



NATIONAL CANCER INSTITUTE
Office of Cancer
Nanotechnology Research

NCI **Alliance** for
Nanotechnology
in Cancer

caNanoLab Data Portal Overview

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June 30, 2017
NIEHS NHIR Meeting

caNanoLab Data Portal: A Resource for Data Sharing



Home Page

Data Type	Public Results
Search Protocols Search for nanotechnology protocols leveraged in performing nanomaterial characterization assays.	50
Search Samples Search for information on nanomaterials including the composition of the nanomaterial, results of physico-chemical, <i>in vitro</i> , <i>in vivo</i> and other characterizations, and associated publications. See also Advanced Sample Search	1217 130 Sample Sources 4817 Characterizations 1296 Physico-chemical 2179 <i>In Vitro</i> 66 <i>In Vivo</i> 1274 Other
Search Publications Search for information on nanotechnology publications including peer reviewed articles, reviews, and other types of reports related to the use of nanotechnology in biomedicine.	1925

caNanoLab Goal

To provide a nanotechnology resource that facilitates data sharing in the community to expedite and validate the use of nanomaterials in biomedicine

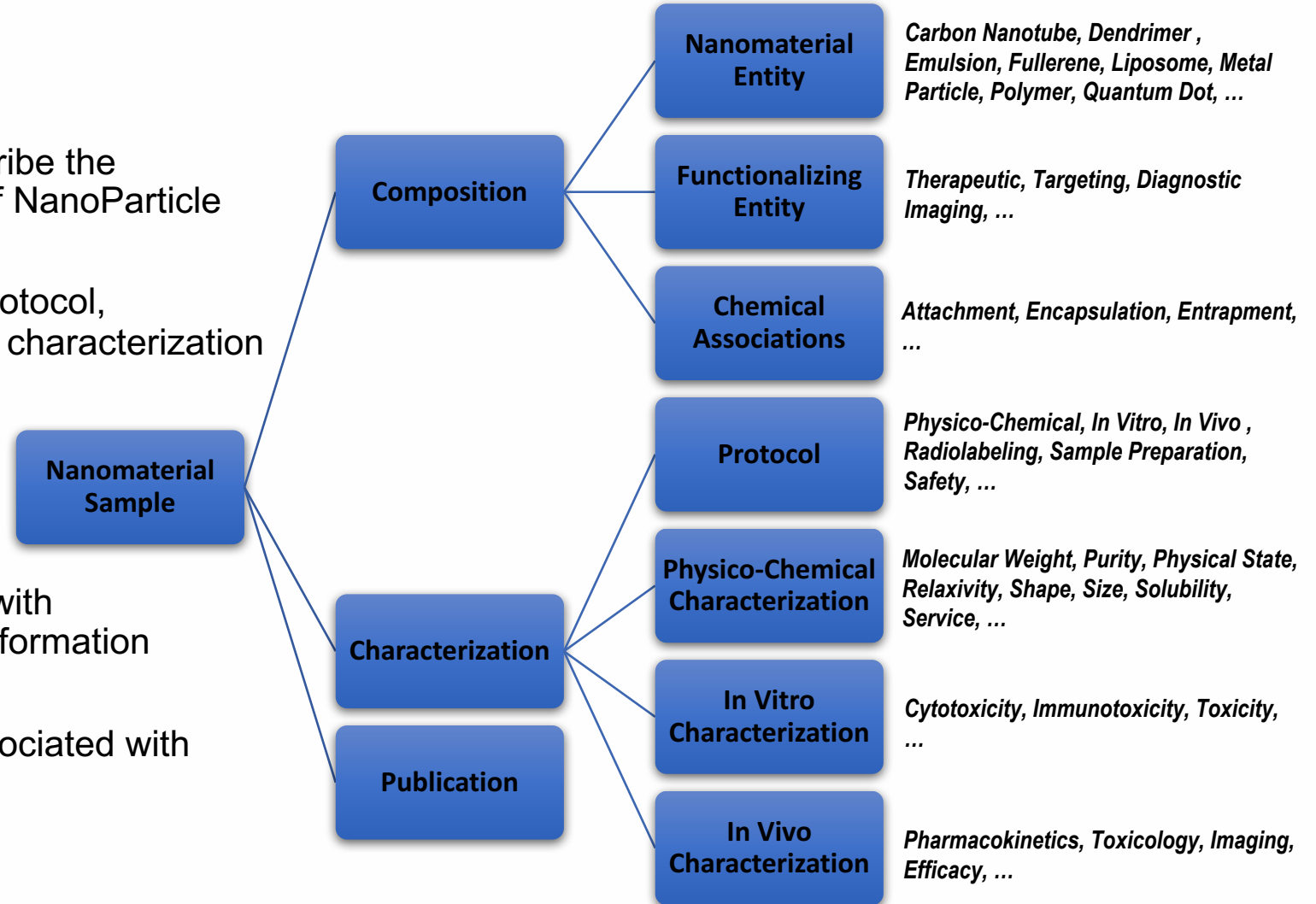
<https://cananolab.nci.nih.gov>

- Provides support for the annotation of nanomaterials with composition information, and physico-chemical, *in vitro*, and *in vivo* characterizations
- Provides access to nanomaterial information, protocols, and publications from the NCI Nanotechnology Characterization Laboratory (NCL), NCI Alliance for Nanotechnology in Cancer, and the broader biomedical nanotechnology community

