CLAIMS

1. An impeller usable in a variable diameter bioreactor having multiple vessel sections of successively increasing or decreasing volume, the impeller comprising:

an impeller blade having an edge extending along an impeller blade axis between first and second axial ends and having opposed impeller blade faces, an impeller blade leading edge, and an impeller blade trailing edge; wherein

the leading and trailing edges each define a helix or spiral between the first and second axial ends of the impeller blade; and

wherein the impeller blade is one of at least two impeller blades joined together along an axially extending impeller shaft.

2. The impeller according to claim 1, wherein the helix or spiral has a pitch approximately equal to one half of a length between the first and second axial ends.

3. The impeller according to claim 1, wherein the helix or spiral has a pitch higher than one half of a length between the first and second axial ends.

4. The impeller according to claim 1, wherein the helix or spiral has a pitch lower than one half of a length between the first and second axial ends.

5. An impeller usable in a bioreactor, the impeller comprising:

an impeller blade having an edge extending along an impeller blade axis between first and second axial ends and having opposed impeller blade faces, an impeller blade leading edge, and an impeller blade trailing edge; wherein

the leading and trailing edges each define a helix or spiral between the first and second axial ends of the impeller blade; and

wherein the impeller blade is one of at least two impeller blades joined together along an axially extending impeller shaft.

6. The impeller according to claim 5, wherein the helix or spiral has a pitch approximately equal to one half of a length between the first and second axial ends.

7. The impeller according to claim 5, wherein the helix or spiral has a pitch higher than one half of a length between the first and second axial ends.

8. The impeller according to claim 5, wherein the helix or spiral has a pitch lower than one half of a length between the first and second axial ends.

9. A variable diameter bioreactor arrangement comprising:

a variable diameter bioreactor having multiple vessel sections of successively increasing or decreasing volume; and

an impeller having an impeller shaft and an impeller blade extending along the impeller shaft between first and second axial ends of the shaft and having opposed impeller blade faces, an impeller blade leading edge, and an impeller blade trailing edge; wherein

the leading and trailing edges each define a helix or spiral between the first and second axial ends of the impeller blade; and

wherein the impeller blade is one of at least two impeller blades joined together along an axially extending impeller shaft.

10. The variable diameter bioreactor arrangement according to claim 9, wherein the helix or spiral has a pitch approximately equal to one half of a length between the first and second axial ends.

11. The variable diameter bioreactor arrangement according to claim 9, wherein the helix or spiral has a pitch higher than one half of a length between the first and second axial ends.

12. The variable diameter bioreactor arrangement according to claim 9, wherein the helix or spiral has a pitch lower than one half of a length between the first and second axial ends.

13. A process of treating a microorganism culture comprising:

placing a fluid containing the microorganism culture in a variable diameter bioreactor arrangement, including a variable diameter bioreactor having multiple vessel sections of successively increasing or decreasing volume and an impeller having an impeller shaft, an impeller blade extending along the impeller shaft between first and second axial ends of the shaft and including opposed impeller blade faces, an impeller blade leading edge, and an impeller blade trailing edge, with the leading and trailing edges each defining a helix or spiral between the first and second axial ends of the impeller blade; and

rotating the impeller in the fluid containing the microorganism culture; and

wherein the impeller blade is one of at least two impeller blades joined together along an axially extending impeller shaft.

14. The process according to claim 13, wherein the impeller is rotated at a rate of 54-75 rpm.

15. The process according to claim 13, wherein the variable diameter bioreactor has a 20,000 liter fluid capacity.