CLAIMS

1. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells and a growth media comprising at least two carbon sources selected from the group consisting of: casein, lactate, dextrose, fructose, fructan, glucose, sucrose, lactose, maltose, acetate, glycerol, mannitol, saccharose, xylose, molasses, fucose, glucosamine, dextran, a fat, an oil, glycerol, sodium acetate, arabinose, soy protein, soluble protein, raffinose, amylose, starch, and combinations thereof,

(b) harvesting the cells under anaerobic conditions,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

(d) freezing the cells, and

(e) freeze-drying the cells,

wherein 1×10^7 to 1×10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying, wherein the method is performed on a commercial scale,
and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

2. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells, at least one cryoprotectant, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

and a growth media comprising at least two carbon sources selected from the group consisting of: casein, lactate, dextrose, fructose, fructan, glucose, sucrose, lactose, maltose, acetate, glycerol, mannitol, saccharose, xylose, molasses, fucose, glucosamine,

dextran, a fat, an oil, glycerol, sodium acetate, arabinose, soy protein, soluble protein, raffinose, amylose, starch, and combinations thereof,

(b) harvesting the cells under anaerobic conditions,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

(d) freezing the cells, and

(e) freeze-drying the cells,

wherein 1 x 10^7 to 1 x 10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying, wherein the method is performed on a commercial scale,

and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

3. The method of claim 1 or 2, wherein the at least two carbon sources consist of 50-90% of a first carbon source and 10-50% of a second carbon source, wherein the second carbon source is different from the first carbon source, and wherein 100% of the at least two carbon sources consists of the first carbon source and the second carbon source.

4. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells and a growth media,

(b) harvesting the cells under anaerobic conditions before the culture enters the stationary phase,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

(d) freezing the cells, and

(e) freeze-drying the cells,

wherein 1 x 10^7 to 1 x 10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying, wherein the method is performed on a commercial scale,

and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

5. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells, at least one cryoprotectant, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

and a growth media,

(b) harvesting the cells under anaerobic conditions before the culture enters the stationary phase,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

(d) freezing the cells, and

(e) freeze-drying the cells,

wherein 1×10^7 to 1×10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying,
wherein the method is performed on a commercial scale,
and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

6. The method of any one of claims 1 to 5, wherein the harvesting comprises at least one technique selected from the group consisting of: centrifugation, filtration, dialysis, reverse osmosis, and combinations thereof.

7. The method of claim 6, wherein the filtration comprises tangential flow filtration.

8. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells and a growth media,

(b) harvesting the cells under anaerobic conditions,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, betaine, and combinations thereof,

(d) freezing the cells at a temperature of -80 °C to -210 °C within 5 hours of harvesting, and

(e) freeze-drying the cells,

wherein 1 x 10^7 to 1 x 10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying, wherein the method is performed on a commercial scale,

and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

9. A method of producing freeze-dried *Megasphaera elsdenii* cells on a commercial scale, comprising:

(a) preparing a liquid culture under anaerobic conditions comprising *M. elsdenii* cells, at least one cryoprotectant, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, betaine, and combinations thereof,

and a growth media,

(b) harvesting the cells under anaerobic conditions,

(c) adding at least one cryoprotectant to the cells, wherein the cryoprotectant is selected from the group consisting of: fructose, glucose, sucrose, milk powder, infant formula, skim milk, trehalose, maltodextrin, and betaine,

(d) freezing the cells at a temperature of -80 °C to -210 °C within 5 hours of harvesting, and

(e) freeze-drying the cells,

wherein 1 x 10^7 to 1 x 10^{12} CFU/g of *M. elsdenii* cells are viable after freeze-drying, wherein the method is performed on a commercial scale,

and wherein the commercial scale is a liquid culture volume between 2 liters and 75,000 liters.

10. The method of any one of claims 1-9, wherein the cryoprotectant comprises maltodextrin and skim milk, trehalose and skim milk, skim milk or trehalose.

11. The method of any one of claims 1, 2, 4, 5, 8, and 9, wherein the cryoprotectant is added to the harvested cells at a ratio of 1/1, 1/5, or 1/10.

12. The method of any one of claims 2, 5, and 9, wherein the cryoprotectant is added to the culture in an amount of 1% to 50% (w/v) of the culture, 1% to 40% (w/v) of the culture, 1% to 30% (w/v) of the culture, 1% to 20% (w/v) of the culture, or 1% to 10% (w/v) of the culture.

13. The method of any one of claims 1-12, wherein the freeze-dried *M. elsdenii* cells are viable after storage at a temperature of 25 °C for at least 2 weeks or 4 °C for at least one month.