UNIVERSITY OF NORTH CAROLINA CHARLOTTE

V-lab 10 years!!

Juan L. Vivero-Escoto
Associate Professor
Department of Chemistry
The University of North Carolina at Charlotte

Vision

Our vision is that by combining **basic science understanding with material science, some of the most relevant problems of our time will be addressed.** In particular, we will focus our initial efforts toward developing nanoparticle-based technologies for biomedical applications.

Mission

The goal of our laboratory is **to develop creative solutions** to overcome some of the main issues in the application of nanotechnology to biomedicine. By its **diverse nature** our laboratory will provide an excellent and friendly environment for undergraduates, graduate students and postdoctoral research fellows. As a participant to the formation of the next generation of scientists, we will ask for **the best individual performance** (safety, ethics, research and education).

The V-lab TEAM

- Postdocs = 3
- Graduate students = 13 (Ph.D. = 7; M.S. = 6)
- Undergraduate students = 60
- Visiting scholars = 3
- Undergraduate students (Summer research) = 18
- High school students = 11

Our NAMES

- Dr. Hemapriyadarshini (Priya) Vadarevu
- Dr. Paula Loman-Cortes
- Dr. Mubin Tarannum
- Dr. Ridhima Juneja
- Dr. Merlis Alvarez-Berrios
- Dr. Zachary Lyles
- M.S. Alexis Johnston
- M.S. Paolo Siano
- M.S. Alexandra Hurst
- M.S. Eric Fink
- M.S. Daniel Vega
- M.S. William Walker

- Abbe Eliasof, B.S. Chemistry
- Ashvini Dandapani, B.S. Biology/B.A. Chemistry
- Kira Marsh, B.S. Chemistry
- Anh Nguyen, B.A. Chemistry
- Alejandra Villa, B.A. Chemistry
- Emma Anderson, B.A. Chemistry
- Madi Pareja, B.S. Chemistry
- Zaneta Zhin, B.S. Chemistry
- Aliyah Aguila, B.S. Chemistry
- Karina Benitez, B.S. Biology
- Janay Clegg, B.A. Chemistry
- Joshua Mikombo, B.S. Biology
- Jacob Dobbs, B.S. Chemistry
- Amanda Derby, B.S. Biology
- Christina Payne, B.S. Biology
- Ishaq Ibrahim, B.S. Chemistry
- Taraneh Barjesteh, B.S. Chemical Engineering
- Vir Kalaria, B.S. Chemistry
- Samuel McManama, Post-Bac

- McKinley Kerns, B.S. Chemistry
- Taylor Walls, B.S. Biology Honors
- Meredith Collins, B.S. Biology
- Ricky Son, B.S. Biology (UNC-CH)/B.A. Chemistry
- Jose Marquez, B.S. Biochemistry
- Jonathan Duhon, B.S. Chemistry
- Brandon Black, B.S. Biology Honors
- Cayli Mena, B.S. Biochemistry
- Roa Saleh, B.S. Chemistry
- Jessica Hovey, B.S. Chemistry
- Caroline Rawlings, B.S. Biology
- Kebba Mba, B.S. Bioinformatics
- Sebin Yang, B.A. Chemistry
- Dmitriy Yermakovich, B.S. Biology
- Trang Tran, B.S. Biology
- Rachel Jones, B.S. Biology
- Cameron Woodall, B.S. Exercise Science
- Christian Sangio, B.S. Biology/B.A. Chemistry
- Julius Koomson, B.S. Biology
- Kristen Armstrong, B.S. Biology

Our NAMES

- Amir Hashemi, B.A. Chemistry
- Alexandra Hurst, B.S. Psychology/B.A. Chemistry
- Sheram Serrano-Camacho, B.S. Biology
- Ashutosh Patel, B.S. Biology
- Patrick Lodge, B.S. Chemistry/Biochemistry
- Austin Gibbs, B.S. Chemistry
- Shayan Shaghayeq Nazari B.S. Chemistry and Biochemistry
- Daniel DeCillis B.A. Biology
- Alisa D. Geier, Post-Baccalaureate
- Ankit Amin, B.A. Chemistry
- Sydney Kent, B.A. Chemistry
- Edward Lynch, B.S. Chemistry and B.A. Biology
- Erin Danielle Ross, B.S. Chemistry/Biochemistry
- Daniel Vega, B.A. Chemistry and B.S. Biology
- Laura Fritts, B.S. Biochemistry
- Breyinn Loftin, B.S. Chemistry
- Preston Pope, B.S. Chemistry/Biochemistry
- Cesar Roque-Alfaro B.S.Chemistry/Biochemistry

