream comprising CO_2 is produced by a gas production source comprising at least one of a sugar-based ethanol production source, a first generation

corn-ethanol production source, a second generation corn-ethanol production source, a sugarcane ethanol production source, a cane sugar ethanol production source, a sugar beet ethanol production source, a molasses ethanol production source, a wheat ethanol production source, a grain based ethanol production source, a starch based ethanol production source, a cellulosic based ethanol production source, a cement production source, a methanol synthesis source, an olefin production source, a steel production source, a ferroalloy production source, a refinery tail gas production source, a post combustion gas production source, a biogas production source, a landfill production source, an ethylene oxide production source, a methanol production source, an ammonia production source, mined CO_2 production source, natural gas processing production source, a gasification source, an organic waste gasification source, direct air capture, or any combination thereof; or

c) wherein at least one of the C1 fixing bacterium is selected from *Clostridium autoethanogenum, Clostridium ljungdahlii,* or *Clostridium ragsdalei;* or

d) any combination thereof.

15. The process of claim 9 further wherein the CO enriched exit stream comprises hydrogen and the process further comprising separating hydrogen from the CO enriched exit stream and recycling the separated hydrogen to combine with the tail gas stream or to the compressor.

16. The process of claim 15 further comprising compressing the remainder of the CO enriched exit stream after the separation of hydrogen.

17. The process of claim 9 wherein the tail gas stream comprises methane, the process further comprising passing a portion of the tail gas stream to a methane conversion unit to generate a methane conversion unit effluent and combining the methane conversation unit effluent with the tail gas stream.

18. The process of claim 17 further comprising generating a stream comprising oxygen from an oxygen source and passing the stream comprising oxygen to the methane conversion unit.

19. The process of claim 9 further comprising passing a second gaseous stream comprising hydrogen from the hydrogen source to the bioreactor or to combine with the CO enriched exit stream, passing a second gaseous stream comprising CO_2 from the CO_2 source to the bioreactor or to combine with the CO enriched exit stream, or any combination thereof.

20. The process of claim 19 wherein the combining of the second gaseous stream comprising hydrogen from the hydrogen source with the CO enriched exit stream, or the combining of the second gaseous stream comprising CO_2 from the CO_2 source with the CO enriched exit stream, or both utilize mixing in a mixer.
21. The process of claim 19 wherein the ratio of the second gaseous stream comprising hydrogen from the hydrogen source to the CO enriched exit stream entering the bioreactor is from about greater than 0:1 to about 4:1.
22. The process of claim 9 further comprising passing a portion of CO enriched exit stream to an inoculator reactor, a buffer tank, or both.
23. An integrated process for the production of at least one fermentation product from a gaseous stream, the process comprising:
    a) obtaining a first gaseous stream comprising hydrogen and a second gaseous stream comprising CO_2;
    b) passing at least a portion of the second gaseous stream and optionally a portion of the first gaseous stream to a reverse water gas shift CO_2 to CO conversion system operated under conditions to produce a CO enriched exit stream;
    c) passing at least a portion of the first gaseous stream comprising hydrogen and the CO enriched exit stream to a bioreactor having a culture of one or more C1 fixing bacterium and fermenting to produce at least one fermentation product stream and a bioreactor tail gas stream;
    d) compressing the bioreactor tail gas stream to generate a compressed bioreactor tail gas stream;
    e) passing at least a first portion of the compressed bioreactor tail gas stream, in any order, to:
        i) a gas desulfurization and or acid gas removal unit; or
        ii) a gas component removal unit; or
        iii) both the gas desulfurization and or acid gas removal unit and the gas component removal unit;

        to generate a compressed treated bioreactor tail gas stream;
    f) recycling the compressed treated bioreactor tail gas stream:

i) to combine with the first gaseous stream, the second gaseous stream, or a combination thereof; or

ii) to the reverse water gas shift CO_2 to CO conversion system; or

iii) to combine with the CO enriched exit stream; or

iv) any combination thereof; and

g) optionally recycling a second portion of the compressed bioreactor tail gas stream to combine with the CO enriched exit stream or to the bioreactor.

24. The process of claim 23 further comprising passing at least another portion of first gaseous stream comprising hydrogen to the reverse water gas shift CO_2 to CO conversion system.

25. The process of claim 23 further comprising compressing any portions of the first gaseous stream, the second gaseous stream, or combinations thereof.

26. The process of claim 23 further comprising controlling the relative amounts of the first portion of the compressed tail gas stream and the second portion of the compressed tail gas stream using a control valve.

27. The process of claim 23 further comprising passing at least a portion of the tail gas stream to a tail gas reverse water gas shift CO_2 to CO conversion system selected from a reverse water gas shift unit, a thermo-catalytic conversion unit, a partial combustion unit, a plasma conversion unit, a gasification unit, or a reforming unit, to generate a CO enriched effluent stream and recycling the second CO enriched effluent stream to the bioreactor.

28. The process of claim 23, wherein the CO enriched exit stream comprises a H_2:CO:CO_2 molar ratio of about 5:1:1, about 4.5:1:1, about 4.33:1:1, about 3:1:1, about 2:1:1, about 1:1:1; or about 1:3:1.

29. The process of claim 23, wherein the reverse water gas shift CO_2 to CO conversion system comprises at least one of a reverse water gas shift unit, a thermo-catalytic conversion unit, a partial combustion unit, a reforming unit, or a plasma conversion unit.

30. The process of claim 23, wherein:

a) the at least one fermentation product is selected from ethanol, acetate, butanol, butyrate, 2,3-butanediol, lactate, butene, butadiene, methyl ethyl ketone, ethylene, acetone, isopropanol, lipids, 3-hydroxypropionate, isoprene, fatty acids, 2-butanol, 1,2-propanediol, hexanol, octanol, or 1-propanol; or

b) the first gaseous stream comprising hydrogen is produced by a hydrogen production source comprising at least one of a water electrolyser, a hydrocarbon reforming source, a hydrogen purification source, a solid biomass gasification source, a solid waste gasification source, a coal gasification source, a hydrocarbon gasification source, a methane pyrolysis source, a refinery tail gas production source, a plasma reforming reactor, partial oxidation reactor, or any combination thereof; or

c) the second gaseous stream comprising CO_2 is produced by a gas production source comprising at least one of a sugar-based ethanol production source, a first generation corn-ethanol production source, a second generation corn-ethanol production source, a sugarcane ethanol production source, a cane sugar ethanol production source, a sugar beet ethanol production source, a molasses ethanol production source, a wheat ethanol production source, a grain based ethanol production source, a starch based ethanol production source, a cellulosic based ethanol production source, a cement production source, a methanol synthesis source, an olefin production source, a steel production source, a ferroalloy production source, a refinery tail gas production source, a post combustion gas production source, a biogas production source, a landfill production source, an ethylene oxide production source, a methanol production source, an ammonia production source, mined CO_2 production source, natural gas processing production source, a gasification source, an organic waste gasification source, direct air capture, or any combination thereof; or

d) wherein at least one C1 fixing bacterium is selected from *Clostridium autoethanogenum, Clostridium ljungdahlii,* or *Clostridium ragsdalei*; or

e) any combination thereof.