WHAT IS CLAIMED

1. A method of culturing one or more microorganisms, comprising:

(a) culturing one or more microorganisms in a medium comprising crude glycerol at a first concentration level and a nitrogen source;

(b) feeding to the medium an additional amount of crude glycerol, once the first concentration of glycerol is reduced to a first threshold level, at a concentration sufficient to achieve the first concentration level, wherein a nitrogen source is not added to the medium during the feeding step;

(c) monitoring the crude glycerol concentration until the first concentration level of the crude glycerol is reduced to the first threshold level; and

(d) repeating steps (b) and (c) until a desired microorganism cell density is achieved.

2. The method of claim 1, wherein the one or more microorganisms is of the genus *Thraustochytrium* or the genus *Schizochytrium*.

3. The method of any one of claims 1-2, wherein the one or more microorganisms is ONC-T18.

4. The method of any one of claims 1-3, wherein the microorganisms are capable of producing one or more fatty acids.

5. The method of claim 4, wherein the fatty acids are polyunsaturated fatty acids.

6. The method of claim 5, wherein the polyunsaturated fatty acids are selected from the group consisting of alpha linolenic acid, arachidonic acid, docosahexanenoic acid, docosapentaenoic acid, eicosapentaenoic acid, gamma-linolenic acid, linoleic acid, linolenic acid, and combinations thereof.

7. The method of claim 4, wherein the method further comprises isolating the fatty acids.

8. The method of any one of claims 1-7, wherein the first concentration level is between 1 and 60 g/L.

9. The method of any one of claims 1-8, wherein the first threshold level is between 0 and 5 g/L.

10. The method of any one of claims 1-9, wherein the monitoring does not comprise measuring dissolved oxygen levels.

11. The method of any one of claims 1-10, wherein the monitoring comprises obtaining a sample of the media and determining the glycerol concentration in the sample.

12. The method of claim 11, wherein the monitoring comprises analyzing the sample using calorimetric assay, chemical reaction based calorimetric assay, fluorescence assay, HPLC assay, enzymatic assay, or combinations thereof.

13. The method of any one of claims 1-10, wherein the cell density is between 50 g/L and 250 g/L.

14. The method of any one of claims 1-13, wherein the microorganism cell density contains 50 % to 80% by weight of total fatty acids.

15. The method of any one of claims 1-13, wherein the total fatty acids comprise 10 to 45% DHA.

16. The method of any one of claims 1-13, wherein the microorganism cell density contains 5 to 36% DHA by total cell weight.

17. The method of any one of claims 1-16, wherein the medium comprises one or more additional carbon sources.

18. The method of any one of claims 1-16, wherein the crude glycerol is not sterilized.

19. The method of any one of claims 1-16, wherein the crude glycerol comprises methanol, water, ash, non-glycerin organic matter, sodium sulphate, methyl tallowate, or a combination thereof.

20. The method of claim 19, wherein the ash comprises calcium, iron, magnesium, potassium, sodium, zinc or a combination thereof.

21. The method of any one of claims 1-20, wherein the crude glycerol is a biodiesel byproduct.

22. A method for producing one or more fatty acids, comprising:

(a) providing a Thraustochytrid microorganism capable of producing fatty acids;

(b) providing a media comprising crude glycerol and nitrogen; and

(c) culturing the microorganism in the media by repeatedly adding fresh crude glycerol without nitrogen once the crude glycerol in the media is between 0 and 5 g/L to produce the one or more fatty acids to provide a final concentration of the one or more unsaturated fatty acids that is at least 50% by total cell weight of the microorganisms.

23. The method of claim 22, wherein the microorganism is of the genus *Thraustochytrium* or the genus *Schizochytrium*.

24. The method of claim 22, wherein the microorganism is ONC-T18.

25. The method of any one of claims 22-24, wherein the fatty acids comprise polyunsaturated fatty acids.

26. The method of claim 25, wherein the polyunsaturated fatty acids are selected from the group consisting of alpha linolenic acid, arachidonic acid, docosahexanenoic acid, docosapentaenoic acid, eicosapentaenoic acid, gamma-linolenic acid, linoleic acid, linolenic acid, and combinations thereof.

27. The method of any one of claims 22-26, further comprising isolating the fatty acids.

28. The method of any one of claims 22-27, wherein the media comprises one or more additional carbon sources.

29. The method of any one of claims 22-28, wherein the crude glycerol is not sterilized.

30. The method of any one of claims 22-29, wherein the crude glycerol comprises methanol, water, ash, non-glycerin organic matter, sodium sulphate, methyl tallowate, or a combination thereof.

31. The method of claim 30, wherein the ash comprises calcium, iron, magnesium, potassium, sodium, zinc or a combination thereof.

32. The method of any one of claims 22-20, wherein the crude glycerol is a biodiesel byproduct.

33. The method of claim 1, wherein the crude glycerol is not pre-treated.

34. The method of claim 1, wherein the nitrogen source comprises at least 4.2 g/L nitrogen.

35. The method of claim 1, wherein the desired microorganism cell density is between 160 g/L and 250 g/L.

36. The method of claim 1, wherein the nitrogen source is ammonium sulfate.

37. The method of claim 36, wherein the medium comprises 20 g/L to 25 g/L ammonium sulfate.

38. The method of claim 1, wherein the microorganism cell density contains from 70% to 80% by weight of total fatty acids.

39. The method of claim 17, wherein the second carbon source is glucose.

40. The method of claim 29, wherein the crude glycerol to glucose volume ratio of 80:20 or 20:80.