- Vivero-lab internship and NC-MSEN Pre-College Program program
- Camila Vallejo
- Maram Elnagheeb
- Charles Hood
- Jaquan Dozier
- Jared Johnson
- Nithin Ragunathan
- Faheem Diaab
- Brenda Dominguez
- Aarthi Saravanan
- Kailey Spicer

Our FACES


Fall 2012


Fall 2015


Fall 2014


Fall 2013


Summer 2016


Summer 2017

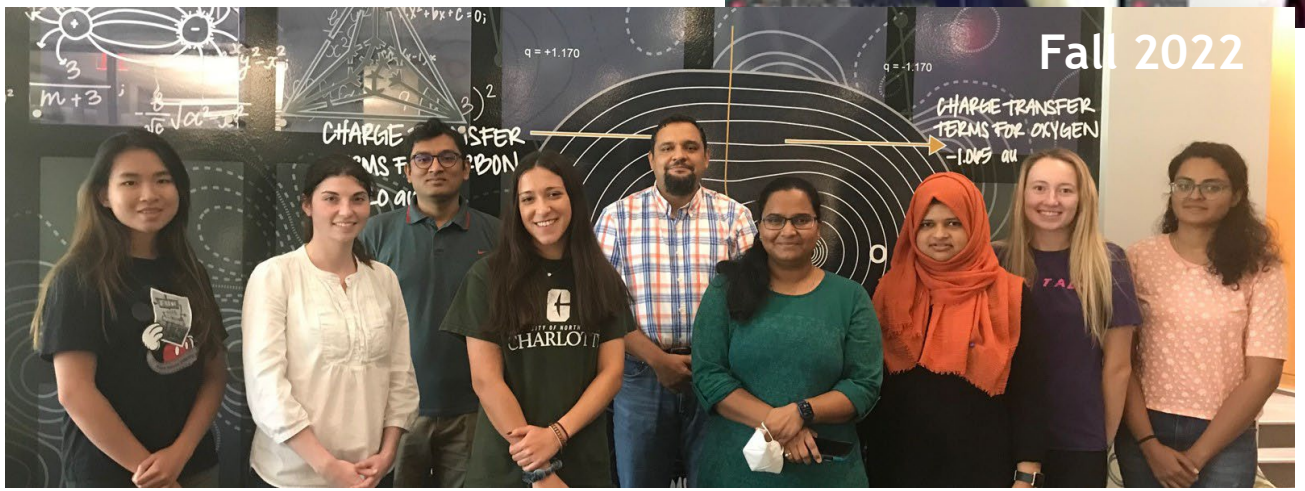

Fall 2018


Fall 2019

Our FACES

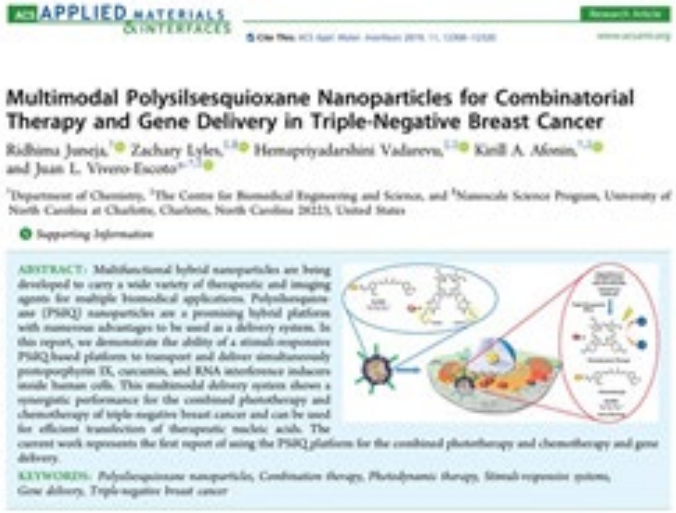

Fall 2020
Juan Vivero-Escoto (Host, me)
Emma Anderson
Tamanna Binte Huq
Paula
Varsha Godakhindi
Mubin Tarannum
Priya Vadarevu


