Florida Association for Nanotechnology

20 YEARS
20th anniversary of the Nanotechnology Revolution

NanoFlorida 2024 Conference

April 19 - 21

2024

Augustus B. Turnbull III Florida State University Conference Center

Tallahassee, Florida

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Florida Association for Nanotechnology

20 YEARS 20th anniversary of the Nanotechnology Revolution

How to Connect to FSU Wi-fi

Guests will need to connect using the "FSUEvent" network.

No Password Required.

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Bill Proctor
Commissioner • District 1

Dear Attendees:

As a dedicated Leon County Commissioner, it is with great pleasure that I extend a warm welcome to you for the upcoming NanoFlorida Conference. This conference, which is scheduled to occur at the esteemed Augustus B. Turnbull Conference Center from April 19 to April 21, 2024, promises to be instructive and beneficial for all delegates there.

I'm extending my heartfelt wishes for a fantastic and fulfilling experience as you prepare to join us in Tallahassee for this important event. The conference which is full of interesting talks and presentations will offer you valuable networking opportunities. I have no doubt that the contacts you make and the information you learn will come in very handy for your career aspirations.

I urge you to spend some time seeing the wonderful city of Tallahassee and all it has to offer, in addition to the great academic program. There are plenty of things to do and places to visit during your visit, from gastronomic delights to historical sites.

I would want to express my heartfelt appreciation to you on behalf of the people of Leon County for your devotion to the science of nanotechnology and your pursuit of innovation and advancement. Your commitment to quality and your wish to have a good influence on the world are demonstrated by your attendance at the NanoFlorida Conference.

Warm regards,

Bill Proctor, Leon County Commissioner

Leon County Courthouse
301 South Monroe Street, Fifth Floor
Tallahassee, Florida 32301
Email: proctorb@leoncountyfl.gov

(850) 606-5361
FAX: (850) 606-5303

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Representative Gallop Franklin II
District 8

Committee:
Education & Employment
Select Committee on Hurricane Resiliency & Recovery

Subcommittees:
Education Quality
Health Care Regulation
Higher Education Appropriations
Insurance & Banking

Dear Attendees:

It is an absolute privilege to invite you to the 2024 NanoFlorida Conference set for April 19th to April 21st, 2024, at the Augustus B Turnbull Conference Center in Tallahassee. This event promises an informative, enlightening, and enriching experience for all participants.

The agenda for this exciting conference promises to be a stimulating one with ample opportunities for attendees to network, share valuable insights, and cultivate enduring connections and friendships within the nanotechnology community.

As you come together to discuss the emerging opportunities in nanoscience and nanotechnology arena, I encourage you to explore all that Tallahassee and the Big Bend region has to offer. Whether you opt to delve into the area's rich history, indulge in its culinary delights, or simply bask in its natural splendor, Tallahassee and the Big Bend promises ample opportunities for relaxation and rejuvenation amidst your academic pursuits.

I extend heartfelt gratitude for your unwavering dedication to the field of nanotechnology and your relentless pursuit of scientific exploration. Your participation in the NanoFlorida Conference stands as a testament to your profound passion for knowledge and your unwavering commitment to shaping a better world for us all.

Sincerely,

Gallop Franklin II

REP. GALLOP FRANKLIN
Florida House of Representatives, District 8

1001 The Capitol • 402 South Monroe Street • Tallahassee, FL 32399-1300 • (850) 717-5008 •
Email: gallop.franklin@myfloridahouse.gov

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Tallahassee, Florida 32307
TELEPHONE: (850) 412-5102
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DIVISION OF RESEARCH

Dear Attendees:

Greetings from Division of Research, Florida A&M University.

I am thrilled to extend a warm welcome to you all to the upcoming 2024 NanoFlorida Conference. As the Vice President of Research at FAMU, it gives me great pleasure to invite you to participate in this exciting event, which will be held at the Augustus B Turnbull Conference Center, nestled in the heart of Tallahassee, Florida, from April 19th to April 21st, 2024. The NanoFlorida Conference serves as a premier platform for researchers, scientists, educators, and industry professionals to come together and exchange insights, share innovative ideas, and foster collaborations in the field of nanotechnology. Hosted jointly by Florida A&M University and Florida State University, this conference promises to be an enriching experience, offering a diverse array of presentations, workshops, and networking opportunities.

With a focus on cutting-edge research and advancements in nanotechnology, the conference will feature keynote speakers, panel discussions, poster sessions, and interactive exhibits, providing attendees with valuable insights into the latest trends and developments shaping the future of this dynamic field.

We are confident that your participation in the NanoFlorida Conference will not only enrich your professional network but also inspire new ideas and collaborations that will contribute to the advancement of nanotechnology research and its applications.

We look forward to welcoming you to Tallahassee and to the NanoFlorida Conference, where together, we will embark on a journey of discovery and innovation.

Charles Weatherford

Charles A. Weatherford, PhD
Vice President for Research
sponsor@famu.edu

Florida Agricultural and Mechanical University
Tallahassee, Florida 32307

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TELEPHONE: (850)599-3301
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Dear Esteemed FAN Colleagues and Friends:

Greetings from Florida A&M, Florida State and the Florida Association for Nanotechnology (FAN)!

