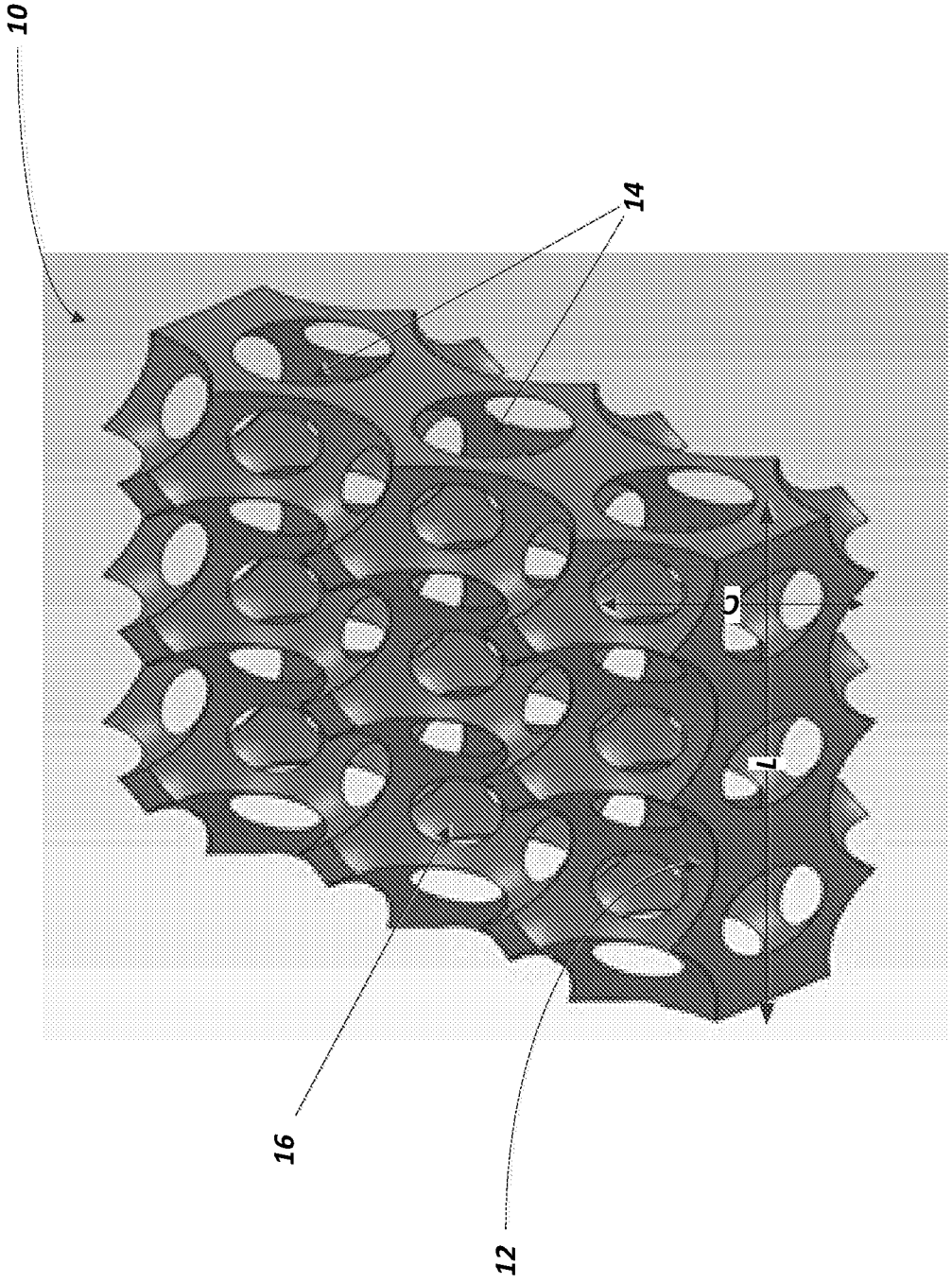


FIG. 1

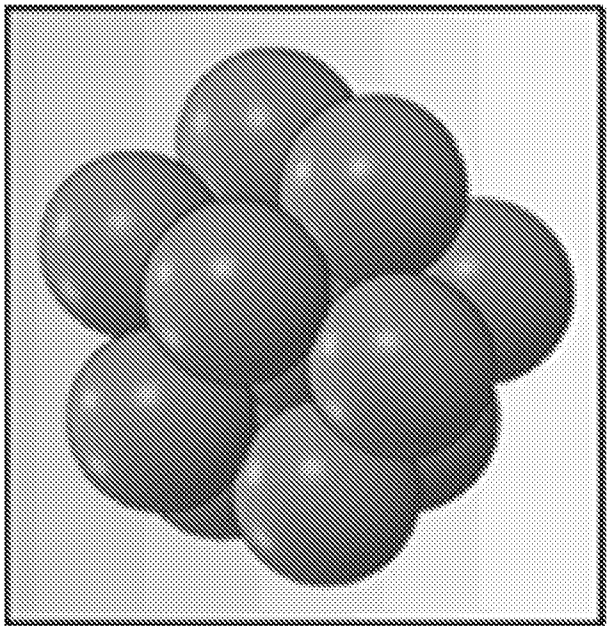


FIG. 1b

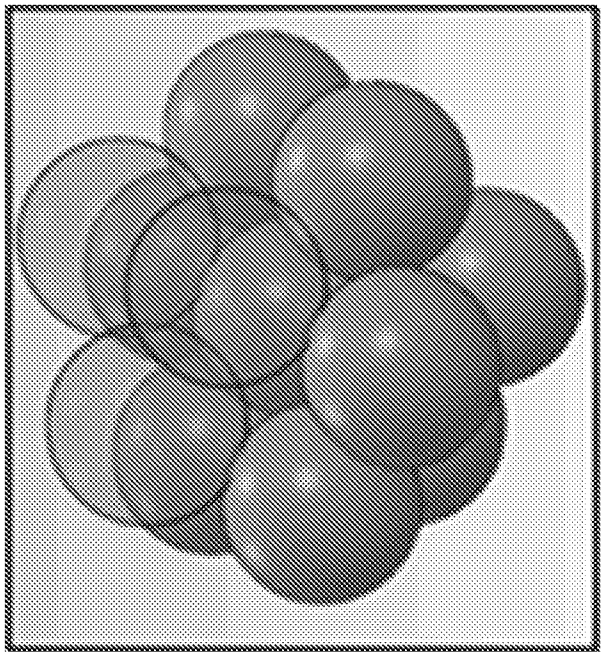


FIG. 1a

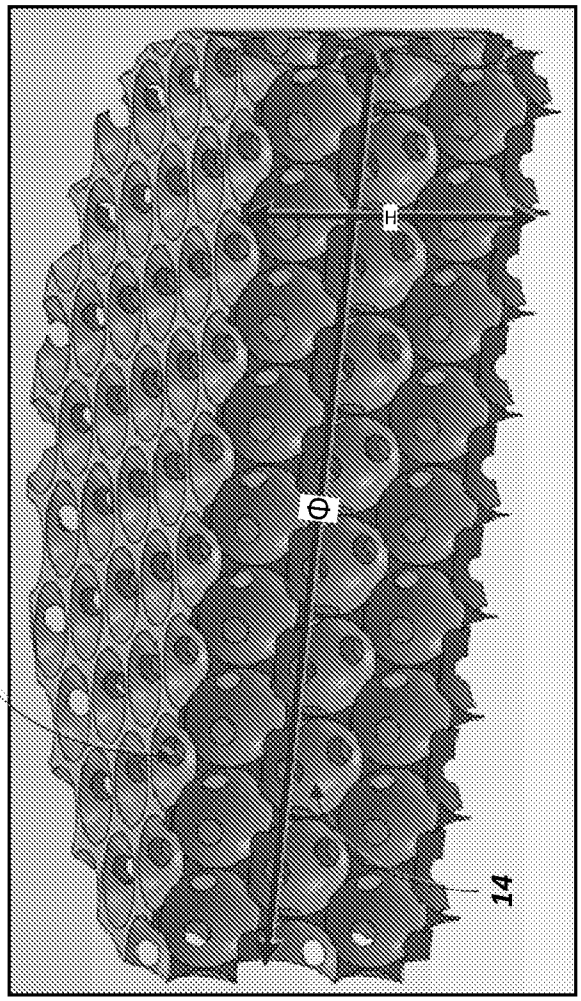


FIG. 1d

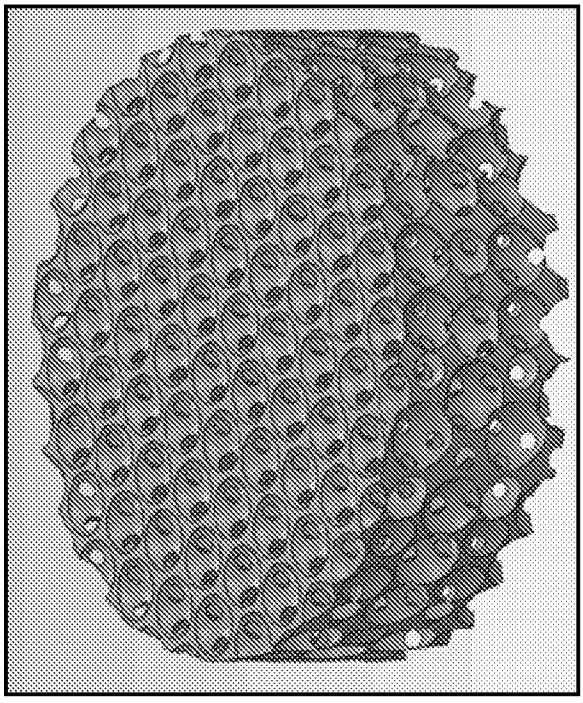