Fall 2021
Madi Pareja
Paula Lomas
Kira Marsh
Anh Nguyen


Fall 2022
q = +1.170
q = -1.170
CHARGE TRANSFER TERMS FOR OXYGEN
-1.065 au

Publications and Funding

- Publications = 35 (Papers = 26; Reviews = 2; Book chapters = 3; Proceedings = 4)
- Funding = ORAU, NIH 1R15CA192160, NSF-EAGER (#1835688), UNC ROI, NIH 1R01CA263897, NIH 1R16GM145434



APPLIED MATERIALS & INTERFACES

Multimodal Polysilsesquioxane Nanoparticles for Combinatorial Therapy and Gene Delivery in Triple-Negative Breast Cancer

Ridhima Juneja, Zachary Lyles, Hemapriyadarshini Vadarevu, Kirill A. Afonin, and Juan L. Vivero-Escoto

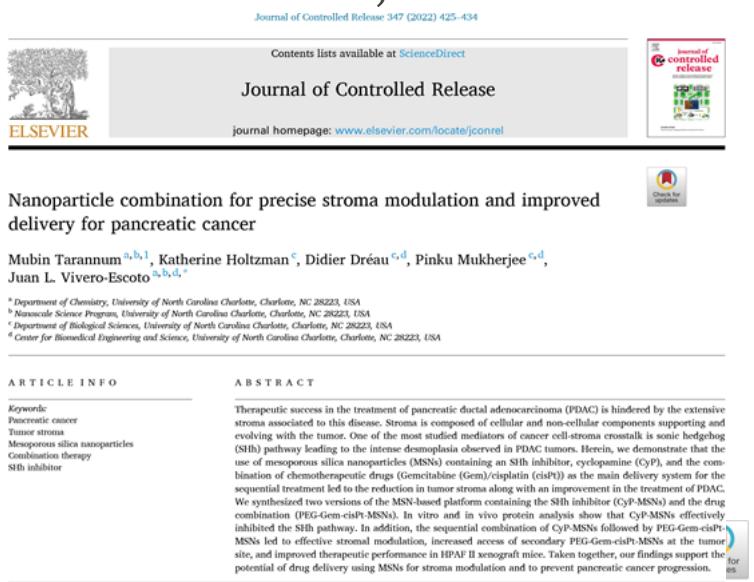
molecules

MDPI

Review

Use of Polyhedral Oligomeric Silsesquioxane (POSS) in Drug Delivery, Photodynamic Therapy and Bioimaging

Paula Loman-Cortes, Tamanna Binte Huq and Juan L. Vivero-Escoto



Journal of Controlled Release 347 (2022) 425–434

Contents lists available at ScienceDirect

Journal of Controlled Release

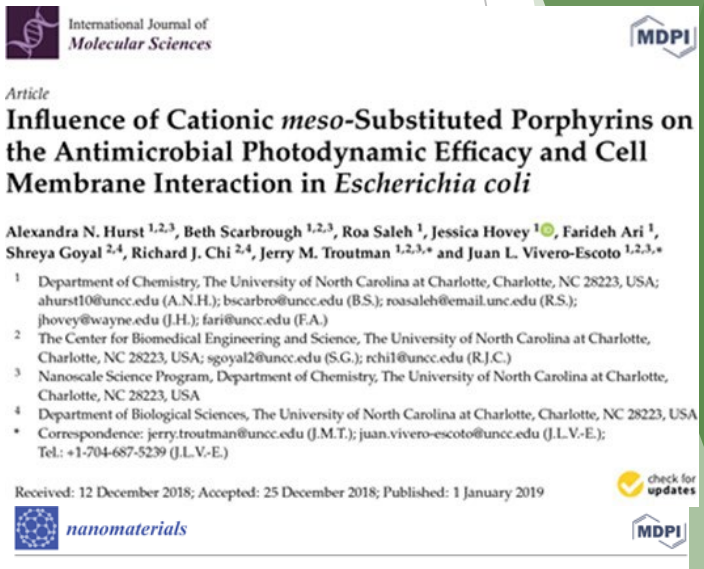
journal homepage: www.elsevier.com/locate/jconrel

Nanoparticle combination for precise stroma modulation and improved delivery for pancreatic cancer