Welcome to NanoFlorida conference being held at Tallahassee, Augustus B Turnbull Conference Center from April 19-21, 2024, organized jointly by Florida A&M and Florida State Universities. This year's conference topics will include nanoelectronics, nanobiotechnology, AI in nanotechnology, biosensing, nano-diagnostics, nanoimaging, and other innovative areas of research and their applications in medicine and pharmacy. Aligning with the Florida Association for Nanotechnology (FAN) vision; *Foster and encourage collaborative research efforts between academicians from different Florida universities and institutes and beyond nationally and internationally*, this conference will give you an invigorating and stimulating experience in the broad area of Nanotechnology.

Please join us in networking with other institutions, companies, and affiliated partners through a wide variety of presentations, activities, and research discussions for the time you are here. I hope this meeting provides you with a great platform to network with your fellow scientists and also make new research collaborators and scientific colleagues. I thank our current sponsors for this year's conference which have made this event to be held with great enthusiasm with more than 120 oral and poster presentations including key notes and plenary talks.

I heartily welcome all the delegates to this conference and hope you will have a great time in the city of seven hills, Tallahassee.

Best wishes to All

Mandip Sachdeva, Co-Chair, Nano Florida, 2024

Dr. Steven Lenhert
Associate Professor of Biological Science
Bio Unit I, 89 Chieftan Way
Tallahassee, FL 32306-4370
http://www.bio.fsu.edu/lenhertgroup/

Office: 850 645 4773
Fax: 850 644 0481
lenhert@bio.fsu.edu

Dear Colleagues,

I am excited to welcome you to the NanoFlorida conference in Tallahassee this year. This conference is unique in that it brings together scientists and engineers with common interests, not only from different locations across Florida, but more importantly from different academic disciplines. A desire to explore and understand the nanoscale is something that is distributed throughout physics, chemistry, biology, and engineering departments. Even within Tallahassee many of us with interests in nanotechnology rarely or never interact because of artificial academic barriers that both unite and divide us. Each of these academic disciplines brings a unique perspective. For instance, physics can tell us how properties of materials change as feature sizes become smaller. Chemistry can help us understand how new properties can emerge when atoms and molecules are put together to build larger structures. Biology provides examples of remarkable functions that are possible when complex nanoscale machinery is assembled. Finally, engineering extends this knowledge to the production of technologies such as computers, materials, and medicine. As we have a lot to learn from each other, I encourage you to meet some people working in areas that seem different from your own and ask them questions. They may have answers to your questions, and you might have answers to theirs. Together we can solve problems that can't be solved alone.

Sincerely,

Steven Lenhert

Florida Association for Nanotechnology

Dear Colleagues and Attendees,

On behalf of the Florida Association of Nanotechnology, we welcome you to the 2024 NanoFlorida Conference. This year, the conference seeks to develop the theme, "Two Decades of Nanotechnology Revolution." This year marks the 20th anniversary of the "21st Century Nanotechnology Research and Development Act," a law which prioritized nanotechnological innovation and application across the United States. The NanoFlorida Conference is a unique event with a long, successful tradition of uniting student researchers from across the state of Florida to share their discoveries in nanotechnology and learn from distinguished speakers from around the United States.

The intent of this conference is to converge the thinking of global leaders of nanotechnology to advance innovative solutions for their worldwide applications. This conference will feature symposia addressing advances in nanoscale interactions, nanoelectronics, nanobiotechnology, biosensing, nano-diagnostics, nanoimaging, artificial intelligence, and other innovative areas of research and their applications in a wide range of disciplines. It will also provide opportunities to network with researchers from other academic institutions and the broader nanotechnology and nanopharma industry.

Please take this opportunity to network and collaborate with other researchers in the field, which will ultimately aid in the development of a new generation of nanoscientists.

Thank you for attending and we hope you enjoy the 2024 NanoFlorida Conference!

Sincerely,

Shyam S. Mohapatra, PhD
President, Florida Association for Nanotechnology
NanoFlorida 2024 Conference Co-Chair
www.nanoflo.org

Chairs

Steven Lenhert, Ph.D
Associate Professor, Dept. of Biological Science
Florida State University, Tallahassee, FL

Mandip Sachdeva, Ph.D.
Professor, Dept. of Pharmaceutical Sciences
Florida A&M University, Tallahassee, FL

Shyam Mohapatra, Ph.D, MBA
Associate Dean, Graduate Programs,
Taneja College of Pharmacy
Director of the Division of Translational Medicine and
Center for Research & Education in Nano-bioengineering,
Morsani College of Medicine
University of South Florida, Tampa, FL