FIG. 1c

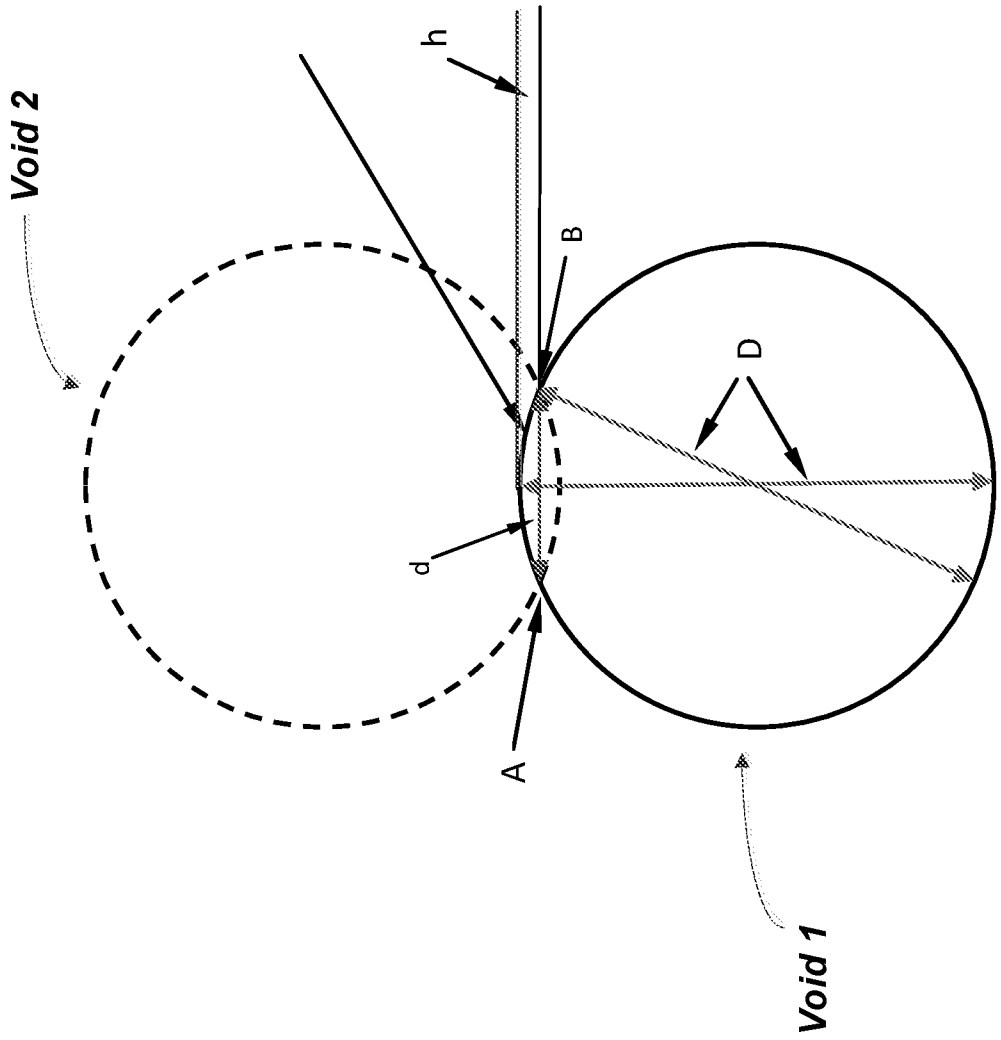


FIG. 1e

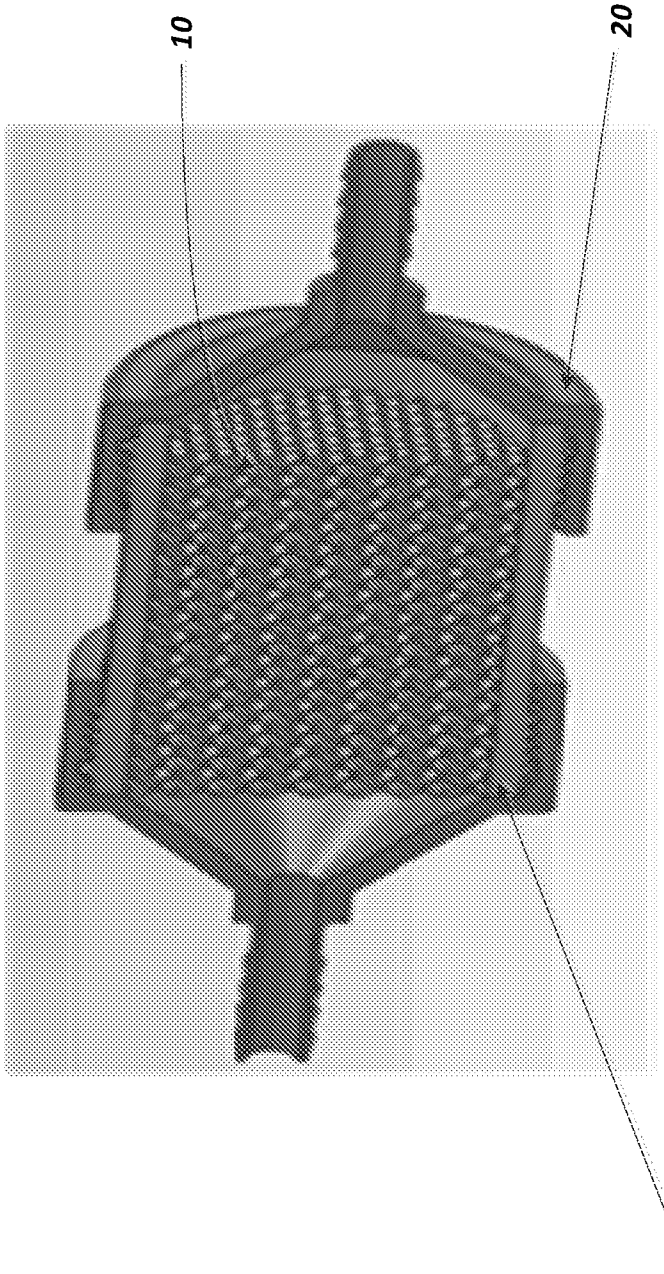


FIG. 2

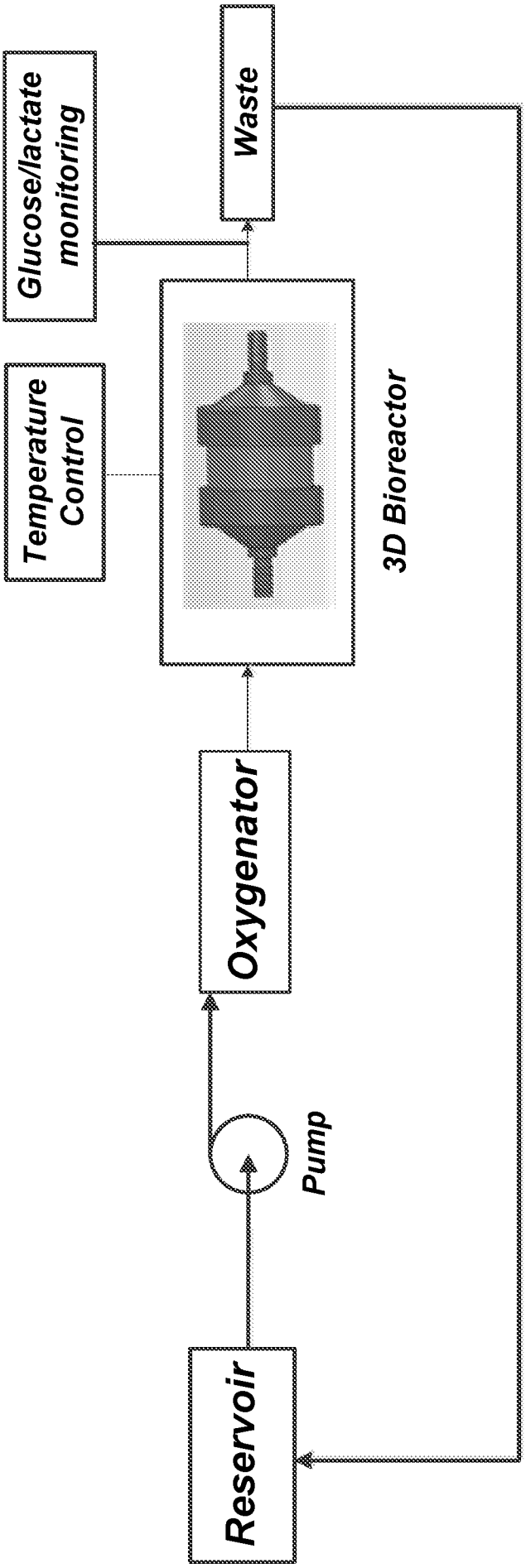

Waste
Glucose/lactate monitoring
Temperature Control
3D Bioreactor
Oxygenator
Pump
Reservoir