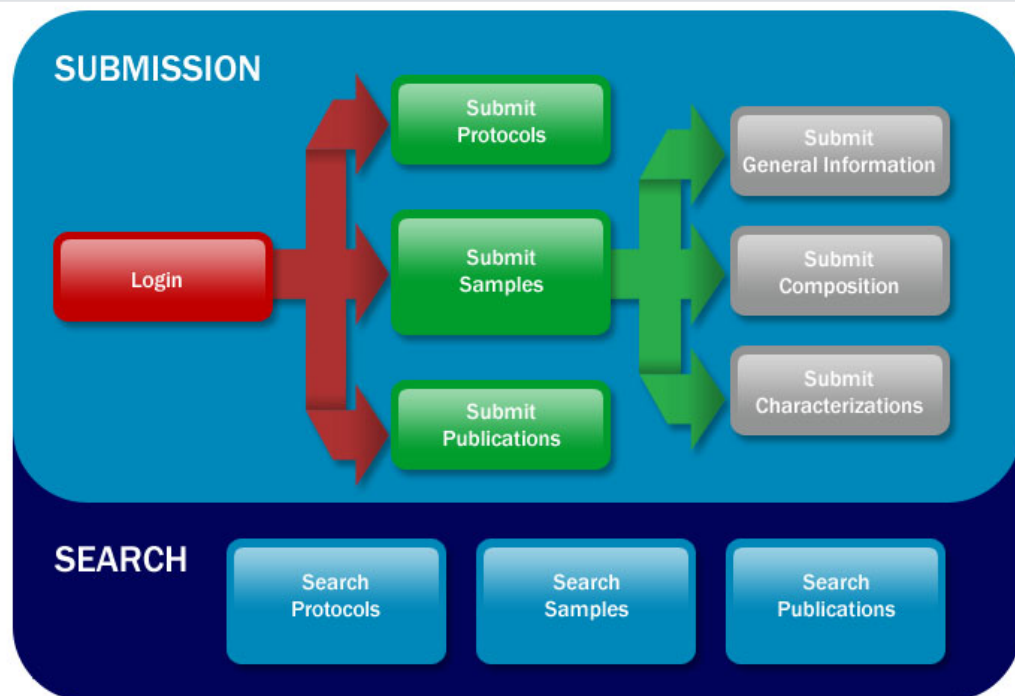
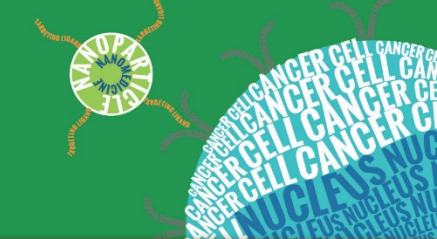
caNanoLab High-Level Concepts



- caNanoLab maintains metadata to describe the composition of each particle type; use of NanoParticle Ontology
- For characterizations, can specify the protocol, instruments, and techniques used in the characterization assay
- Submitted protocols can be associated with characterizations during nanomaterial information submission
- Similarly, submitted samples can be associated with publications