Student Organizers

Tracey Bell
Florida State University

Aakash Nathani
Florida A&M University

Ana Ramirez
Florida State University

Shu Liu
Florida A&M University

Session Moderators

Ramesh Kenchappa
Lonza,USA

Marc Knecht
University of Miami, USA

Jack Judy
University of Florida, USA

Sapna Deo
University of Miami, USA

Satya Prakash, Ph.D
McGill University, Canada

Ajeet Kaushik
Florida Polytechnic University, USA

Arti Vashist, Ph.D
Florida International University, USA

Subhra Mohapatra, Ph.D
University of South Florida, USA

Ratnesh Lal, Ph.D
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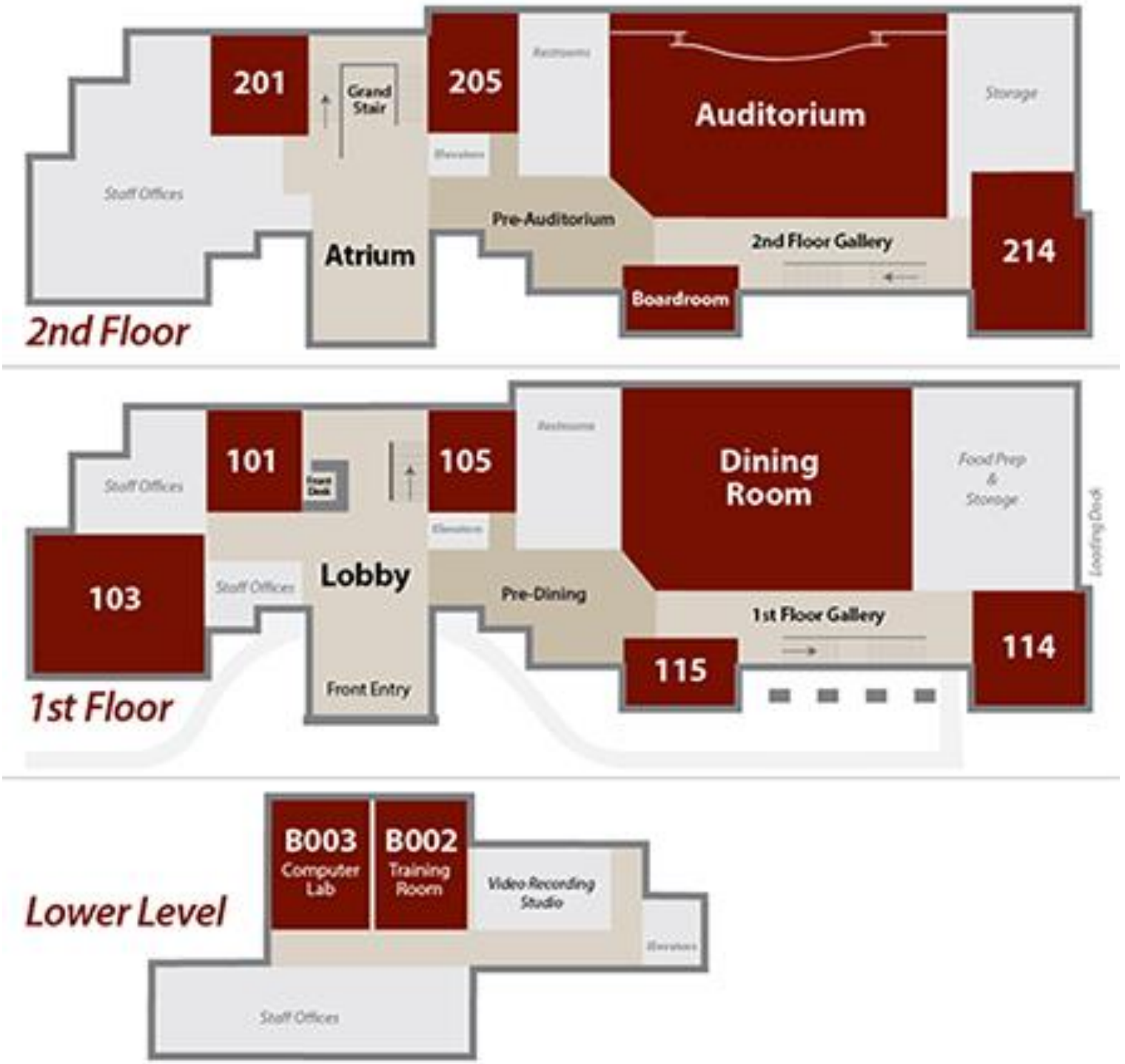
2nd Floor
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Atrium
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214
Boardroom
1st Floor
101
105
Dining Room
Food Prep & Storage
Staff Offices
103
Lobby
Pre-Dining
1st Floor Gallery
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115
Front Entry
Lower Level
B003 Computer Lab
B002 Training Room
Video Recording Studio
Staff Offices

NanoFlorida 2024 International Conference

April 19-21, 2024

FAMU Auditorium & Turnbull Conference Center

Friday, April 19	
5:30 – 5:45	**Registration** *Ist Floor, College of Pharmacy and Pharmaceutical Sciences, FAMU*
5:45 – 7:15	**Welcome Reception (Session 1)** *2nd Floor, College of Pharmacy and Pharmaceutical Sciences, FAMU*
	Opening Remarks: **Dean of College of Pharmacy, Johnnie Early,** FL A&M Univ **Conf Co Chair, Mandip Sachdeva,** FL A&M Univ
	Two Decades Nanotechnology Revolution: A fire-side chat on 'UniLabs to Products' Moderator: **Shyam Mohapatra,** *Univ of South Florida* Panelists: **Nasser Nassiri Koopaei** *Univ of Florida, Gainesville;* **Brian McMillan** *Bravado Pharma, Tampa Florida;* **Jeff Whalen** *FL State Univ, Tallahassee*

Saturday, April 20th	
8:00 – 9:00	**Registration and Poster Setup** *Atrium*
9:00 – 10:45	**Conference Inauguration (Session 2)** *(Room 208)*
	Moderators: Steven Lenhert
9:00 – 9:15	***Dignitaries Welcome: (Dr Lenhert, Dr Mohapatra, Dr Sachdeva)*** **Charles Weatherford** – *FAMU VP for research* **Michael Shatruk** - *Florida State Univ* **Bill Proctor** - *Leon County Commissioner* ***(Photo Session)***
Keynote: 9:15 – 9:45	**Adam Braunschweig:** *City Univ of New York - "Hypersurface Photolithography: A new approach to creating multidimensional hypersurfaces"*
9:45 – 9:55	Break