Mubin Tarannum, Katherine Holtzman, Didier Dréau, Pinku Mukherjee, Juan L. Vivero-Escoto

Biodegradable Silica-Based Nanoparticles with Improved and Safe Delivery of Protoporphyrin IX for the In Vivo Photodynamic Therapy of Breast Cancer

Zachary K. Lyles, Mubin Tarannum, Cayli Mena, Natalia M. Inada, Vanderlei S. Bagnato, and Juan L. Vivero-Escoto*



International Journal of Molecular Sciences

MDPI

Article

Influence of Cationic *meso*-Substituted Porphyrins on the Antimicrobial Photodynamic Efficacy and Cell Membrane Interaction in *Escherichia coli*

Alexandra N. Hurst, Beth Scarbrough, Roa Saleh, Jessica Hovey, Farideh Ari, Shreya Goyal, Richard J. Chi, Jerry M. Troutman and Juan L. Vivero-Escoto

nanomaterials

MDPI

Article

Light-Activated Protoporphyrin IX-Based Polysilsesquioxane Nanoparticles Induce Ferroptosis in Melanoma Cells

Hemapriyadarshini Vadarevu, Ridhima Juneja, Zachary Lyles and Juan L. Vivero-Escoto

Publications

RESEARCH ARTICLE

small
www.small-journal.com

Advanced Nanoengineering Approach for Target-Specific, Spatiotemporal, and Ratiometric Delivery of Gemcitabine–Cisplatin Combination for Improved Therapeutic Outcome in Pancreatic Cancer

*Mubin Tarannum, Md Akram Hossain, Bryce Holmes, Shan Yan, Pinku Mukherjee, and Juan L. Vivero-Escoto**

Pancreatic ductal adenocarcinoma (PDAC) is an intractable malignancy with a dismal survival rate. Recent combination therapies have had a major impact on the improvement of PDAC prognosis. Nevertheless, clinically used combination regimens such as FOLFIRINOX and gemcitabine (Gem)/nab-paclitaxel still face major challenges due to lack of the safe and ratiometric delivery of multiple drugs. Here, a rationally designed mesoporous silica nanoparticle (MSN)-based platform is reported for the target-specific, spatiotemporal, ratiometric, and safe co-delivery of Gem and cisplatin (cisPt). It is shown that systemic administration of the nanoparticles results in synergistic therapeutic outcome in a syngeneic and clinically relevant genetically engineered PDAC mouse model that has rarely been used for the therapeutic evaluation of nanomedicine. This synergism is associated with a strategic engineering approach, in which nanoparticles provide redox-responsive controlled delivery and in situ differential release of Gem/cisPt drugs with the goal of overcoming resistance to Pt-based drugs. The platform is also rendered with additional tumor-specificity via a novel tumor-associated mucin1 (tMUC1)-specific antibody, TAB004. Overall, the platform suppresses tumor growth and eliminates the off-target toxicities of a highly toxic chemotherapy combination.

the stages combined; a trend that has not improved significantly over decades.[1–3] Multiple reasons contribute to the ineffectiveness of current PDAC treatments, underscoring the need for developing novel and effective therapeutic options aimed at improving PDAC prognosis.[4,5] Basic as well as clinical research have recently turned toward combination therapies with the FDA's approval of FOLFIRINOX (5-fluorouracil, leucovorin, irinotecan, and oxaliplatin), gemcitabine (Gem) plus nab-paclitaxel, and ONIVYDE (liposomal formulation of irinotecan) used in combination with 5-fluorouracil and leucovorin.[6–8] A number of other combinations, including multidrug chemotherapy and molecular agents, are also currently under investigation.[9,10] Recent insights gained from the characterization of recurrent genetic alterations has revealed that a subset of PDACs, linked to germline-based mutations, can ben-

Materials Today Communications 29 (2021) 102815

Contents lists available at ScienceDirect

Materials Today Communications

journal homepage: www.elsevier.com/locate/mtcomm

Molecular dynamic simulation of polyhedral oligomeric silsesquioxane porphyrin molecules: Self-assembly and influence on morphology

Paula Loman-Cortes [a,b], Donald J. Jacobs [c,d,*], Juan L. Vivero-Escoto [a,b,d,**]