caNanoLab Curation and Content

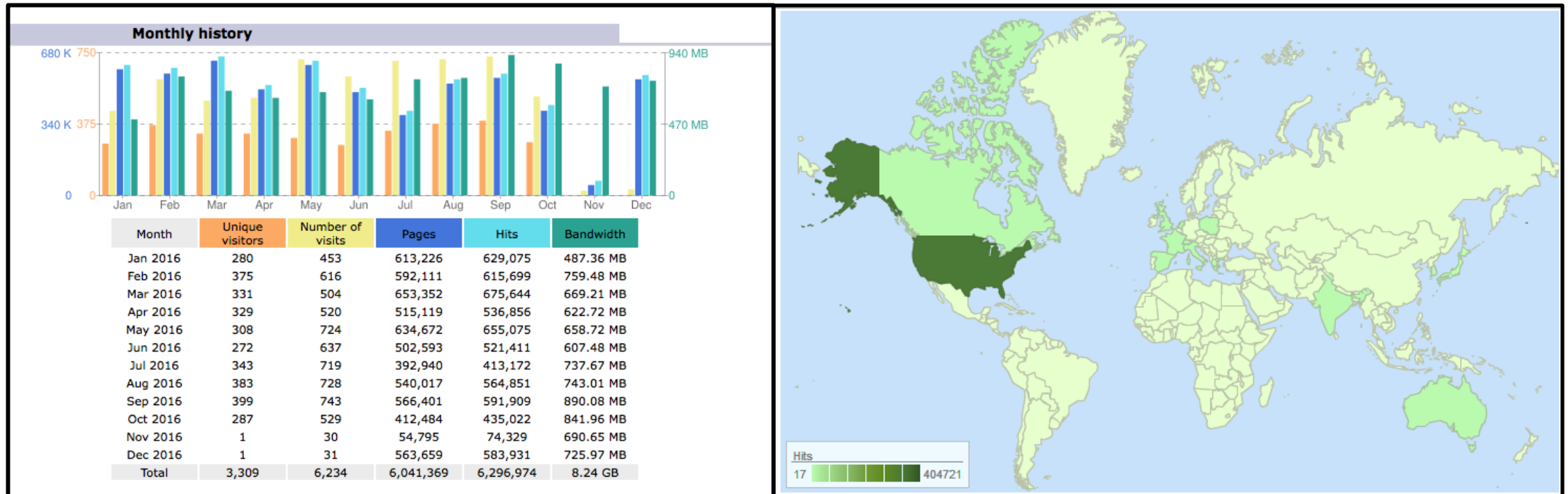


Current caNanoLab Content:

- 1,217 Sample Records
 - 130 sample sources; 4,817 characterizations
- 1,925 Publications
- 50 Protocols
- Particle types include: liposomes, metal, metal oxide, silica, polymers, emulsions, dendrimers, and more

- In-house curator; submission directly by users encouraged!
- Initial data sources Alliance and NCL; sources have grown to include laboratories across the U.S. and other countries; ~10% derived from international publications (e.g., United Kingdom, Canada, China, Greece)
- Researchers can submit data via web-based forms and download reports in a spreadsheet-based format
- Search for samples, publications, and protocols by a variety of factors such as keyword, name, PubMed ID/DOI (publications), characterization, and composition

caNanoLab Usage



- ~4000 unique visitors for all of 2016—average 330 unique visitors/month
- Top countries accessing caNanoLab: United States, Taiwan, Germany, Japan, Great Britain, Romania, Italy, Canada, India

Screenshots

Protocol Submission

Update Protocol

Protocol Type * physico-chemical assay ▼

Protocol Name* NIST - NCL Joint Assay Protocol, PCC-13

Protocol Abbreviation PCC-13

Protocol Version 1.1

Protocol File ☐ Upload ☒ Enter File URL

[Disclaimer]

File Title Measuring the pH of Nanoparticle Suspensions

Description Protocol for measuring the pH of dilute nanoparticle suspensions of composition similar to NIST Reference Materials (RMs) 8011, 8012, and 8013, which contain gold nanoparticles in a dilute electrolyte solution

Access to the Protocol [Add](#)

Publication Submission

Update Publication

Publication Type * peer review article ▼ **Publication Status*** published ▼

PubMed ID [Click to look up PubMed Identifier](#)

clicking outside of the text field after entering a valid PubMed ID enables auto-population of PubMed related fields

Digital Object ID

Title* Cooperative nanomaterial system to sensitize, target, and treat tumors.

Journal Proceedings of the National Academy of Sciences of the United States of America

Year of Publication

Volume **Start Page** **End Page**

Authors [Add](#)

First Name	Last Name	Initials	
Ji-Ho	Park	JH	Edit
Geoffrey	Maltzahn	G	Edit
Mary	Xu	MJ	Edit
Valentina	Fogal	V	Edit
Venkata	Kotamraju	VR	Edit
Erkki	Ruoslahti	E	Edit
Sangeeta	Bhatia	SN	Edit
Michael	Sailor	MJ	Edit

Keywords (one keyword per line)
ANTINEOPLASTIC AGENTS/ADMINISTRATION & DOSAGE/THERAPEUTIC USE
CELL LINE, TUMOR
Doxorubicin/administration & dosage/therapeutic use

Description A significant barrier to the clinical translation of systemically administered therapeutic nanoparticles is their tendency to be removed from circulation

Sample Search

SAMPLE LINKS

[Search Existing Samples](#)

Enter search criteria to obtain information on samples of interest.

[Advanced Sample Search](#)

Enter advanced search criteria based on caNanoLab metadata to obtain information on samples of interest.

Keywords

searching characterization keywords, publication keywords and text in characterization descriptions
enter one keyword per line

Sample Name

Sample Point of Contact

searching organization name or person name

Nanomaterial Entity

Functionalizing Entity

Function

Characterization

Assay Type

size

Point of Contact

DNT

Design Description

The effect of size based on 25 degree Celsius and Saline solvent

Experiment Configurations

Technique
dynamic light scattering(DLS)

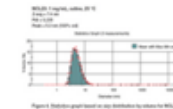
Instruments
dynamic light scattering instrument (Malvern)

Description

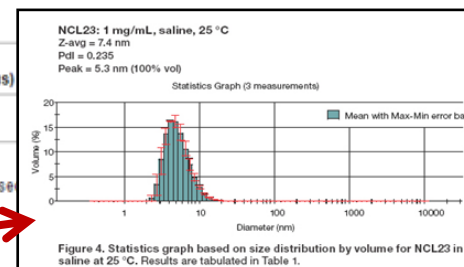
Characterization Results Data and Conditions

PDI (observed)	size (Z-average,nm)	temperature (observed,Celsius)
0.235	7.4	25

Files



Statistics graph based on Celsius



Assay Type

size

Point of Contact

DNT

Design Description

The effect of size based on 25 degree Celsius and PBS solvent

Experiment

Technique

Instruments

Description

Sample Characterization

caNanoLab Data Submission



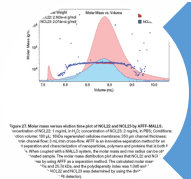
General Information

- Submit Sample Name and Investigator or other point of contact



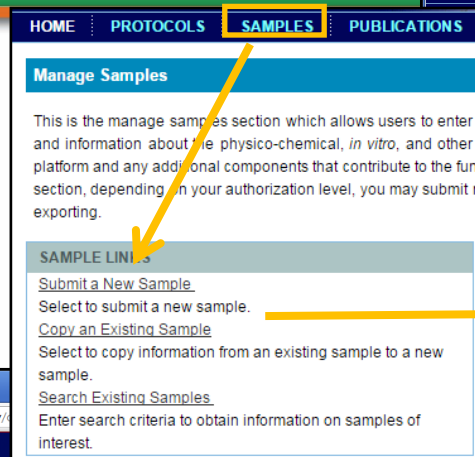
Composition

- Submit Nanomaterial and Functionalizing Entities and Chemical Associations



Characterizations

- Submit Physico-Chemical, *In Vitro*, and/or *In Vivo* Characterizations



Nanomaterial Entity Submission

Sample Characterization Submission

caNanoLab Data Sharing Options



Modernized authorization (user access) modules



- Data Sharing Options: private, sharing with another caNanoLab registered user, collaboration group or request to make public.
- The Collaboration Group Feature: all group members will be added with the same access level—Read and Edit. →

caNanoLab Functionality



- Usability enhancements from feedback obtained via the caNanoLab survey
- myWorkspace feature to allow users to view submitted samples, protocols, and publications and their submission status
- myFavorites feature to allow user to save samples, protocols, and publications for easy access
- Support for Advanced and Google-like Search capabilities

☒ Samples ☒ Protocols ☒ Publications

My Samples

Actions	Sample Name	Sample Submission Status	Created Date	Sample Access
View Edit	Dendrimer-Demo	In Draft	12/17/10	(Owner, Shared by: Curator, Demo University)
View Edit	Liposome-Demo	In Draft	12/9/11	(Owner, Shared by: Curator)
View Edit	Carbon_Nanotube-Demo	In Draft	2/29/12	(Owner, Shared by: Carbon Tube Group, Curator)
View Edit	Metal_Particle-Demo	In Draft	4/24/12	(Owner, Shared by: Curator)

My Protocols

Actions	Protocol Name	Protocol Submission Status	Created Date	Protocol Access
View Edit	NIST - NCL Joint Assay Protocol, PCC-6	Retracted	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-7	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-10	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-8	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-9	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-11	Retracted	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-14	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-12	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NIST - NCL Joint Assay Protocol, PCC-13	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	ITA-14	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	ITA-5.1	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	ITA 5.2	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NCL Method GTA-14	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NCL Method GTA-11	Approved	12/8/10	(Owner, Shared by: Curator, Public)
View Edit	NCL Method GTA-12	Approved	12/8/10	(Owner, Shared by: Curator, Public)

My Publications

MyWorkspace

Advanced Sample Search

Advanced Search

Sample Criteria

-- Please Select -- -- Please Select --

Add Reset

Composition Criteria

nanomaterial entity dendrimer Edit

-- Please Select -- -- Please Select -- with chemical name -- Please Select --

Add Reset

Characterization Criteria

physico-chemical size size > 10 nm Edit

in vitro cytotoxicity LC50 > 10 mg/L Edit

-- Please Select -- -- Please Select -- -- Please Select --

Add Reset

☒ AND ☐ OR

☒ AND ☐ OR

Searching without any parameters returns all samples.

Reset Search

Promoting caNanoLab Data



NIH and NCI

- Both caNanoLab and Nanomaterial Registry on list of [NIH Data Sharing Repositories](#) maintained by National Library of Medicine.
- [NCI Data Catalog](#) lists caNanoLab—list of data collections produced by NCI initiatives
- [PubMed LinkOut](#) Resource

PubMed LinkOut

Format: Abstract ▾

[J Am Chem Soc.](#) 2016 Feb 24;138(7):2158-61. doi: 10.1021/jacs.5b13458. Epub 2016 Feb 16.

Nanoscale Metal-Organic Frameworks for Ratiometric Oxygen Sensing in Live Cells.

[Xu R¹](#), [Wang Y^{1,2}](#), [Duan X¹](#), [Lu K¹](#), [Micheroni D¹](#), [Hu A²](#), [Lin W¹](#).

⊕ Author information

Abstract

We report the design of a phosphorescence/fluorescence dual-emissive nanoscale metal-organic framework (NMOF), R-UiO, as an intracellular oxygen (O₂) sensor. R-UiO contains a Pt(II)-porphyrin ligand as an O₂-sensitive probe and a Rhodamine-B isothiocyanate ligand as an O₂-insensitive reference probe. It exhibits good crystallinity, high stability, and excellent ratiometric luminescence response to O₂ partial pressure. In vitro experiments confirmed the applicability of R-UiO as an intracellular O₂ biosensor. This work is the first report of a NMOF-based intracellular oxygen sensor and should inspire the design of ratiometric NMOF sensors for other important analytes in biological systems.