9:55 – 11:10	**Parallel Sessions** 3: Nanomedicine *(Room 208)* 4: Nanophysics/Quantum Engineering *(Room 205)* 5: Nanophysics/Quantum Engineering *(Room 201)*
	Session 3: Nanomedicine *(Room 208)*
	Moderators: ***Ramesh Kenchappa***
9:55 – 10:20	**Subhra Mohapatra:** *Univ of South FL-"A nanomedicine approach to treating Long COVID: What's in the horizon"*
10:20 - 10:30	Coffee Break
10:30 - 10:55	**Andrea Raymond:** *FL International Univ- "Magnetoelectric exosomal-EV latency targeting(MELT) Nanotherapeutic for the eradication of HIV by the Block-Lock-and-Kill strategy*"
10:55 - 11:08	Jorge David Tovar Castro *Univ of Miami- "Novel Nanodrug Platform for Pharmacologically Inducing Therapeutic Hypothermia (TH) After Traumatic Brain Injury (TBI)"*
	Session 4: Nanophysics/Quantum Engineering *(Room 205)*
	Moderators: ***Marc Knecht***
9:55 – 10:20	**Guangxin Ni:** *FL State Univ- "3 Area -Scanning Nano-Optical Imaging of Quantum Materials"* /
10:20 - 10:32	Mohammad Irfan *FL State Univ- "Robust Topological Surface States in YbB12 A Comparative Study with SmB6 using planar tunneling spectroscopy"*
10:32 - 10:42	Coffee Break
10:42 - 10:56	Omair Faqah *FL Atlantic Univ- "Rapid Testing Platform for HIV Detection*
	Session 5: Nanobiotechnology / Nanophysics *(Room 201)*
	Moderators: ***Jack Judy***
9:55 – 10:20	**Laura Greene:** *FL State Univ-* ***"****Novel Electron Pairing in the Unconventional Superconductor CeCoIn5"*
10:20 - 10:32	Jaideep Katuri *FL State Univ- "Control of cohesive states in colloidal chiral fluids through phoretic interactions"*
10:32 - 10:42	Coffee Break
10:42 - 10:56	Arthur Rech Tondin *Univ of Miami- "Enhanced Immunomodulation in Allogeneic Transplantation: Harnessing Mesenchymal Stem Cells with a NanoFibril Rapamycin System for Targeted Inflammat…"*
10:56 - 11:08	Dr. Navneet Kaur *FL State Univ- "Comparative Analysis of Microparticle Uptake Role of Particle Anisotropy in 2D and 3D Cell Culture"*
11:10 – 12:25	***TWO DECADES OF NANOTECHNOLOGY REVOLUTION*** *(Room 208)* *Moderators:* ***Steven Lenhert***
11:10 – 11:35	**Sylvia Daunert**: *Univ of Miami -* "*Nanomedicine, successes, challenges & the frontier"*
11:35 – 12:00	**Ratnesh Lal**: *UC San Diego - "Atomic Force Microscope & Nano-Imaging Tools"*
12:00 – 12:25	**Shyam Mohapatra***: Univ of South FL -* "*Nanotechnology and AI intersection: a new frontier"*

12:25 – 1:30	**Lunch** *(Atrium)*
	FAN Steering Committee Meeting *(Room 201)*
1:30 -1:45	**Photo session**
1:50 - 2:20	**Keynote Session** *(Room 208)* *Moderators:* ***Shyam Mohapatra***
Keynote 1:50 - 2:20	**Jason White** *Conn Gvt* **(zoom)** *"Nanobiotechnology-based Strategies for Enhanced Crop Stress Resilience"*
2:20 - 3:05	**Parallel Sessions** 6: Simulation / AI in Nano *(Room 208)* 7: Nanoagriculture / Nanomaterials *(Room 205)* 8: Nanochemistry / Devices for Biosensing *(Room 201)*
	Parallel Session 6: Simulation / AI in Nano *(Room 208)*
	Moderators: Sapna Deo
2:20 - 2:45	**Prem Chapagain:** *FL International Univ- From structure prediction to nanomolecular design: the rapidly evolving landscape of molecular modeling and simulations"*
2:45 - 2:57	Belal Jahannia *Univ of FL- "Binarized neural networks"*
2:57 - 3:09	Coffee Break
3:09 - 3:21	Jiachi Ye *Univ of FL- "Demultiplexing structured beams using hybrid optical-electronic neural network"*
3:21 - 3:33	Sophie Jermyn *FL State Univ- "Dynamics of Rigid Achiral Magnetic Microswimmers in Shear-Thinning Fluids"*
	Parallel Session 7: Nanoagriculture / Nanomaterials *(Room 205)*
	Moderators: Satya Prakash
2:20 - 2:45	**Swadesh Santra** *Univ of Central FL– "Nanotechnology for crop protection"*
2:45 - 2:57	Melissa Deinys *Univ of Central FL- "Nanoformulation-based Intervention for Mitigating Pestalotiopsis spp. in Mangrove Die-off A Sustainable Approach for Ecosystem Conservation"*
2:57 - 3:09	Coffee Break
3:09 - 3:21	Md Zakariya Mohayman *Univ of Central FL- "Exploring the Impact of Lithium Concentration on the Mechanical Properties of Li6PS5Cl Solid Electrolytes for All-Solid-State Lithium Batt"*
3:21 - 3:33	Utkarsh Misra *Univ of South FL- "Reduced Graphene Oxide A New Contender for Thermal Management in RF IC Packaging"*