[a] Department of Chemistry, University of North Carolina, Charlotte, NC 28223, USA
[b] Nanoscale Science Program, University of North Carolina, Charlotte, NC 28223, USA
[c] Department of Physics and Optical Science, University of North Carolina, Charlotte, NC 28223, USA
[d] The Center for Biomedical Engineering and Science, University of North Carolina, Charlotte, NC 28223, USA

ARTICLE INFO

Keywords:
Polyhedral oligomeric silsesquioxane (POSS)
Porphyrin
Self-assembly
Aggregation
Simulation

ABSTRACT

Molecular dynamics was used to study the aggregation in water of three versions of polyhedral oligomeric silsesquioxane porphyrin (POSSP) molecules. The POSSP molecules have different functional groups; POSSP-IB has one hepta-isobutyl POSS unit, POSSP-Ph has one hepta-phenyl POSS molecule, and POSSP-TIB has four hepta-isobutyl POSS units. Three control porphyrins (TPP, ATPP, TATPP) were also simulated in this study. The effects of the different substituents on the POSSP aggregation process and final morphology were investigated. It is observed that the isobutyl substituents in the POSS units drives the aggregation mainly through the hydrophobic effect. In the case of the phenyl POSS unit, the self-assembly process is also carried through the hydrophobic effect, but π-π and H-bonding interactions play a role too. The final morphology of the aggregates show that the porphyrins associated with POSSP-IB and POSSP-TIB are far apart from each other contrary to POSSP-Ph, which may have a major implication on the optical properties of these aggregates. This study provides valuable insights on the aggregation in water of POSSP molecules, which are a tunable platform to design novel functional materials.

Advanced Drug Delivery Reviews 187 (2022) 114357

Contents lists available at ScienceDirect

Advanced Drug Delivery Reviews

journal homepage: www.elsevier.com/locate/adr

Nanoparticle-based therapeutic strategies targeting major clinical challenges in pancreatic cancer treatment

Mubin Tarannum [a,b,1], Juan L. Vivero-Escoto [a,c,*]

[a] Department of Chemistry, University of North Carolina Charlotte, Charlotte, NC 28223, USA
[b] Nanoscale Science Program, University of North Carolina Charlotte, Charlotte, NC 28223, USA
[c] The Center for Biomedical Engineering and Science, University of North Carolina Charlotte, Charlotte, NC 28223, USA

ARTICLE INFO

Article history:
Received 23 January 2022
Revised 11 April 2022
Accepted 17 May 2022
Available online 21 May 2022

Keywords:
Nanoengineered approaches
Pancreatic ductal adenocarcinoma
Combinatorial drug delivery
Tumor microenvironment
Cancer immunotherapy
Stroma modulation

ABSTRACT

Pancreatic ductal adenocarcinoma (PDAC) is one of the deadliest cancers due to its aggressiveness and the challenges for early diagnosis and treatment. Recently, nanotechnology has demonstrated relevant strategies to overcome some of the major clinical issues in the treatment of PDAC. This review is focused on the pathological hallmarks of PDAC and the impact of nanotechnology to find solutions. It describes the use of nanoparticle-based systems designed for the delivery of chemotherapeutic agents and combinatorial alternatives that address the chemoresistance associated with PDAC, the development of combination therapies targeting the molecular heterogeneity in PDAC, the investigation of novel therapies dealing with the improvement of immunotherapy and handling the desmoplastic stroma in PDAC by remodeling the tumor microenvironment. A special section is dedicated to the design of nanoparticles for unique non-traditional modalities that could be promising in the future for the improvement in the dismal prognosis of PDAC.

molecules

MDPI

Article

Imaging and SERS Study of the Au Nanoparticles Interaction with HPV and Carcinogenic Cervical Tissues

Andrea Ceja-Fdez [1], Ramon Carriles [2], Ana Lilia González-Yebra [3], Juan Vivero-Escoto [4], Elder de la Rosa [5] and Tzarara López-Luke [6,*]