FIG. 3

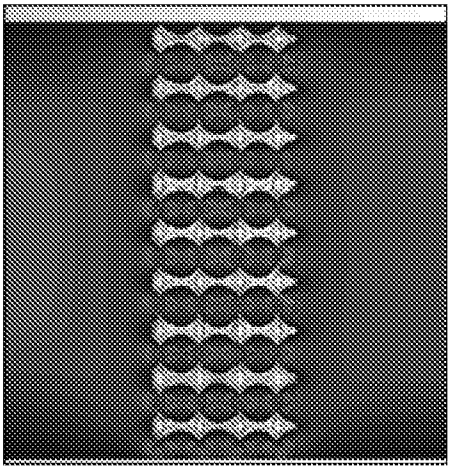


FIG. 4a

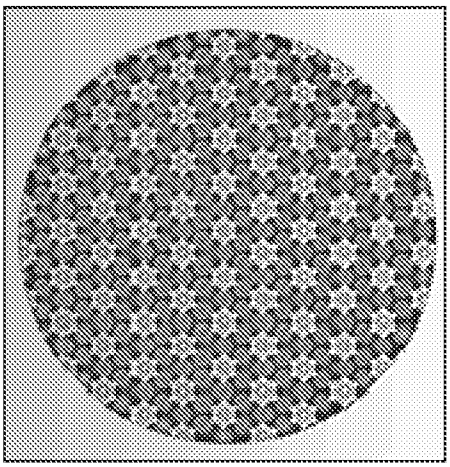


FIG. 4b

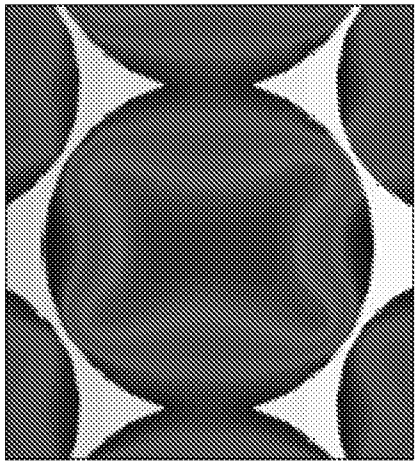


FIG. 4c

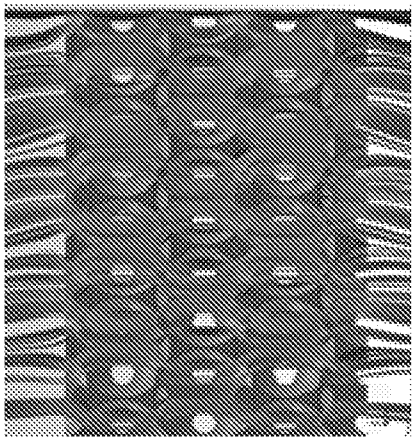


FIG. 4d

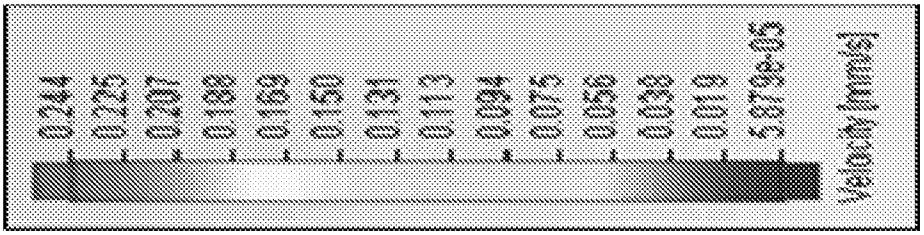


FIG. 4e

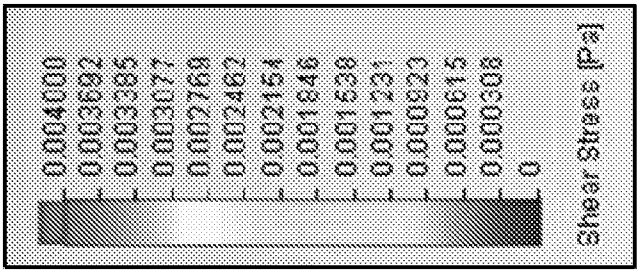


FIG. 5c

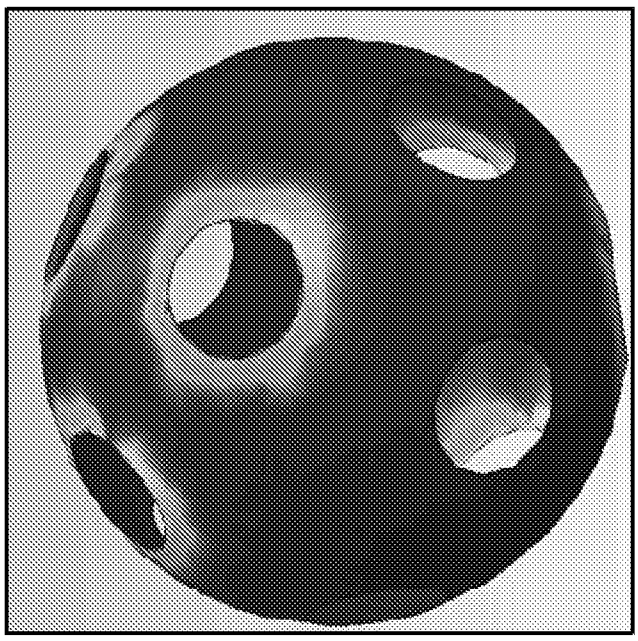


FIG. 5b

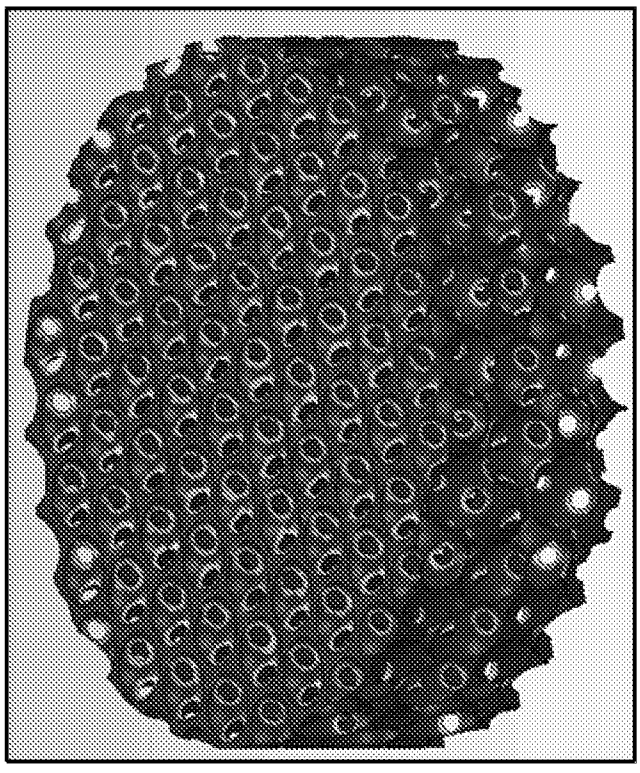


FIG. 5a

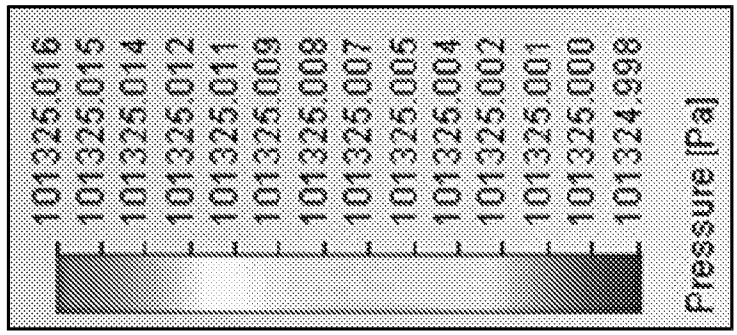

101325.016
101325.015
101325.014
101325.012
101325.011
101325.009
101325.008
101325.007
101325.005
101325.004
101325.002
101325.001
101325.000
101324.998
Pressure [Pa]

FIG. 6b

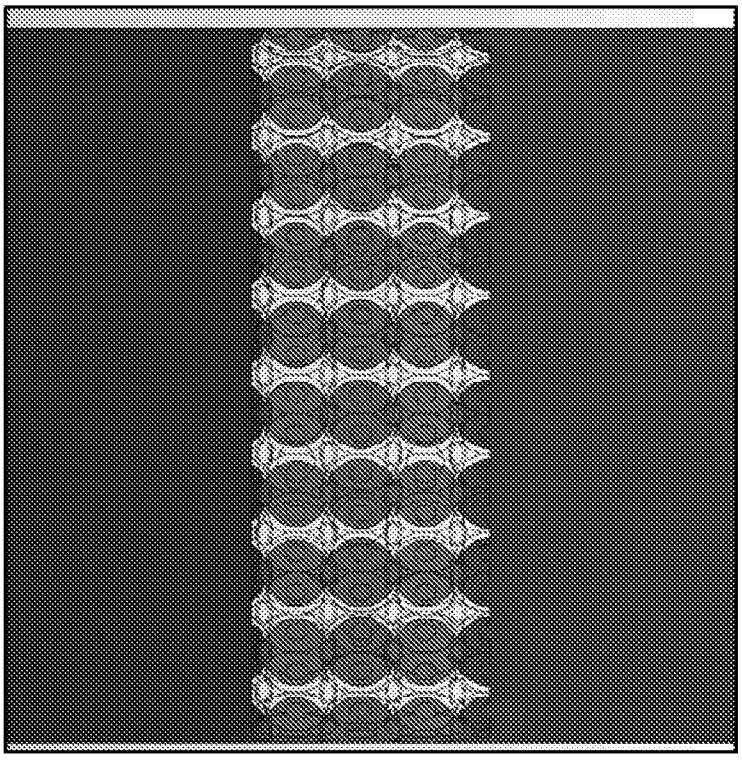


FIG. 6a

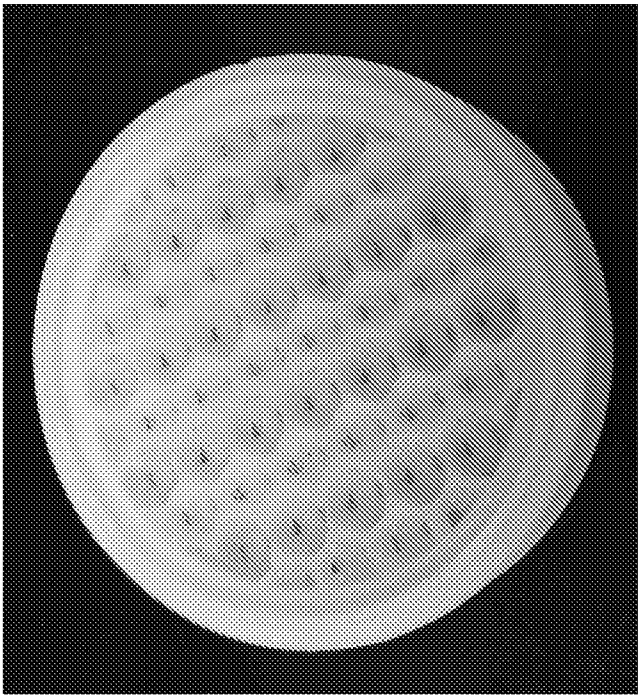


FIG. 7b

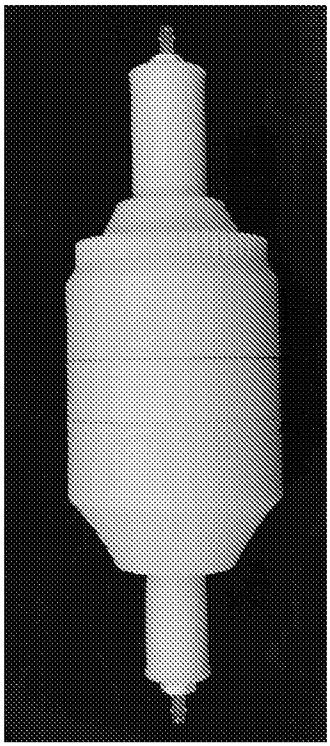


FIG. 7d

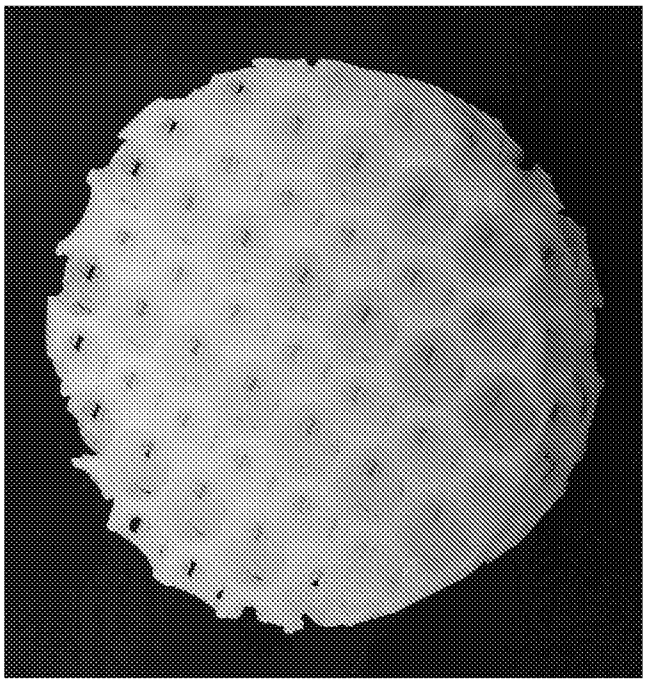


FIG. 7a

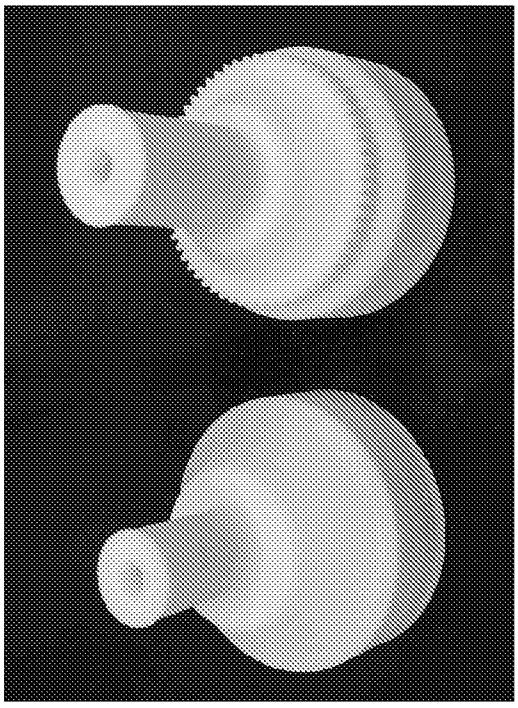


FIG. 7c

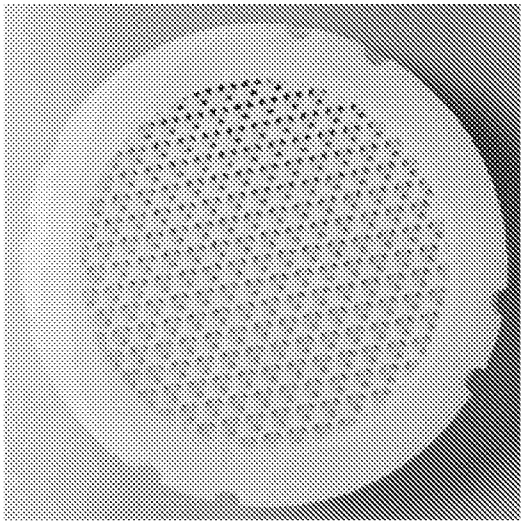


FIG. 7f

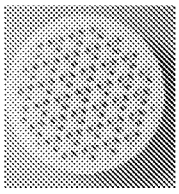


FIG. 7e

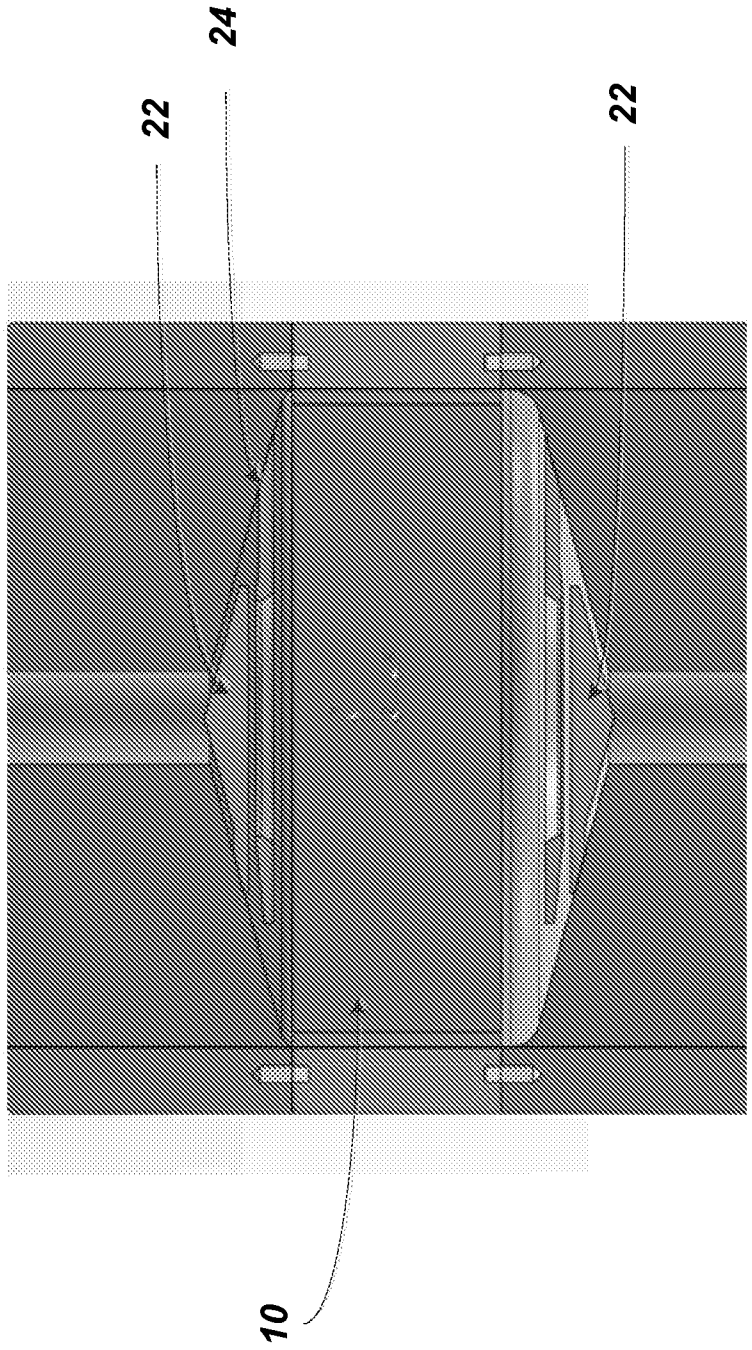


FIG. 8

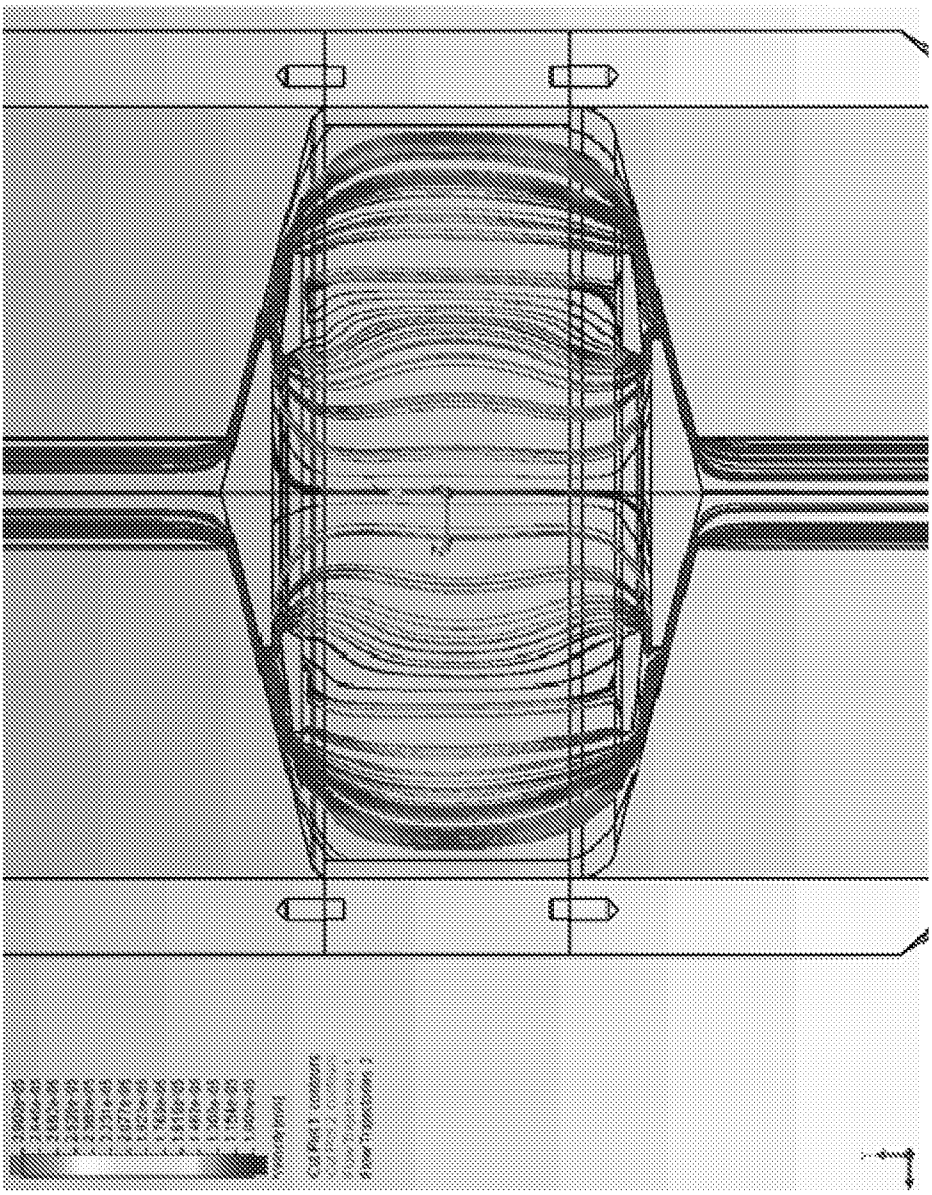


FIG. 9

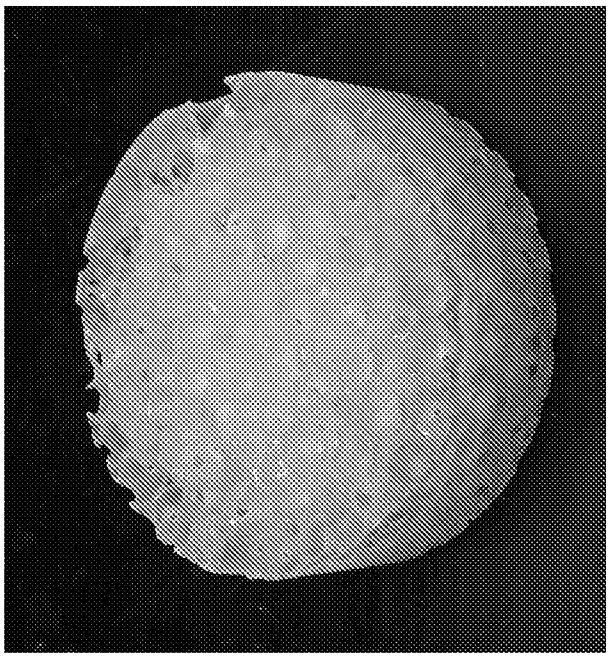


FIG. 10b

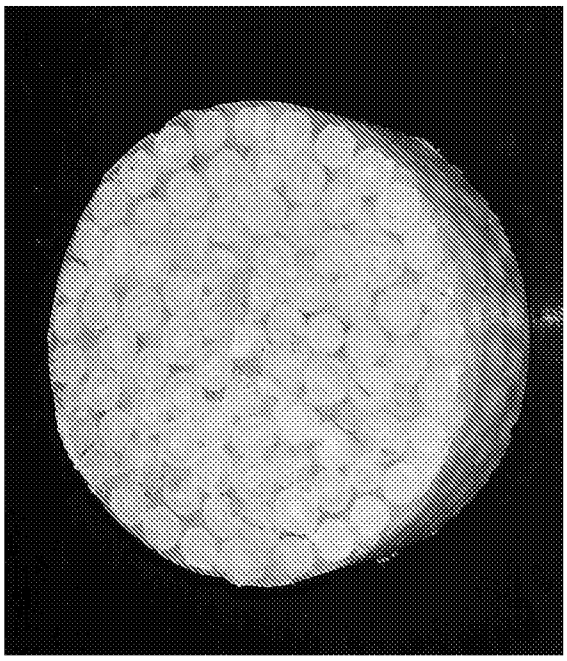


FIG. 10a

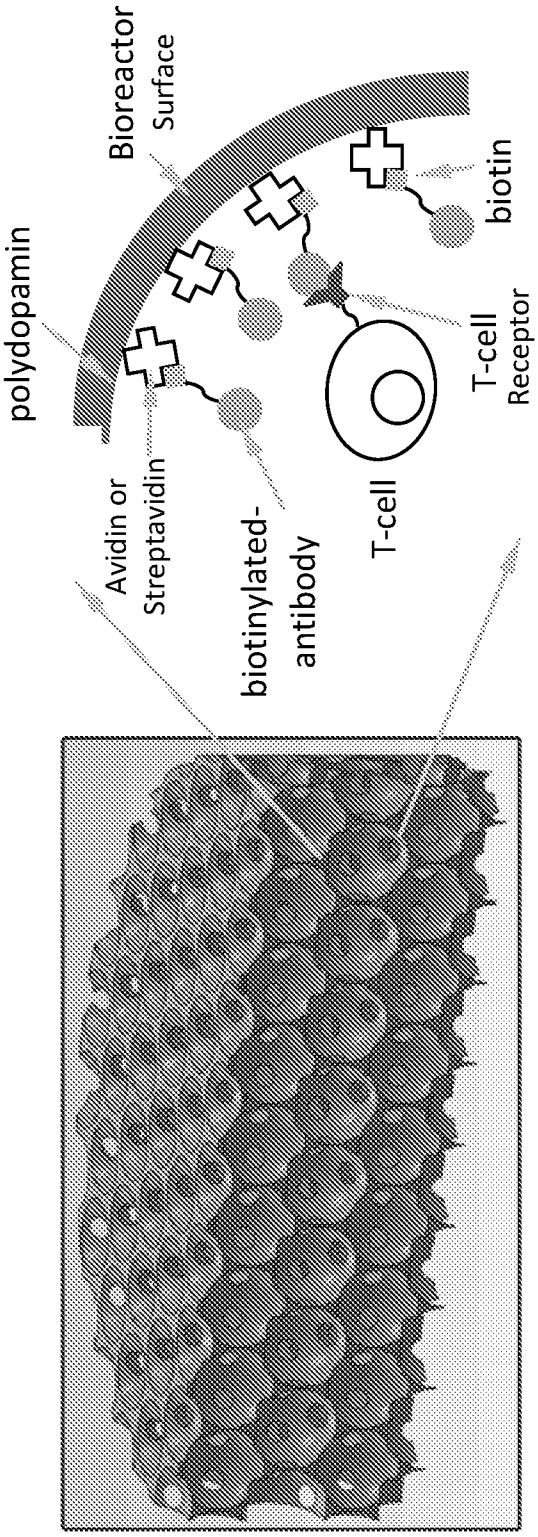

Bioreactor
Surface
polydopamin
biotin
T-cell
Receptor
Avidin or
Streptavidin
biotinylated-
antibody
T-cell

FIG. 11

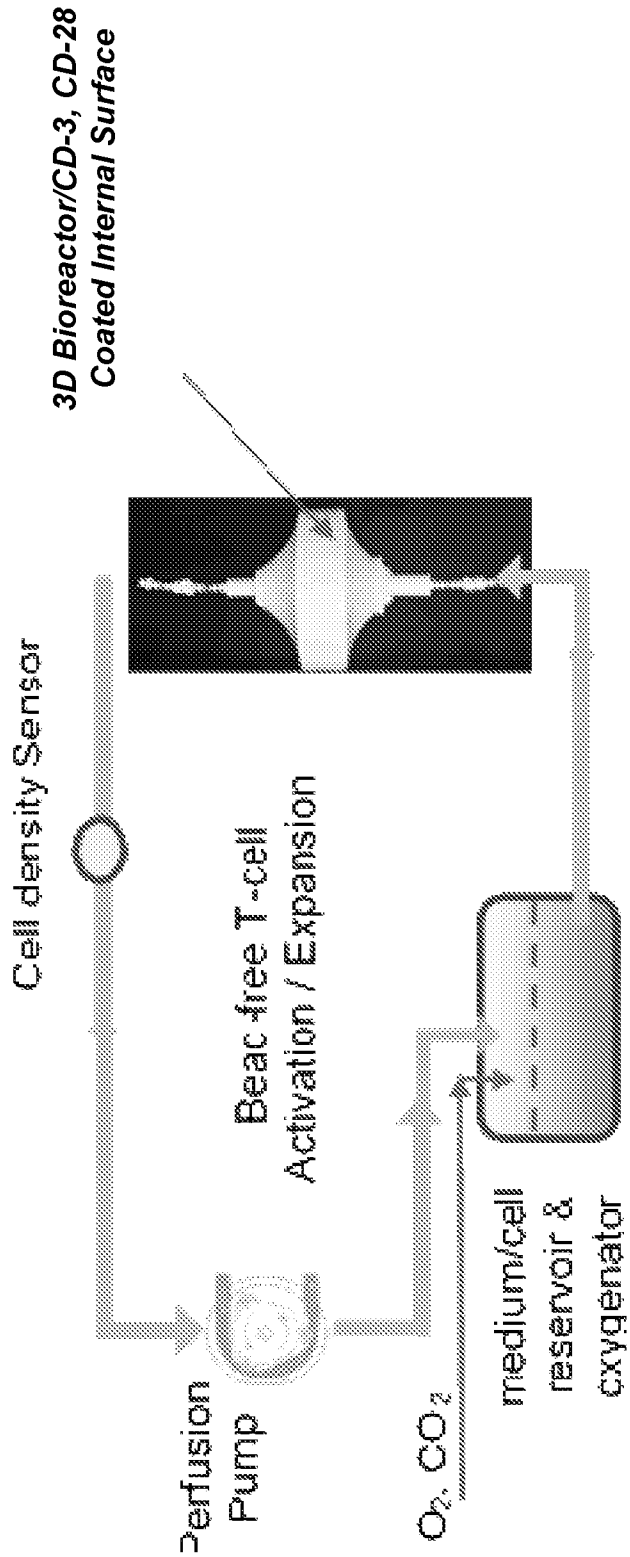

3D Bioreactor/CD-3, CD-28
Coated Internal Surface
Cell density Sensor
Beac free T-cell
Activation / Expansion
Perfusion
Pump
O2, CO2
medium/cell
reservoir &
oxygenator