	Parallel Session 8: Nanochemistry / Devices for Biosensing *(Room 201)*
	Moderators: Subhra Mohapatra
2:20 - 2:45	**Ajeet Kaushik** *FL Polytechnic Univ- "Smart sensor for health and environmental management"*
2:45 - 2:57	Sawyer Chang *Univ of Central FL- "Pragmatic synthesis of loaded tea-derived polymer-polyphenol particles"*
2:57 - 3:09	Coffee Break
3:09 - 3:21	Yusuf Muhammed *FL State Univ- "Drug-induced Cell Death and its Heterogeneity in Single Lung Adenocarcinoma Cells Observed using Scanning Ion Conductance Microscopy"*
3:21 - 3:33	Ana Ramirez *FL State Univ-"Functionalization of Nanopipettes with Aptamers for Biosensing of Biomolecules"*
3:40 - 6:30	**Poster Sessions 1 and 2** *(Hallway)*
3:40 - 5:05	***Poster Session 1***
5:05 - 6:30	***Poster Session 2***
***5.00-6:30**	**Refreshments** *(Hallway)*

Sunday, April 21

Keynote: 9:00 – 9:30	**Elias Sayour** *Univ of FL-* **(zoom)** ***"****Unlocking cancer immunotherapy with RNA-nanoparticle vaccines"*
9:30 – 10:20	**University – Industry Education Collaboration** *(Room 208)*
	Moderators: Ratnesh Lal
9:30 – 9:55	**Shyam Mohapatra** *(FAN- Summer Internship)*
9:55 – 10:20	**Ramesh Kenchappa** *(Lonza)*
10:25 – 11:50	**Parallel Sessions** 9: Nanomedicine *(Room 208)* 10: Nanobiotechnology & Cancer Therapeutics (205) 11: Nanoenergy/Nanomaterials/Nanobiotechnology *(Room 201)*
	Parallel Session 9: Nanomedicine *(Room 208)*
	Moderators: Ajeet Kaushik
10:25 - 10:50	**Nasser Koopaei:** *Univ of FL-* ***"****Novel exosomes for targeted delivery of therapeutic cargos"*
10:50 - 11:02	Anatasian Estephan *Univ of South FL-"Potential of CBD and Nano-CBD as adjunct therapy for Epilepsy"*
11:02 - 11:14	Break
11:14 - 11:26	Mounika Aare *FL A&M Univ - "CBD camel milk-derived exosome formulation with enhanced bioavailability for the treatment of Breast cancer"*

11:26 - 11:38	Aakash Nathani *FL A&M Univ - "Combined role of interleukin-15 stimulated natural killer cell-derived extracellular vesicles and carboplatin in Osimertinib resistant H1975 lung cancer with…"*
11:38 - 11:50	Stephanie Herrera *Univ of FL-"Supramolecular peptide-protein granule system for intracellular co-delivery of proteins"*
	Parallel Session 10: Nanobiotechnology & Cancer Therapeutics *(Room 205)*
	Moderators: Steven Lenhert
10:25 - 10:50	**Satya Prakash** *McGill Univ - "Nano siRNA formulation as Head and Neck Cancer and Lung Cancer Therapeutics"*
10:50 - 11:02	Torus Washington *UC San Diego- "Bowl-Ing for Cancer Drug Delivery Success Striking Down Lung Cancer with Silica Nanobowls"*
11:02 - 11:14	Break
11:14 - 11:26	Sophia Claymore *Univ of South FL- "Utilization of Bixen-loaded Nanoparticles to Ameliorate E-Cig-mediated Dysregulation of Airway iNOS Pathway"*
11:26 - 11:38	Yating Mao *FL State Univ- "Microrheological Characterization of Pseudomonas aeruginosa and Staphylococcus aureus Biofilms"*
11:38 - 11:50	Qi Wang *FL State Univ- "Fabrication and Propulsion of Erythrocyte-Based Micromotors in Low Reynolds Number Fluids"*
	Parallel Session 11: Nanoenergy / Nanomaterials / Nanobiotechnology *(Room 201)*
	Moderators: Arti Vashist
10:25 - 10:50	**Nikki Tjahjono** *"Engineering a novel chemigenetic fluorescent biosensor for multiplexed glutamate imaging"*
10:50 - 11:02	Ryan Green *Univ of South FL- "Potential for Cannabidiol to Improve Lung Cancer Patient Treatment, Rehabilitation, and Quality of Life"*
11:02 - 11:14	Break
11:14 - 11:26	Supun Attanayake *Univ of South FL- "Size-TunableMagnetite Superparticles for Magnetic Hyperthermia Therapy"*
11:26 - 11:38	Ahmed Hegazy *Univ of Central FL- "Wafer-scale development, characterization, and high temperature stabilization of epitaxial Cr2O3 films grown on Ru(0001)"*
11:38 - 11:50	Samaiyah Mason *FL A&M Univ- "The Development of BNNTTi2C3 Silicon Carbide Composite Nanomaterials with Enhanced Thermal and Electronic Properties"*
12:00 – 1:30	**Poster Prizes and Closing Remarks** *(Room 208)* *Moderators: Mandip Sachdeva*

