US009296989B2

(12) **United States Patent**
Trevino et al.

(10) **Patent No.: US 9,296,989 B2**
(45) **Date of Patent: *Mar. 29, 2016**

(54) **COMPOSITION AND METHOD FOR DELIVERY OF LIVING CELLS IN A DRY MODE HAVING A SURFACE LAYER**

(75) Inventors: **Ramiro Trevino**, McKinney, TX (US); **Steven R. Ellis**, McKinney, TX (US)

(73) Assignee: **DryLet LLC**, McKinney, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/236,387**

(22) PCT Filed: **Apr. 3, 2012**

(86) PCT No.: **PCT/US2012/031997**

§ 371 (c)(1),
(2), (4) Date: **Jan. 31, 2014**

(87) PCT Pub. No.: **WO2012/138656**

PCT Pub. Date: **Oct. 11, 2012**

(65) **Prior Publication Data**

US 2014/0206080 A1 Jul. 24, 2014

Related U.S. Application Data

(60) Provisional application No. 61/471,641, filed on Apr. 4, 2011.

(51) **Int. Cl.**

C12N 5/071	(2010.01)
C12N 5/00	(2006.01)
A01N 1/02	(2006.01)

(52) **U.S. Cl.**

CPC ***C12N 5/0602*** (2013.01); ***A01N 1/0231*** (2013.01); ***C12N 5/0068*** (2013.01); *C12N 2533/12* (2013.01)

(58) **Field of Classification Search**

CPC C12N 5/0068
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,644,215	A	2/1972	Muller
3,719,496	A	3/1973	Chen et al.
3,726,693	A	4/1973	Harris et al.
3,871,957	A	3/1975	Mohan et al.
3,882,253	A	5/1975	Schafer et al.
3,895,219	A	7/1975	Richardson et al.
4,304,857	A	12/1981	Brouillard et al.
4,426,570	A	1/1984	Hikino et al.
4,486,651	A	12/1984	Atsumi et al.
4,590,685	A	5/1986	Roth
4,591,455	A	5/1986	Macedo et al.
4,647,464	A	3/1987	Todd, Jr. et al.
4,717,561	A	1/1988	Krivak et al.
4,965,434	A	10/1990	Nomura et al.
4,971,820	A	11/1990	Likuski et al.
5,035,804	A	7/1991	Stowe
5,077,461	A	12/1991	Hasegawa
5,194,279	A	3/1993	Okel
5,395,808	A	3/1995	Miller et al.
5,403,799	A	4/1995	Miller et al.
5,443,845	A	8/1995	Felix
5,552,176	A	9/1996	Marino
5,569,634	A	10/1996	Miller et al.
5,635,214	A	6/1997	Ponchon et al.
5,678,238	A	10/1997	Billings et al.
5,906,843	A	5/1999	Dew et al.
6,001,322	A	12/1999	Chevallier et al.
6,184,408	B1	2/2001	Burns et al.
6,991,802	B1	1/2006	Ahola et al.
7,067,062	B2	6/2006	Yang et al.
7,153,521	B2	12/2006	Viot
7,422,737	B1	9/2008	Nussinovitch et al.
7,538,067	B2	5/2009	Hu et al.
2003/0026845	A1	2/2003	Etzel et al.
2003/0091641	A1	5/2003	Tiller et al.
2006/0019016	A1	1/2006	Torcatis
2006/0147546	A1	7/2006	Ferlin et al.
2007/0017195	A1	1/2007	Withiam et al.
2007/0281063	A1	12/2007	Carapelli
2008/0071129	A1	3/2008	Yang et al.
2009/0114569	A1	5/2009	Osaheni et al.
2009/0120872	A1	5/2009	Kroh
2009/0211453	A1	8/2009	Nassivera et al.
2009/0214701	A1	8/2009	Forchhammer et al.
2009/0232950	A1	9/2009	Brothers, Jr et al.

FOREIGN PATENT DOCUMENTS

EP	0 067 459	A1	12/1982
EP	1 048 697	A2	11/2000
FR	2 573 772	A1	5/1986

(Continued)

OTHER PUBLICATIONS

Teramura et al. "Islet-encapsulation in ultra-thin layer-by-layer membranes of poly(vinyl alcohol) anchored to poly(ethylene glycol)-lipids in the cell membrane", Biomaterials, 2007, 28:4818-4825.*

Baca et al. "Cell-directed assembly of bio-nano interfaces-a new scheme for cell immobilization", Acc. Chem. Res. 2007, 40:836-845.*

Feller et al. "Polyunsaturated fatty acids in lipid bilayers: intrinsic and environmental contributions to their unique physical properties", JACS, 2002, 124(2):318-326.*

Huang et al. "Highly efficient cellular labeling of mesoporous nanoparticles in human mesenchymal stem cells: implication for stem cell tracking", The FASEB J., 2005, 19:2014-2016.*

Harper et al. ACSNANO, 2010, 4(10):5539-5550.*

PCT International Search Report and Written Opinion dated Jun. 25, 2012; International Application No. PCT/US2013/031997; International File Date.: Apr. 3, 2012.

(Continued)

Primary Examiner — Bin Shen

(74) *Attorney, Agent, or Firm* — Dentons US LLP

(57) **ABSTRACT**

The present invention generally relates to compositions and methods of delivering living cells in a dry mode, wherein the compositions include a surface layer disposed on the outer surface of the composition that is permeable to carbon dioxide and oxygen. The compositions may be used to deliver living cells to a delivery point without the use of expensive refrigerants such as dry ice or liquid nitrogen.

24 Claims, 1 Drawing Sheet