FIG. 12

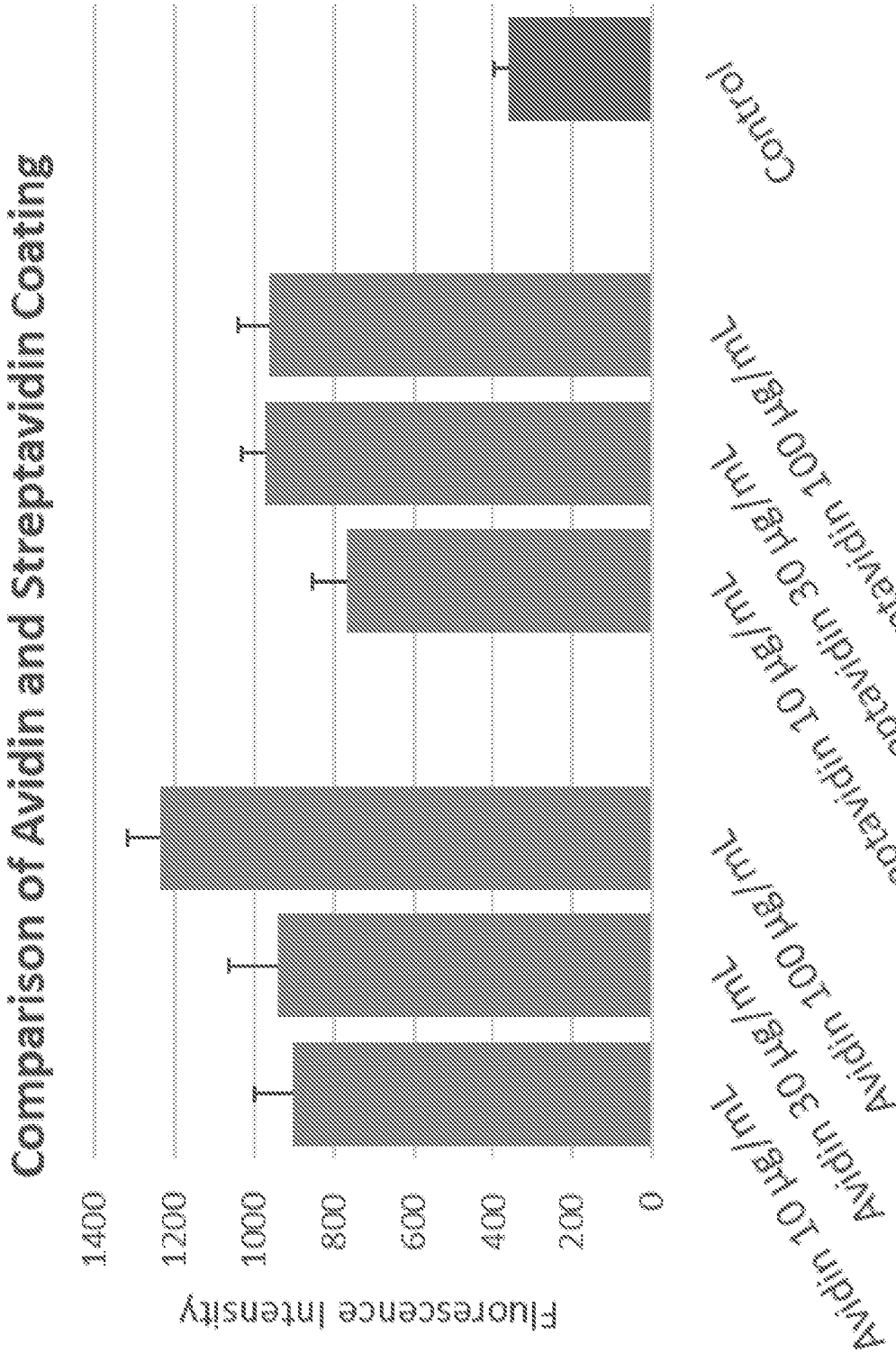

Comparison of Avidin and Streptavidin Coating
Fluorescence Intensity
1400
1200
1000
800
600
400
200
0
Avidin 10 ug/mL
Avidin 30 ug/mL
Avidin 100 ug/mL
Streptavidin 10 ug/mL
Streptavidin 30 ug/mL
Streptavidin 100 ug/mL
Control

FIG. 13

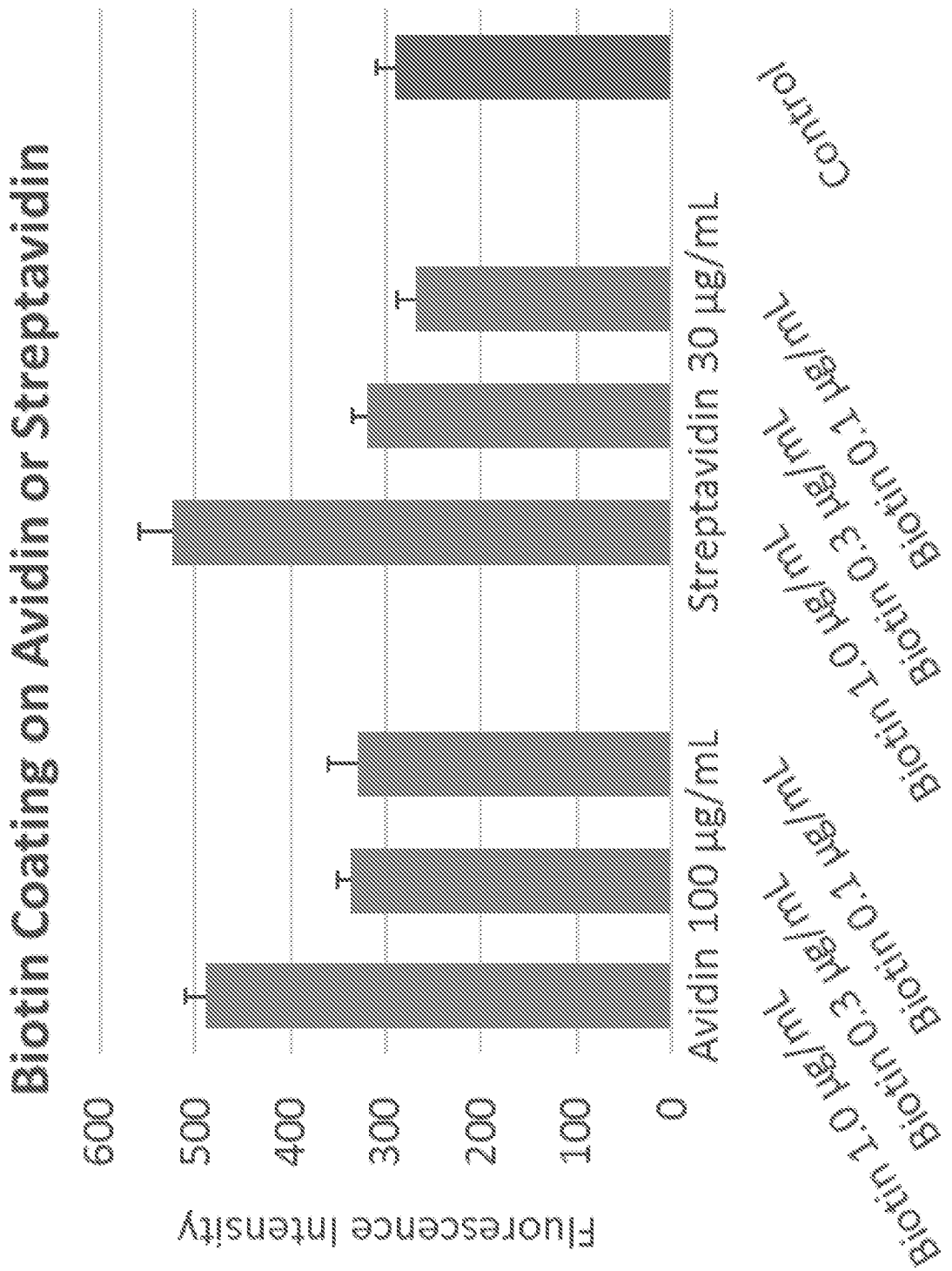

Biotin Coating on Avidin or Streptavidin
Fluorescence Intensity
600
500
400
300
200
100
0
Avidin 100 µg/mL
Streptavidin 30 µg/mL
Biotin 1.0 µg/mL
Biotin 0.3 µg/mL
Biotin 0.1 µg/mL
Control

FIG. 14

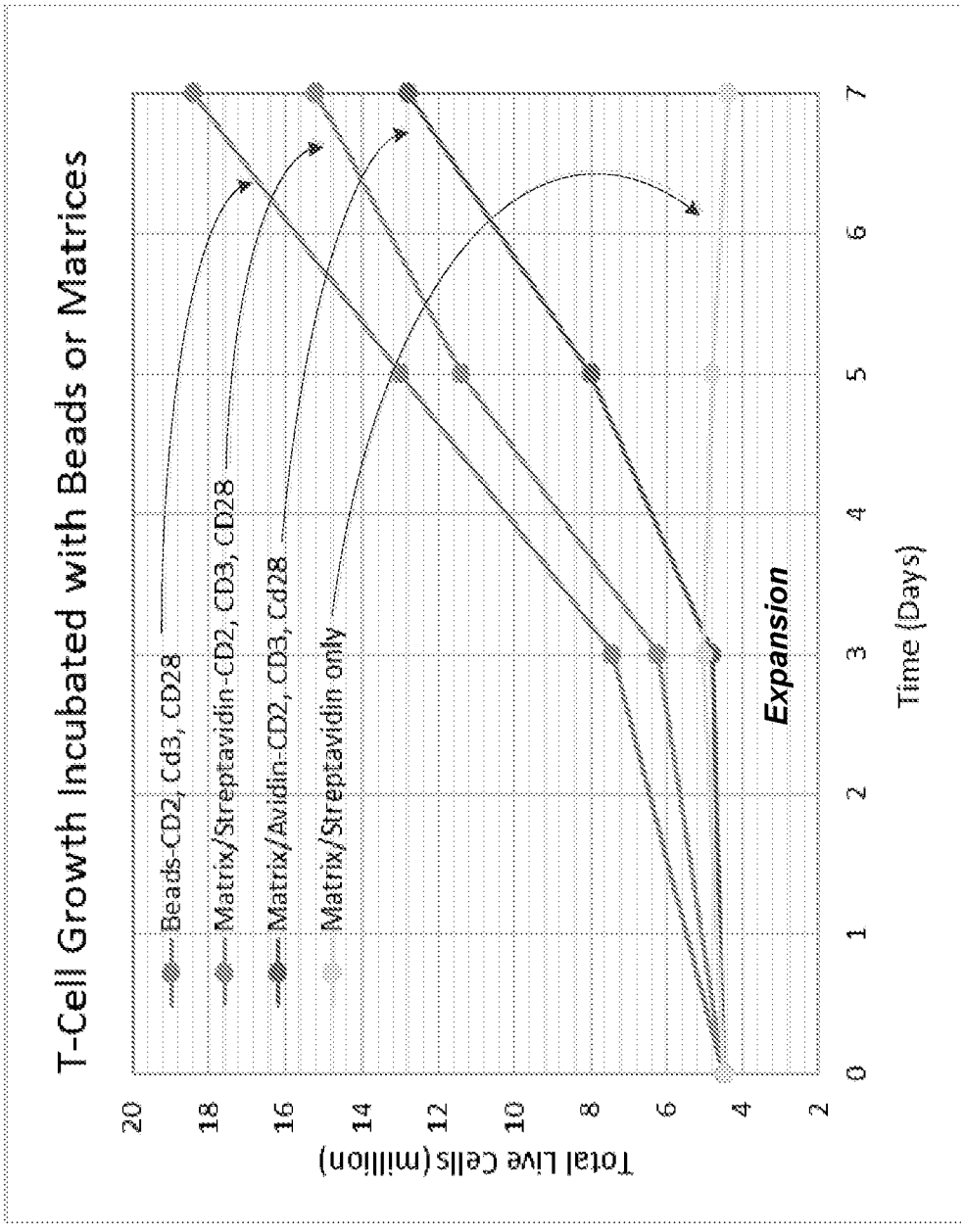

T-Cell Growth Incubated with Beads or Matrices
Beads-CD2, Cd3, CD28
Matrix/Streptavidin-CD2, CD3, CD28
Matrix/Avidin-CD2, CD3, Cd28
Matrix/Streptavidin only
Expansion
Total Live Cells (million)
Time (Days)
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7

FIG. 15

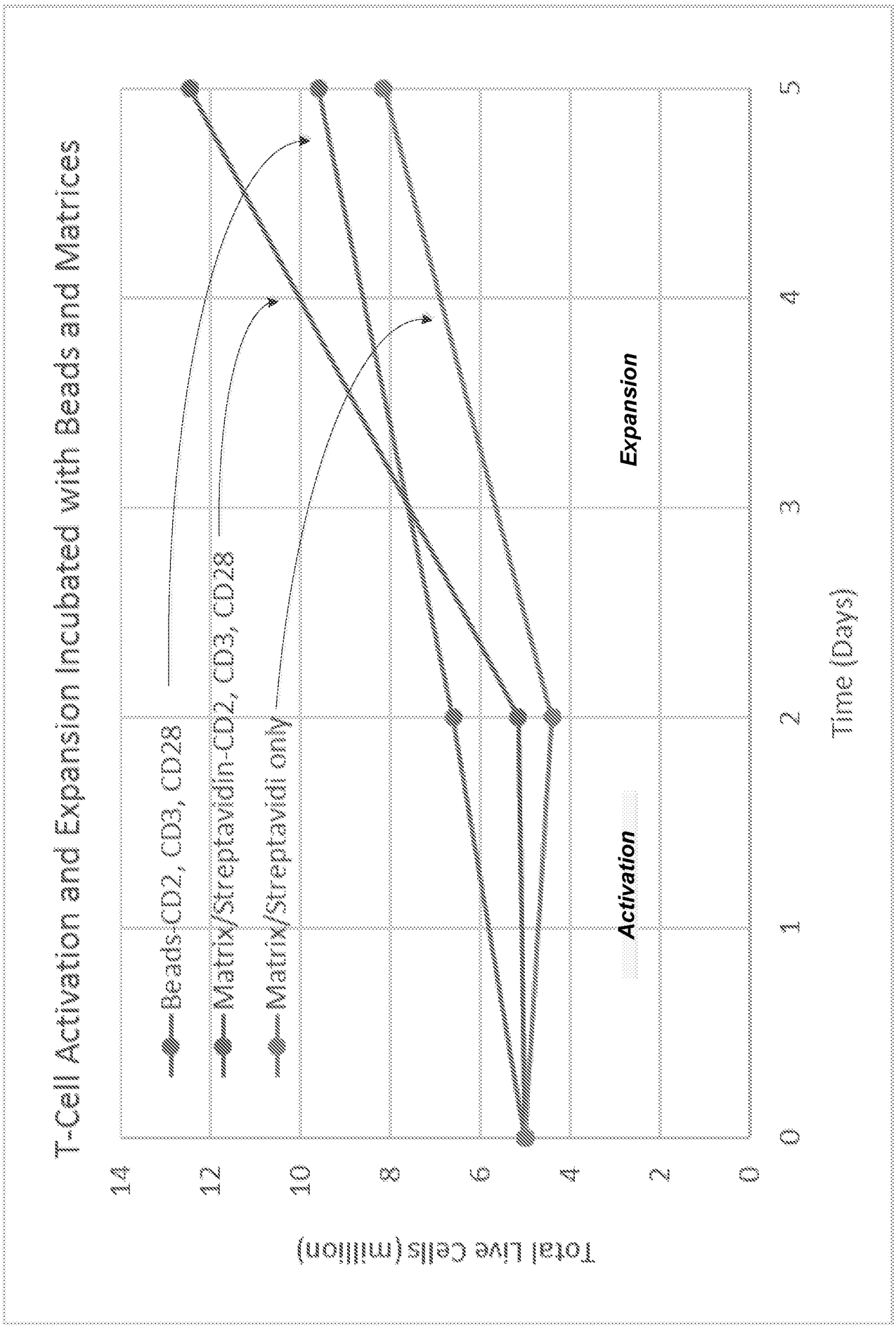

T-Cell Activation and Expansion Incubated with Beads and Matrices
Beads-CD2, CD3, CD28
Matrix/Streptavidin-CD2, CD3, CD28
Matrix/Streptavidi only
Activation
Expansion
Total Live cells (million)
Time (Days)
0
2
4
6
8
10
12
14
0
1
2
3
4
5

FIG. 16

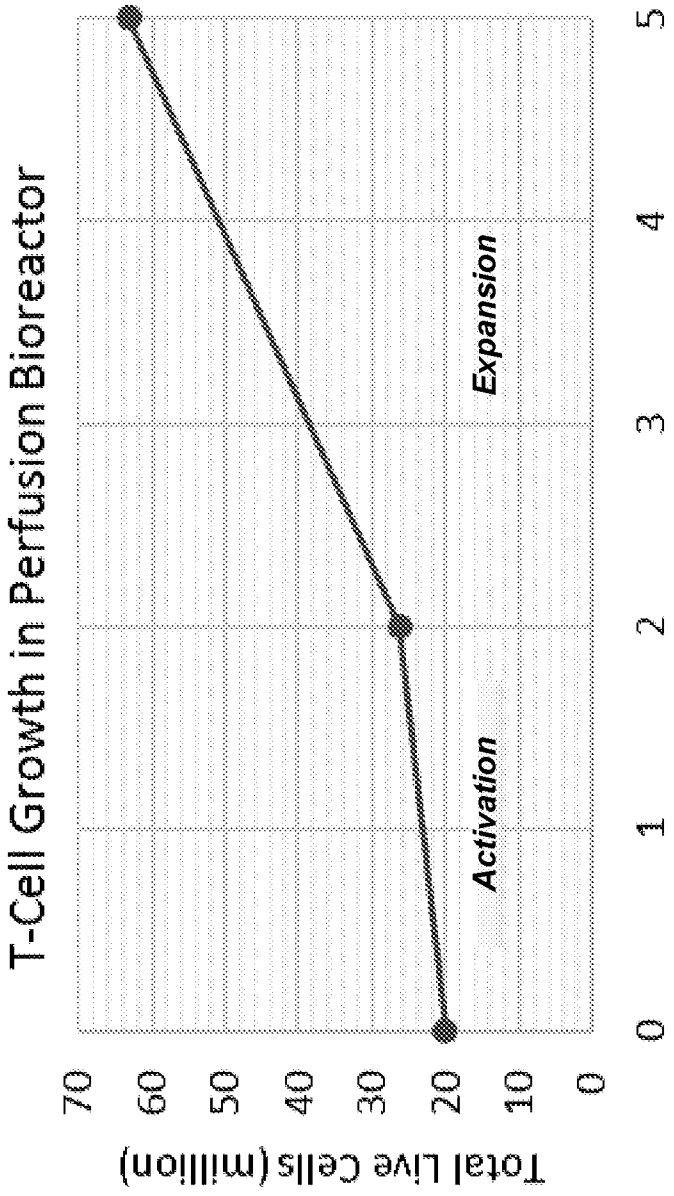

T-Cell Growth in Perfusion Bioreactor
Total Live Cells (million)
0
10
20
30
40
50
60
70
Time (Days)
0
1
2
3
4
5
Activation
Expansion

FIG. 17