Session 1 | 5:45pm – 7:15pm EST

Johnnie Early II, Ph.D., RPh Fellow NPhA
Dean of the College of Pharmacy
Florida A&M University, Tallahassee, FL

Early has served as Dean at the Historically Black 1890 Land Grant Florida A&M University, 1987-1993 and 2018- date; a free-standing academic medical center, Medical University of South Carolina; and UT, a metropolitan research university. He values communication, collaboration and student-centeredness and is committed to serving the needs of students, increasing diversity in health care fields, and engaging international partnerships. The College, which was recognized with the Toledo NAACP Public Institution Award, has recently seen the development of new degree programs, a 50% enrollment increase, enhanced residency training, endowed student scholarships, new facilities and more diverse student, faculty and staff populations, along with commendations by its accreditor.

Mandip Sachdeva, Ph.D
Professor, Dept. of Pharmaceutical Sciences
Florida A&M University, Tallahassee, FL

Professor and section leader for pharmaceutics activity at Florida A&M, College of Pharmacy and is also a fellow of American Association of Pharmaceutical Scientists (AAPS). He has made significant contributions in the area of drug delivery with special emphasis in inhalation/aerosol delivery as applied to lung cancer and topical delivery of neuropeptides. He is also Editor in Chief for CRC Critical Reviews in Therapeutic Drug Carrier Systems. He has over 120 publications in the area of Drug Delivery and over 250 presentations and has been invited worldwide to give talks at various meetings as plenary or regular speaker.

Two Decades Nanotechnology Revolution: A fire-side chat on 'UniLabs to Products'

Moderator

Shyam Mohapatra, Ph.D, MBA (Chair)
Associate Dean, Graduate Programs, Taneja College of Pharmacy
University of South Florida, Tampa, FL

Panelists

Nasser Nassiri Koopaei, Ph.D.
Co-Founder and Chief Executive Officer
EriVan Bio

Brian McMillan
Founder and CEO
Bravado Pharma, Tampa, Florida

Jeff Whalen, Ph.D.
Founder and Director
MagLab, Florida State University, Tallahassee, Florida

Session 2 | 9:00am – 10:45am EST

Steven Lenhert, Ph.D
Associate Professor, Dept. of Biological Science
Florida State University, Tallahassee, FL

Steven Lenhert is an Associate Professor in the department of Biological Science at the Florida State University (FSU). He completed his doctoral degree in Biology from the University of Muenster in 2004. He did postdoctoral research at Karlsruhe Institute of Nanotechnology in Germany and Northwestern University in the USA, performing research in nanobiotechnology. He teaches courses on introductory biology, synthetic biology, and nanotechnology. His research seeks to understand how lipid-based aggregates function to encapsulate, recognize, and deliver other molecules in biological Environments, publishing more than 40 peer reviewed publications on this subject. He has pioneered the use of arrays of micro- and nanoscopic lipid droplets for miniaturized high throughput screening and biosensor arrays.

Shyam Mohapatra, Ph.D, MBA (Chair)
Associate Dean, Graduate Programs, Taneja College of Pharmacy
University of South Florida, Tampa, FL

Shyam S. Mohapatra, PhD, MBA has had a distinguished career in academia in the areas of research, teaching and service at USF since 1996. Since 2014, he has served as Associate Dean of Graduate Programs at the USF Taneja College of Pharmacy and established a highly innovative Master of Science program in Pharmaceutical Nanotechnology with additional concentrations in Drug Discovery and Development and Biomedical Engineering. This program has grown exponentially, generating a revenue of ~$1 million in three years. He has created and is the founding president of a non-profit organization, Florida Association for Nanobiotechnology (>200 members), which encompasses all academic and industry institutions in the State of Florida engaged in the research and education of nanobiotechnology.

Mandip Sachdeva, Ph.D.
Professor, Dept. of Pharmaceutical Sciences
Florida A&M University, Tallahassee, FL

Professor and section leader for pharmaceutics activity at Florida A&M, College of Pharmacy and is also a fellow of American Association of Pharmaceutical Scientists (AAPS). He has made significant contributions in the area of drug delivery with special emphasis in inhalation/aerosol delivery as applied to lung cancer and topical delivery of neuropeptides. He is also Editor in Chief for CRC Critical Reviews in Therapeutic Drug Carrier Systems. He has over 120 publications in the area of Drug Delivery and over 250 presentations and has been invited worldwide to give talks at various meetings as plenary or regular speaker.

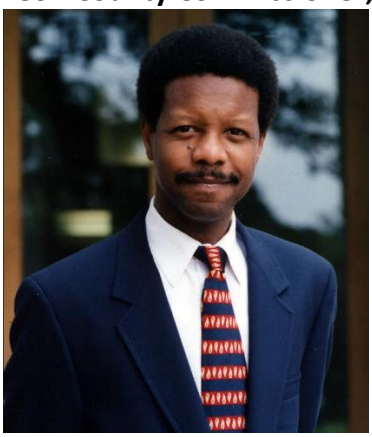
Charles Weatherford, Ph.D.
Vice President for Research
Florida A&M University, Tallahassee, FL

A computational atomic, molecular and plasma physicist, Weatherford has taught at FAMU since 1978. Prior to his appointment as Vice President for Research at FAMU in 2019, he served as interim vice president for research and associate vice president for research. He was also interim Title III executive director and a former chairman of the Physics Department. The Louisiana State University graduate who is credited with securing millions of research dollars has done a sabbatical at the Goddard Space Flight Center and completed summers at IBM- Almaden Research Center in San Jose, Calif., NASA-Goddard, NASA-Ames, and the U.S. Department of Energy's Lawrence-Livermore and Argonne national laboratories.