PMID: 26864385 DOI: [10.1021/jacs.5b13458](#)

[PubMed - in process]

[f](#) [t](#) [s](#)

Publication Types, Grant Support ▾

LinkOut - more resources ▴

Full Text Sources

[American Chemical Society](#)

Other Literature Sources

[caNanoLab samples curated from the publication - NCI caNanoLab Data Portal](#)

Full text links

[ACS Publications](#)

Save items

★ Add to Favorites ▾

Similar articles

Nanoscale metal-organic framework for intracellular pH sensing in live cells [J Am Chem Soc.

A Chlorin-Based Nanoscale Metal-Organic Framework for Photodynamic Therapy [J Am Chem Soc.

Tunable fluorescent/phosphorescent metal-organic frameworks for intracellular oxygen sensing [Chem Commun.

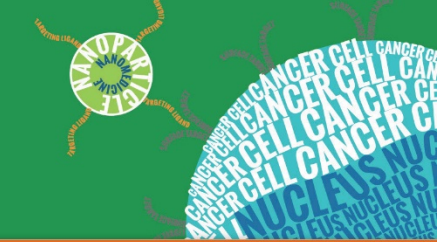
Review Nanoscale metal-organic frameworks for biomedical imaging and drug delivery [Acc Chem Res.

Review Luminescent sensing of intracellular oxygen: fierce competition to the existing methods [Chem Rev.

Cited by 1 PubMed Central article

The development of fluorescent metal-organic frameworks for intracellular oxygen sensing and live cell imaging [Chem Commun.

Promoting caNanoLab Data



Publishers and Journals

- [Nature](#), [PLOS](#), and [Elsevier](#) journals added nanomaterial databases as recommended data repositories
- Opportunities to publish data descriptor articles with Nature's *Scientific Data*
- Have an established [bidirectional interface](#) with Elsevier articles and caNanoLab data

Publication Interface

Journal of Controlled Release
Volume 170, Issue 1, 28 August 2013, Pages 74-82

Oral delivery of taurocholic acid linked heparin-docetaxel conjugates for cancer therapy
Zehedina Khatun^{a,1}, Md Nurunnabi^{a,1}, Gerald R. Recek^a, Kwang Jae Cho^a, Yong-kyu Lee^a

doi:10.1016/j.jconrel.2013.04.024

Abstract
We have synthesized taurocholic acid (TCA) linked heparin-docetaxel (DTX) conjugates for oral delivery of anticancer drug. The ternary biomolecular conjugates formed self-assembly nanoparticles where docetaxel was located inside the core and taurocholic acid was located on the surface of the nanoparticles. The coupled taurocholic acid in the nanoparticles had enhanced oral absorption, presumably through the stimulation of a bile acid transporter of the small intestine. The oral absorption profile demonstrated that the concentration of the conjugates in plasma is about 6 fold higher than heparin alone. An anti-tumor study in MDA-MB231 and KB tumor bearing mice showed significant tumor growth inhibition activity by the ternary biomolecular conjugates. Ki-67 histology study also showed evidence of anticancer activity of the nanoparticles. Finally, noninvasive imaging using a Kodak Molecular Imaging System demonstrated that the nanoparticles were accumulated efficiently in tumors. Thus, this approach for oral delivery using taurocholic acid in the ternary biomolecular conjugates is promising for treatment of various types of cancer.

Graphical abstract

TCA-linked heparin-DTX conjugates (HOTA)

Legend: Control, HOTA, MDA-MB231

Y-axis: Plasma concentration (ng/mL)

X-axis: Time (h)

Sample Information by Publication

Publication REF	Authors	Title	Sample Composition	Sample Characterization	Journal	Year	Vol(Iss)Pg
DOI Id: 10.1016/j.jconrel.2013.04.024	Khatun, Z, Nurunnabi, M, Recek, GR, Cho, KJ, Lee, YK	Oral delivery of taurocholic acid linked heparin-docetaxel conjugates for cancer therapy.	Samples curated in caNanoLab: KNUT_KSU_CUK-ZKhatunJCR2013-01 , KNUT_KSU_CUK-ZKhatunJCR2013-02 , KNUT_KSU_CUK-ZKhatunJCR2013-03 , KNUT_KSU_CUK-ZKhatunJCR2013-04 , KNUT_KSU_CUK-ZKhatunJCR2013-05 , KNUT_KSU_CUK-ZKhatunJCR2013-06 , KNUT_KSU_CUK-ZKhatunJCR2013-07 , KNUT_KSU_CUK-ZKhatunJCR2013-08	Samples curated in caNanoLab: KNUT_KSU_CUK-ZKhatunJCR2013-01 , KNUT_KSU_CUK-ZKhatunJCR2013-02 , KNUT_KSU_CUK-ZKhatunJCR2013-03 , KNUT_KSU_CUK-ZKhatunJCR2013-04 , KNUT_KSU_CUK-ZKhatunJCR2013-05 , KNUT_KSU_CUK-ZKhatunJCR2013-06 , KNUT_KSU_CUK-ZKhatunJCR2013-07 , KNUT_KSU_CUK-ZKhatunJCR2013-08	Journal of controlled release : official journal of the Controlled Release Society	2013	170:74-82

We have synthesized taurocholic acid (TCA) linked heparin-docetaxel (DTX) conjugates for oral delivery of anticancer drug. The ternary biomolecular conjugates formed self-assembly nanoparticles where docetaxel was located inside the core and taurocholic acid was located on the surface of the nanoparticles. The coupled taurocholic acid in the nanoparticles had enhanced oral absorption, presumably through the stimulation of a bile acid transporter of the small intestine. The oral absorption profile demonstrated that the concentration of the conjugates in plasma is about 6 fold higher than heparin alone. An anti-tumor study in MDA-MB231 and KB tumor bearing mice showed significant tumor growth inhibition activity by the ternary biomolecular conjugates. Ki-67 histology study also showed evidence of anticancer activity of the nanoparticles. Finally, noninvasive imaging using a Kodak Molecular Imaging System demonstrated that the nanoparticles were accumulated efficiently in tumors. Thus, this approach for oral delivery using taurocholic acid in the ternary biomolecular conjugates is promising for treatment of various types of cancer.

Promoting caNanoLab Data



Integrating with other Databases

- Nanomaterial Registry
- eNanoMapper –European project focused on the development of a computational infrastructure for engineered nanomaterial toxicological data management

eNanoMapper Search Interface

Integrated view of eNanoMapper database caNanoLab

Search: [Feedback](#)

Data sources (366)

Nanomaterial type (1465)

- Alloy
- fullerene
- polymer
- carbon_black
- cerium oxide
- emulsion
- multi-walled nan...
- nanorod
- silica
- metal
- titanium oxide
- metal oxide
- zinc oxide

P-CHEM (151)

TOX (227)

Cell (104)

Species (0)

Hits list Selection

polymer multi-walled nanotube metal oxide Clear

< 1 2 3 ... 18 19 > displaying 1 to 20 of 378

CoO2 (Cytotox2011Puzyn14) metal oxide nanoparticle [$\geq 15.0\text{nm}$]
CORE (1): ChemicalName:CoO2
P-CHEM.Particle size distribution (Granulometry) [more](#)
[Material](#) [Composition](#) [Study](#) [Add to Selection](#)

UAM_CSIC_IMDEA-AVillanuevaNT2009-01 metal oxide nanoparticle
P-CHEM.Particle size distribution (Granulometry) [2009] [more](#)
[caNanoLab](#) [Add to Selection](#)

UAM_CSIC_IMDEA-AVillanuevaNT2009-03 metal oxide nanoparticle
P-CHEM.Particle size distribution (Granulometry) [2009] [more](#)
[caNanoLab](#) [Add to Selection](#)

UI-VGrassianEHP2007-01 metal oxide nanoparticle
P-CHEM.Particle size distribution (Granulometry) [2007] [more](#)

<https://search.data.enanomapper.net/>

caNanoLab User Forum

- Forum for users to discuss caNanoLab and data sharing
- Provides guidance for data submission
- Submit New Feature Request or defect using Wish List tab

The screenshot shows the NCI HUB website interface. At the top, the NCI HUB logo is displayed with the tagline 'A COLLABORATORY FOR CANCER RESEARCH'. Navigation tabs include DISCOVER, RESOURCES, COMMUNITY, ABOUT, and SUPPORT. A search bar is located on the right. Below the navigation bar, a yellow banner announces 'New Data in caNanoLab! Targeted PRINT Hydrogels: The Role of Nanoparticle Size and Ligand Density on Cell Association, Biodistribution, and Tumor Accumulation. Reuter et al 2015, Nano Letters. Search for samples associated with this paper here. PMID: 26389971.' The main content area is titled 'caNanoLab User Forum' and includes an 'Overview' tab and a list of topics: biomedicine, databases, Data Sharing, nanoinformatics, nanotechnology, and NCI. A left sidebar contains a navigation menu with 'Overview', 'Members', 'Resources', 'Forum', 'Wish List', 'Usage', 'Projects', 'Calendar', 'Announcements', 'Collections', 'Files', and 'Activity'. The 'Wish List' item is highlighted with a yellow box. The main content area under 'ABOUT THE GROUP' provides information about the caNanoLab Data Repository, how to use the site, and guidance for data submission. A blue button labeled 'caNanoLab User Forum' is positioned at the bottom right of the screenshot.

https://nciphub.org/groups/cananolab_usability/

Upcoming/Ongoing Activities



- Release of caNanoLab 2.4 in August 2017
 - Follow-up with data coordinators
- Accessing image data through caNanoLab
 - Extension of The Cancer Imaging Archive (TCIA) to support preclinical images and data (Wash U CCNE)
- Development of an electronic nanomaterial data notebook
 - For collection of data while generating, sharing between laboratories, and integrating with databases (UNC-Chapel Hill CCNE)
- Acquiring data directly from users
- Increased interaction with community, publishers, and journals in support of data acquisition, and the development of guidelines that promote data sharing and data standards adoption

caNanoLab Team

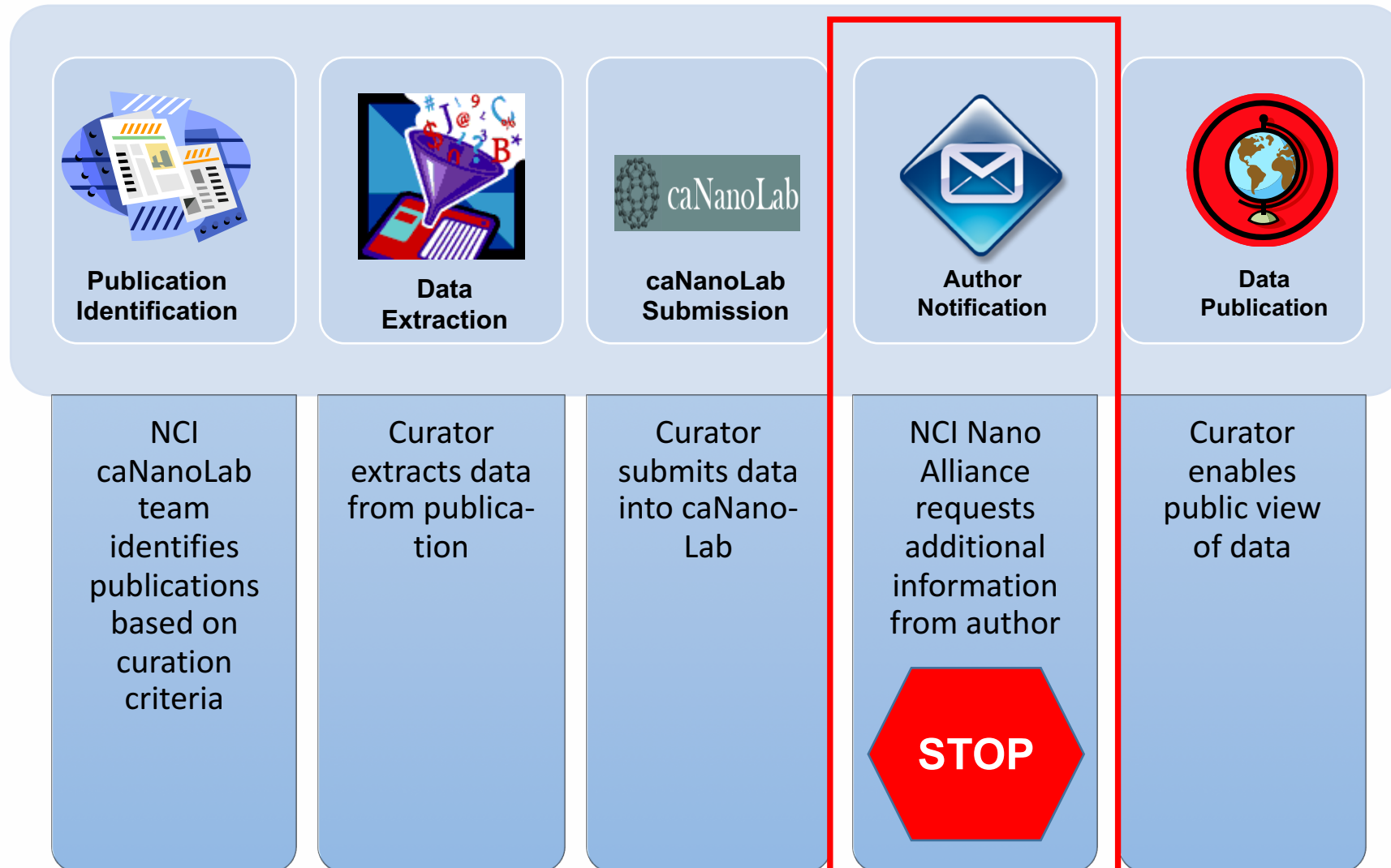


- **Stephanie Morris**, Project Lead, Office of Cancer Nanotechnology Research
- **Mervi Heiskanen**, Project Lead, Center for Biomedical Informatics and Information Technology
- **Michal Lijowski**, Data Curator
- **Philippa Barnes**, Project Manager



Support Slides

Data Curation Procedures



Encouragement to Requirement: Nanomaterials Data Deposition




- For Phase III Alliance, **nanomaterial data deposition a Term and Condition of Award**
 - Included in funding opportunity announcements
- caNanoLab inclusion in data sharing plan; and the designation of at least one scientifically qualified person as nanomaterial data sharing coordinator required once an award has been made
- Dedicated user forum to provide guidance, submit new features request, report defects

HOW TO

- [How do I submit data into caNanoLab?](#)
- [How do I incorporate caNanoLab into a data sharing plan?](#)
- [How do I find nanotechnology protocols?](#)
- [How do I find Nanotechnology publications?](#)
- [How can I search for nanomaterials?](#)
- [How can I search for nanomaterial characterizations?](#)
- [Where can I get definitions for nanotechnology concepts?](#)

<https://wiki.nci.nih.gov/display/caNanoLab/caNanoLab+FAQ>



National Cancer Institute U.S. National Institutes of Health | www.cancer.gov

NCI Wiki New Account Helpful Tips

Dashboard > ICR - caNanoLab > ... > caNanoLab FAQ Browse Log In Search Confluence

How do I incorporate caNanoLab into a data sharing plan?

It is the policy of NIH that the results of research accomplished through Federal support should be made available to the public. To meet this requirement, NIH applicants are required to provide a Data Sharing Plan (Resource Sharing Plan), as described in the [NIH Data Sharing Policy](#) and [SF424 \(R&R\) Application Guide](#). If you are applying for nanotechnology-based research funding that requires a data sharing or data management plan, you may find useful information in the document [caNanoLab & Data Sharing](#) that can be used in your research proposal. The suggested text is based on the requirements for NIH Data Sharing Plans, but please feel free to modify this text to fit the needs of your proposed research. For additional information about caNanoLab or to reference caNanoLab, please refer to [Gaheen et al., 2013, caNanoLab: data sharing to expedite the use of nanotechnology in biomedicine, Comput. Sci. Discov. 6 014010 doi:10.1088/1749-4699/6/1/014010](#).

Example Particle-Specific Composition Metadata



Particle Type	Metadata	# of Particles in caNanoLab
Biopolymer	Name, Type (e.g. DNA, Peptide, RNA), Sequence	62
Carbon Nanotube	Average Length, Chirality, Diameter, Wall Type (e.g. DWNT, MWNT, SWNT)	50
Dendrimer	Branch, Generation	75
Emulsion	Is Polymerized, Polymer Name	88
Fullerene	Average Diameter, Number of Carbons	16
Liposome	Is Polymerized, Polymer Name	37
Metal Oxide	Composing Elements	200
Metal Particle	Composing Elements	142
Polymer	Initiator, Is Cross Linked, Cross Link Degree	231
Quantum Dot	Composing Elements	73
Silica	Composing Elements	55
...	...	

Fall 2015

Example Characterization Assay Metadata (1 of 2)



Characterization Type	Metadata
Physico-Chemical	<ul style="list-style-type: none">• Molecular Weight• Physical State (<i>Type=Solid-Powder...</i>)• Relaxivity (<i>R1, T1, R2, T2</i>)• Shape (<i>Type=2D-Circle...</i>)• Size (<i>Aspect Ratio, Diameter [Avg, Min, Max], Intensity, Size [Avg, Min, Max], Volume, PDI</i>)• Solubility (<i>Solvent, Critical Concentration, Is Soluble</i>)• Surface (<i>isHydrophobic</i>)• Zeta Potential
In Vitro	<ul style="list-style-type: none">• Blood Contact (<i>Plasma Protein Binding, Hemolysis, Platelet Aggregation, Coagulation, Complement Activation</i>)• Cytotoxicity (<i>Cell Line, Cell Viability, IC50, Caspase 3 Apoptosis, Proliferation, Mitochondrial Membrane Potential, Mitochondrial Function, Gene Expression</i>)• Enzyme Induction (<i>Enzyme Name, Enzyme Induction/Suppression</i>)• Immune Cell Function (<i>CFU-GM, Leukocyte Proliferation, Phagocytosis, Cytokine Induction, Chemotaxis, Oxidative Burst, Cytotoxic Activity of NK Cells</i>)• Metabolic Stability• Oxidative Stress (<i>SH Homeostasis, Lipid Peroxidation, ROS Generation</i>)• Sterility (<i>Endotoxin, Bacterial/Yeast/Mold, Mycoplasma</i>)• Targeting (<i>Cell Binding/Internalization, Gene Expression</i>)• Transfection (<i>Cell Line</i>)

Example Characterization Assay Metadata (2 of 2)



Characterization Type	Metadata
In Vivo	<ul style="list-style-type: none">• Pharmacokinetics (<i>AUC, Clearance, Clearance at Time 0, Clearance Route, Clearance Timepoint, cMax, Elimination Rate Constant, Elimination Half Life, Elimination Rate, Half Life, tMax, Volume of Distribution</i>)• Toxicology (<i>Histopathology Finding, Organ/Tissue, Lesion Type, Clinical Observation, Organ Weight Measurement, Body Weight Measurement, Toxicology Measurement [ED50, ID50, LC50, LD50, TD50], Survival Time, Developmental Toxicology, Behavior Toxicology</i>)• Imaging (<i>Type, Image, Region of Interest, Image Contrast Agent Name, Image Contrast Agent Localization, Calibration Protocol</i>)
Ex Vivo	<ul style="list-style-type: none">• Histology (<i>Organ/Tissue, Sample Preparation Protocol</i>)• Imaging (<i>Organ/Tissue, Cell Viability</i>)