1 Departamento de Física Médica, División de Ciencias e Ingenierías Campus León, Universidad de Guanajuato, León 37150, Mexico; a.ceja@ugto.mx
2 Centro de Investigaciones en Óptica, A.P. 1-948, León 37150, Mexico; ramon@cio.mx
3 Departamento de Ciencias Aplicadas al Trabajo, División Ciencias de la Salud, Campus León, Universidad de Guanajuato, León 37670, Mexico; analilia@ugto.mx
4 Department of Chemistry, The University of North Carolina at Charlotte, 9201 University City Blvd., Charlotte, NC 28223, USA; juan.vivero-escoto@uncc.edu
5 Facultad de Ingenierías, Campus Campestre, Universidad De La Salle Bajío, León 37150, Mexico; edelarosa@delasalle.edu.mx
6 Instituto de Investigación en Metalurgia y Materiales, Universidad Michoacana de San Nicolás de Hidalgo, Edificio U, Ciudad Universitaria, Morelia 58030, Mexico
* Correspondence: tzarara@umich.mx

Abstract: In this work, gold NPs were prepared by the Turkevich method, and their interaction with HPV and cancerous cervical tissues were studied by scanning electron microscopy, energy-dispersive x-ray spectroscopy, confocal and multiphoton microscopy and SERS. The SEM images confirmed the presence and localization of the gold NPs inside of the two kinds of tissues. The light absorption of the gold NPs was at 520 nm. However, it was possible to obtain two-photon imaging (red emission region) of the gold NPs inside of the tissue, exciting the samples at 900 nm, observing the morphology of the tissues. The infrared absorption was probably due to the aggregation of gold NPs inside the tissues. Therefore, through the interaction of gold nanoparticles with the HPV and cancerous cervical tissues, a surface enhanced Raman spectroscopy (SERS) was obtained. As preliminary studies, having an average of 1000 Raman spectra per tissue, SERS signals showed changes between the HPV-infected and the carcinogenic tissues; these spectral signatures occurred mainly in the DNA bands, potentially offering a tool for the rapid screening of cancer.

Keywords: gold nanoparticles; HPV; cervical cancer; two-photon imaging; confocal microscopy; multiphoton microscopy; Raman spectroscopy and SERS

check for updates

Citation: Ceja-Fdez, A.; Carriles, R.; González-Yebra, A.L.; Vivero-Escoto, J.; de la Rosa, E.; López-Luke, T. Imaging and SERS Study of the Au Nanoparticles Interaction with HPV and Carcinogenic Cervical Tissues. *Molecules* **2021**, *26*, 3758. https://doi.org/10.3390/molecules26123758

Academic Editor: Jamal Uddin

Received: 16 May 2021

ACS APPLIED MATERIALS & INTERFACES

www.acsami.org

Research Article

Combination of Nucleic Acid and Mesoporous Silica Nanoparticles: Optimization and Therapeutic Performance In Vitro

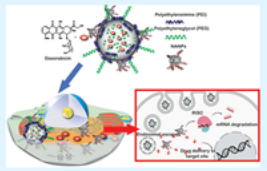
Ridhima Juneja,[⊥] Hemapriyadarshini Vadarevu,[⊥] Justin Halman,[⊥] Mubin Tarannum, Lauren Rackley, Jacob Dobbs, Jose Marquez, Morgan Chandler, Kirill Afonin,[*] and Juan L. Vivero-Escoto[*]

Cite This: *ACS Appl. Mater. Interfaces* 2020, 12, 38873–38886

Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: Programmable nucleic acid nanoparticles (NANPs) with precisely controlled functional compositions can regulate the conditional activation of various biological pathways and responses in human cells. However, the intracellular delivery of NANPs alone is hindered by their susceptibility to nuclease activity and inefficient crossing of biological membranes. In this work, we optimized the internalization and therapeutic performance of several representative NANPs delivered with mesoporous silica nanoparticles (MSNPs) tailored for efficient electrostatic association with NANPs. We compared the immunostimulatory properties of different NA-MS-NP complexes formed with globular, planar, and fibrous NANPs and demonstrated the maximum immunostimulation for globular NANPs. As a proof of concept, we assessed the specific gene silencing by NA-MS-NP complexes functionalized with siRNA targeting green fluorescent protein expressed in triple-negative human breast cancer cells. We showed that the fibrous NANPs have the highest silencing efficiency when compared to globular or planar counterparts. Finally, we confirmed the multimodal ability of MSNPs to co-deliver a chemotherapy drug, doxorubicin, and NANPs targeting apoptosis regulator gene *BCL2* in triple-negative breast cancer and melanoma cell lines. Overall, the combination of NANPs and MSNPs may become a new promising approach to efficiently treat cancer and other diseases via the simultaneous targeting of various pathways.