Michael Shatruk Ph.D.
Cottrell Family Professor of Chemistry
Florida State University, Tallahassee, FL

Mike Shatruk is a Cottrell Family Professor in the Department of Chemistry and Biochemistry, part of the College of Arts and Sciences. Shatruk has been teaching both undergraduate and graduate courses at Florida State for 14 years and serves as a research mentor and lead lab researcher for Shatruk Research Group. He earned his bachelor's, master's and doctoral degrees from Moscow State University and worked as a post-doctoral fellow at Cornell and Texas A&M University.

Bill Proctor
Leon County Commissioner, District 1



Bill Proctor is a member of the Leon County Board of County Commissioners. He represents the citizens of Leon County District 1 which includes the central city and southside areas. Commissioner Proctor served as Chairman of the Board in 2006 and 2015. His priorities as the District 1 Commissioner are affordable housing, quality healthcare, education, and economic development. Commissioner Proctor has engaged in many diverse activities providing leadership, creativity, and vision for our community. The breadth of his service includes church, community, higher education, federal, state and local government. He has served on several community advisory boards and has received numerous awards and recognitions for public service. Commissioner Proctor is a much sought-after speaker, commentator, and writer of political commentaries.

Keynote Speaker
Adam Braunschweig, Ph.D.
Professor, Nanoscience Initiative
City University of New York

Adam Braunschweig is a professor in the Nanoscience Initiative at the Advanced Science Research Center of the City University of New York and in the Department of Chemistry at Hunter College. His group investigates nanolithography of soft matter, photophysics of supramolecular systems, synthetic carbohydrate receptors, and the structure and properties of natural and synthetic mucins.

Abstract: Hypersurface photolithography: Nanoscale control over organic interfaces for biomedical and materials applications

Hypersurface Photolithography (HP) is a printing method for fabricating structures and patterns composed of soft, organic materials bound to solid surfaces and with ~1 micrometer resolution in the x, y, and z dimensions. This platform leverages benign, low intensity light to perform photochemical surface reactions with spatial and temporal control of irradiation, and, as a result, is particularly useful for patterning delicate organic and biological material. By combining novel printing tools with surface-initiated controlled radical polymerizations, we create arbitrary polymer and block-copolymer brush patterns, where the height and composition can be controlled independently for each pixel in the pattern. This lecture will review advances in instrumentation architectures and surface-initiated organic chemistry and polymer chemistry that have made these hypersurfaces possible. Over the course of this discussion, we describe specific applications that have benefited from HP, including new ultrasensitive, multiplexed biosensor architectures for studying carbohydrate binding and stimuli-responsive surfaces.

Session 3 | 9:55am – 11:08am EST

Subhra Mohapatra, Ph.D
Professor, Morsani College of Medicine, Dept. of Molecular Medicine
University of South Florida, Tampa, FL

Dr. Subhra Mohapatra is a Professor of Molecular Medicine and the Director of the Molecular Medicine PhD Concentration at the Morsani College of Medicine, University of South Florida. In addition, Dr. Mohapatra holds a Research Career Scientist position at the James A. Haley Veterans Hospital. With a unique interdisciplinary background in chemistry and immunology, she has been a pioneering researcher, whose work over the past 25 years has been instrumental in advancing the frontiers of personalized cancer treatment, and anti-cancer nanoscale drug delivery systems. Also, her laboratory has focused on the discovery and development of therapeutics for traumatic brain injury and long-COVID. Dr. Mohapatra's research has been supported (with a total of >$20 million to date) by the National Institute of Health (NIH), the Department of Veteran Affairs (VA), and the Florida Department of Health. She is a Fellow of several Academies including AAAS, AIMBE, NAI and FLASEM.

Abstract: Nanotherapeutics for Long-COVID: The New Horizon

The COVID-19 pandemic has caused over 6 billion infections globally thus far with up to 30% of individuals with mild to severe disease developing long COVID, exhibiting diverse neurologic symptoms including dementias. However, there is a paucity of knowledge of molecular brain markers and whether these can precipitate the onset of Alzheimer's disease (AD). This presentation will review the progress made in our understanding of the underpinning mechanisms of Long-COVID and the potential of nanomedicine applications to develop therapeutics.

Andrea Raymond, Ph.D.
Associate Professor, Dept. of Immunology and Nano-Medicine
Florida International University

Andrea D. Raymond, Ph.D. is an Associate professor in the Department of Immunology and Nanomedicine of the Herbert Wertheim College of Medicine at Florida International University(FIU). The long-term goal of Dr. Raymond's research is to study how extracellular vesicles (EVs) contribute to HIV-associated neuroimmune pathology, HIV/AIDS-associated cancers and substance abuse disorders, specifically opiates and cocaine. Dr. Raymond is a member of the Society of Neuroimmune Pharmacology(SNIP) and Society for Neuroscience(SfN). At FIU, Dr. Raymond serves as one of the Directors within the Black Faculty Association.

Abstract: Magnetoelectric exosomal-EV latency targeting(MELT) Nanotherapeutic for the eradication of HIV by the Block-Lock-and-Kill strategy

Human Immunodeficiency Virus (HIV) establishes latent infections in certain parts of the body, such as the brain, which can serve as a reservoir for the virus. Active HIV infections are controlled by antiretroviral therapy(ART) such that viral loads are below detection. However, antiretrovirals do not target latently infected cells. Here, we use an in vitro cellular model of HIV latency to test the efficacy of a magnetoelectric exosomal latency targeting (MELT) nanotherapeutic to treat latently infected microglia. To kill the latently infected, monomethyl auristatin E (MMAE), a drug that disrupts the microtubules and induces apoptosis, was conjugated to magnetoelectric nanoparticles (MENPs) to eliminate the infected cells via targeting HIV-infected cells based on their membrane potential value. MMAE-MENPs were internalized more by cells with a depolarized membrane potential. Findings showed that HIV infection does depolarize the membrane potential and allows the nanoparticle to be internalized more. These results demonstrate that MELT is capable of delivering drugs that specifically target latent HIV-infected cells, suggesting a novel antiretroviral strategy for treating HIV latency in the brain with EVs.

Student Oral Presentations

Jorge David Tovar Castro
University of Miami

"Single-cell manipulation of Pseudomonas aeruginosa using a microfluidic platform"

Session 4 | 9:55am – 10:56am EST

Guangxin Ni, Ph.D.
Assistant Professor of Physics
Florida State University

Dr. Ni received his Ph.D. degree in physics from National University of Singapore in 2013. He worked as a postdoctoral researcher at the University of California San Diego from 2014 to 2017 and postdoctoral research scientist at Columbia University from 2017 to 2019. Dr. Ni joined the faculty at Florida State University in 2020. His research focuses on experimental condensed matter physics and optical physics, specifically, utilizing advanced nano-optics coupled with nano-electronics to study new phase of matters in quantum materials with unprecedentedly spatial, spectral and temporal resolutions.

Abstract: Scanning Nano-Optical Imaging of Quantum Materials

Scanning Nano-Optical imaging is an invaluable resource for exploring new physics of novel quantum materials. Surface plasmon polaritons and other forms of hybrid light-matter polaritons provide new opportunities for advancing this line of inquiry. In particular, polaritonic images obtained with modern scanning nano-infrared tools grant us access into regions of the dispersion relations of various excitations beyond what is attainable with conventional optics. I will discuss this emerging direction of research with two examples from 2D layered materials

Student Oral Presentations

Mohammad Irfan
Florida State University

"Robust Topological Surface States in YbB12 A Comparative Study with SmB6 using planar tunneling spectroscopy"

Omair Faqah
Florida Atlantic University

"Rapid Testing Platform for HIV Detection

Session 5 | 9:55am – 11:08am EST

Laura Greene, Ph.D.
Chief Scientist at National MagLab
Florida State University

Laura H. Greene is the Chief Scientist of the National High Magnetic Field Laboratory and the Marie Krafft Professor of Physics at Florida State University. Her research is on quantum materials, focusing on fundamental studies of novel materials growth and the mechanisms of unconventional superconductivity. As a leading advocate for diversity in science, a champion for women in science and engineering, science diplomacy, ethics, and human rights, she has held leadership roles in many science organizations nationally and internationally, including president of the American Physical Society (APS), the Board of Directors for the American Association for the Advancement of Science (AAAS), and is presently the Vice President of the International Union of Pure and Applied Physics (IUPAP) for Ethics and Outreach. President Joe Biden recently appointed Greene to the President's Council of Advisors on Science and Technology (PCAST) which directly advises POTUS on matters of science, technology, and innovation policy.

Abstract: Novel Electron Pairing in the Unconventional Superconductor CeCoIn5

The heavy-fermion CeCoIn5 is an unconventional superconductor with a pairing symmetry of dx2-y2 but the pairing mechanism remains unknown. After an overview of unconventional superconductivity, I will describe our planar tunnel junctions on single crystals into three crystallographic orientations as a function of temperature down to 20 mK and applied magnetic fields up to 18. The tunneling density of states as a function of applied field at temperatures below Tc (2.3K) or below that that of the preformed pairs (~ 5K) show that with increasing applied field, the superconducting density of states is suppressed, and smoothly evolves into a splitting that increases linearly with applied field, well above HC2. The tunneling conductance does not exhibit field evolution when taken above electron pairing temperatures. This behavior has not been seen before in any conventional or unconventional superconductor, and we conject a model that invokes f-electron (Kondo) scattering as the pairing mechanism.

Student Oral Presentations

Jaideep Katuri
Florida State University

"Control of cohesive states in colloidal chiral fluids through phoretic interactions"

Arthur Rech Tondin
University of Miami

"Enhanced Immunomodulation in Allogeneic Transplantation: Harnessing Mesenchymal Stem Cells with a NanoFibril Rapamycin System for Targeted Inflammation Control"

Dr. Navneet Kaur
Florida State University

"Comparative Analysis of Microparticle Uptake Role of Particle Anisotropy in 2D and 3D Cell Culture"

11:50am – 2:20pm EST

Two Decades of Nanotechnology Revolution

Sylvia Daunert, PharmD, PhD
Professor, Dept. of Biochemistry and Molecular Biology
University of Miami, