

(51) International Patent Classification:
A61K 9/16 (2006.01)(21) International Application Number:
PCT/US2012/026520(22) International Filing Date:
24 February 2012 (24.02.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/446,934 25 February 2011 (25.02.2011) US(71) Applicant (for all designated States except US): **SOUTH DAKOTA STATE UNIVERSITY** [US/US]; Suite 201, 815 Medary Ave, Brookings, SD 57006 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **PERUMAL, Omathanu P.** [IN/US]; 723 Leprechaun Circle, Brookings, SD 57006 (US). **AVERINENI, Ranjith, Kumar** [IN/US]; Apt. 12B, 2229 - 10th Street, Brookings, SD 57006 (US). **PODARALLA, Satheesh** [IN/US]; 3455 Homestead Road, Vista Pointe Apartments, Apt. 28, Santa Clara, CA 95051 (US). **ALQAHTANI, Mohammed** [SA/US]; Apt. 35, 1808 - 8th Street, Brookings, SD 57006 (US).(74) Agents: **HAUKAAS, Michael** et al.; Suite 300, 605 US Highway 169 North, Plymouth, MN 55441 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

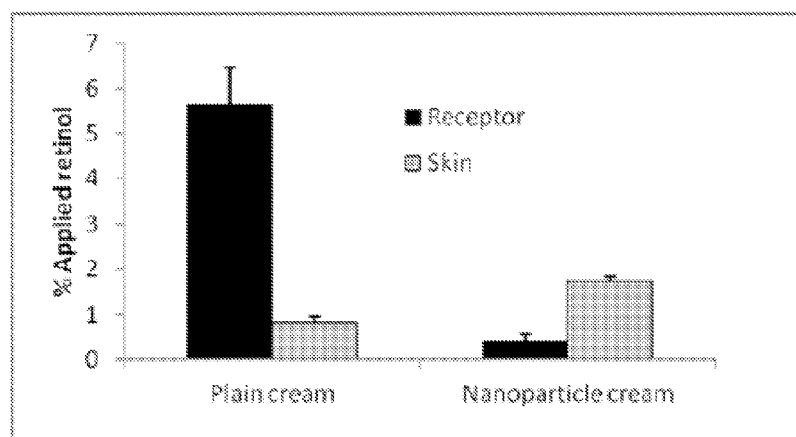
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(88) Date of publication of the international search report:
24 April 2014

(54) Title: PROTEIN NANOCARRIERS FOR TOPICAL DELIVERY

**Figure 45**

(57) Abstract: The invention encompasses nanoparticle assemblies and methods for preparing nanoparticle assemblies and compositions comprising such assemblies. The invention further encompasses methods of complexing various molecular and cellular entities to the nanoparticles using the resulting nanoparticles of the invention as delivery devices. The nanoparticle assemblies can be used for a variety of applications, such as treating cancer, targeting tumors, reducing the toxicity of a drug in vivo, increasing the efficacy of an complexed agent in vivo, protecting an complexed agent against degradation, and enhancing the water solubility of a drug or other agent.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/26520

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61K 9/16 (2012.01)

USPC - 424/491

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A61K 9/16 (2012.01)

USPC - 424/491

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 424/491, 486, 485, 94.1 (see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PubWEST (PGPB, USPT, USOC, EPAB, JPAB, DWPI, TDBD); Google

Search Terms: nanopartilce, white zein, poloxamer, phospholipid, lecithin, sonicating, centrifuging, polydispersity, retinyl, retinoic, esterified, 5-fluorouracil, platelet rich, adsorbed, surface, ?-casein, dextran, conjugate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	WO 2009/137112 A1 (Perumal et al.) 12 November 2009 (12.11.2009) entire document, especially pg 1-5, 11-13, 18-23, 27-28	1-3, 10, 12-18, 39, 42-46, 48, 50
Y	US 2003/0232091 A1 (Shefer et al.) 18 December 2003 (18.12.2003) entire document, especially para [0081]-[0087], [0101]-[0110]	4-9, 11, 19-22, 40-41, 47,
Y	US 2008/0187595 A1 (Jordan et al.) 07 August 2008 (07.08.2008) entire document, especially para [0011], [0038]	4-8, 19-22, 49
Y	US 2007/0087061 A1 (Drake et al.) 19 April 2007 (19.04.2007) entire document, especially para [0026]-[0029], [0042], [0049]	9
Y	US 2009/0311407 A1 (Lucey et al.) 17 December 2009 (17.12.2009) entire document, especially para [0005], [0033]-[0039], [0125]	11, 47
A	Podaralla et al. 'Preparation of zein nanoparticles by pH controlled nanoprecipitation'. J Biomed Nanotechnol. 2010 Aug;6(4):312-7. Abstract.	40, 41
A	Zhong et al. 'Zein nanoparticles produced by liquid liquid dispersion'. Food Hydrocolloids, Volume 23, Issue 8, December 2009, Pages 2380-2387. Abstract.	1-50
A	Lai et al. 'Preparation of new 5-fluorouracil-loaded zein nanoparticles for liver targeting'. Int J Pharm. 2011 Feb 14;404(1-2):317-23. Epub 2010 Nov 19. Abstract.	1-50
		1, 9

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

30 May 2012 (30.05.2012)

Date of mailing of the international search report

08 JUN 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application no.

PCT/US 12/26520

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 23-38
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.