KEYWORDS: *nucleic acid nanoparticles (NANPs), mesoporous silica nanoparticles (MSNPs), small interfering RNA, combination therapy, triple-negative breast cancer, melanoma, doxorubicin*

FULL PAPER

siRNA Delivery

ADVANCED FUNCTIONAL MATERIALS
www.afm-journal.de

RNA Fibers as Optimized Nanoscaffolds for siRNA Coordination and Reduced Immunological Recognition

*Lauren Rackley, Jaimie Marie Stewart, Jacqueline Salotti, Andrey Krokhotin, Ankit Shah, Justin R. Halman, Ridhima Juneja, Jaclyn Smollett, Lauren Lee, Kyle Roark, Mathias Viard, Mubin Tarannum, Juan Vivero-Escoto, Peter F. Johnson, Marina A. Dobrovolskaia, Nikolay V. Dokholyan, Elisa Franco, and Kirill A. Afonin**

RNA is a versatile biomaterial that can be used to engineer nanoassemblies for personalized treatment of various diseases. Despite promising advancements, the design of RNA nanoassemblies with minimal recognition by the immune system remains a major challenge. Here, an approach is reported to engineer RNA fibrous structures to operate as a customizable platform for efficient coordination of siRNAs and for maintaining low immunostimulation. Functional RNA fibers are studied in silico and their formation is confirmed by various experimental techniques and visualized by atomic force microscopy (AFM). It is demonstrated that the RNA fibers offer multiple advantages among which are: i) programmability and modular design that allow for simultaneous controlled delivery of multiple siRNAs and fluorophores, ii) reduced immunostimulation when compared to other programmable RNA nanoassemblies, and iii) simple production protocol for endotoxin-free fibers with the option of their cotranscriptional assembly. Furthermore, it is shown that functional RNA fibers can be efficiently delivered with various organic and inorganic carriers while retaining their structural integrity in cells. Specific gene silencing triggered by RNA fibers is assessed in human breast cancer and melanoma cell lines, with the confirmed ability of functional fibers to selectively target single nucleotide mutations.

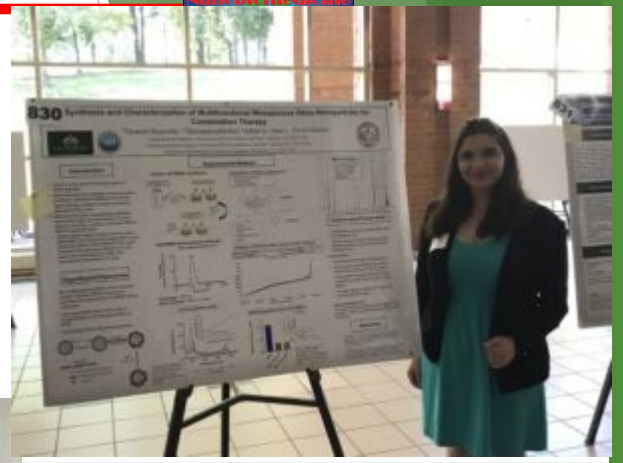
1. Introduction

RNA regulates a myriad of biological processes at different levels. RNA interference (RNAi),[1] for instance, is one of the therapeutically relevant pathways that allows the regulation of gene expression using exogenous RNAs. Notably, the very first therapy based on RNAi has just been approved by FDA.[2] Aside from synthetic RNAi inducers, several other promising classes of therapeutic nucleic acids (TNAs) have been developed, such as antisense oligos, aptamers, ribozymes, and mRNAs.[3,4] TNAs are being increasingly considered for the treatment of a wide variety of conditions, including cancers, metabolic disorders, viral infections, cardiovascular disorders, and inflammatory diseases, especially where traditional small molecule drugs fail.[5]

The simultaneous use of multiple TNAs is anticipated to have significant synergistic effects. One example is combinatorial RNAi, used for the simultaneous

Awards, Conferences, Outreach and More…

- PI/Students (Honors and Awards) = 8
- PI (Seminars/Conferences) = 49
- Graduate/Undergraduate (Presentations/Conferences) = 55
- Outreach = > 20 workshops
- Collaborators = 12



Awards, Conferences, Outreach and More…