



(51) International Patent Classification:

C07K 7/04 (2006.01) A61P 35/00 (2006.01)  
A61K 47/54 (2017.01)

(21) International Application Number:

PCT/US2023/013863

(22) International Filing Date:

24 February 2023 (24.02.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/313,395 24 February 2022 (24.02.2022) US

(71) Applicant: **PURDUE RESEARCH FOUNDATION**  
[US/US]; 101 Foundry Drive, Suite 2500, West Lafayette,  
IN 47906 (US).

(72) Inventors: **LOW, Philip, Stewart**; 5850 Farm Ridge Road,  
West Lafayette, IN 47906 (US). **JUNG, Losha, Dasol**;  
2417 Neil Armstrong Drive, West Lafayette, IN 47906  
(US). **SRINIVASARAO, Madduri**; 975 Marwyck Street,  
West Lafayette, IN 47906 (US). **LOW, Stewart**; 4036 Moss  
Creek Lane, West Lafayette, IN 47906 (US). **NIELSEN,**

Jeffery; 2829 Bentbrook Lane, West Lafayette, IN 47906  
(US).

(74) Agent: **DEAN, Natalie, J.**; Reichel Stohry Dean LLP, 525  
S Meridian Street, Suite 1a2, Indianapolis, IN 46225 (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, BN, BR, BW, BY, BZ,  
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE,  
KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU,  
LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG,  
NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS,  
RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,  
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,  
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, CV,  
GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST,  
SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,  
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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,

(54) Title: CONJUGATES, COMPOSITIONS, AND METHODS FOR HYDROXYAPATITE-TARGETED IMAGING AND THERAPY

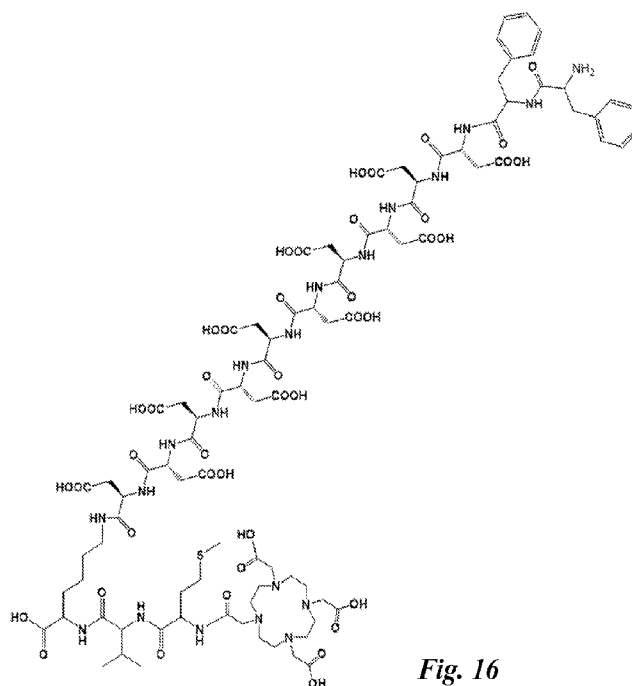


Fig. 16

(57) Abstract: Conjugates that target hydroxyapatite, compositions comprising same, and methods of use for radio-imaging or radio-therapy.



SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,  
GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Published:**

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

**(88) Date of publication of the international search report:**

05 October 2023 (05.10.2023)

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/013863

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - INV. - C07K 7/04 (2023.01) ADD. - A61K 47/54; A61P 35/00 (2023.01) CPC - INV. - C07K 7/04 (2023.05)  ADD. - A61K 47/547; A61P 35/00 (2023.05) According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) See Search History document  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched See Search History document  Electronic database consulted during the international search (name of database and, where practicable, search terms used) See Search History document		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WANG, Targeted Delivery of Dasatinib for Accelerated Bone Fracture Repair, Purdue University, Ph.D., Thesis, May 2019 [retrieved on 14 April 2023]. Retrieved from the Internet: <URL: https://hammer.purdue.edu/articles/TARGETED_DELIVERY_OF_DASATINIB_FOR_ACCELERATED_BONE_FRACTURE_REPAIR/8029322/files/14956928.pdf>. Pgs. 1, 2, 87-95	1-4, 6, 8-10, 17, 27
A	WO 2015/073678 A1 (ENDOCYTE INC. et al.) 21 May 2015 (21.05.2015) entire document	1-4, 6, 8-10, 17, 27
A	US 9,873,711 B2 (MISRA) 23 January 2018 (23.01.2018) entire document	1-4, 6, 8-10, 17, 27
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "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 10 June 2023		Date of mailing of the international search report  <div style="text-align: center; font-size: 1.5em; font-weight: bold;">JUL 26 2023</div>
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300		Authorized officer  <div style="text-align: center;">Taina Matos</div> Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/013863

**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.: 26, 33-51  
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:

See extra sheet(s).

- 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.:  
1-4, 6, 8-10, 17, 27

**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.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/013863

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees need to be paid.

Group I+: claims 1-25 and 27-32 are drawn to conjugates of Formula I, or a pharmaceutically acceptable salt thereof.

The first invention of Group I+ is restricted to a conjugate of Formula I, HB-LA-A, or a pharmaceutically acceptable salt thereof, specifically wherein the conjugate is the compound shown in instant claim 27. It is believed that claims 1-4, 6, 8-10, 17, and 27 read on this first named invention and thus these claims will be searched without fee to the extent that they read on the above embodiment.

Applicant is invited to elect additional formula(e) for each additional compound to be searched in a specific combination by paying an additional fee for each set of election. Each additional elected formula(e) requires the selection of a single definition for each compound variable. An exemplary election would be a conjugate of Formula I, HB-LA-A, or a pharmaceutically acceptable salt thereof, specifically wherein the conjugate is the compound shown in instant claim 27. Additional formula(e) will be searched upon the payment of additional fees. Applicants must specify the claims that read on any additional elected inventions. Applicants must further indicate, if applicable, the claims which read on the first named invention if different than what was indicated above for this group. Failure to clearly identify how any paid additional invention fees are to be applied to the "+" group(s) will result in only the first claimed invention to be searched/examined.

The inventions listed in Groups I+ do not relate to a single general inventive concept under PCT Rule 13.1, because under PCT Rule 13.2 they lack the same or corresponding special technical features for the following reasons:

The Groups I+ formulae do not share a significant structural element requiring the selection of alternatives for the compound variables HB, LA, A and accordingly these groups lack unity a priori.

Additionally, even if Groups I+ were considered to share the technical features of a conjugate having the core structure of Formula I, or a pharmaceutically acceptable salt thereof, these shared technical features do not represent a contribution over the prior art as disclosed by the publication entitled "Targeted Delivery of Dasatinib for Accelerated Bone Fracture Repair by Wang (hereinafter, "Wang").

Wang teaches a conjugate having the core structure of Formula I, or a pharmaceutically acceptable salt thereof (Pg. 92, Fig. 5.2, DD10-S0456 as shown as product of reaction).

The inventions listed in Groups I+ therefore lack unity under Rule 13 because they do not share a same or corresponding special technical feature.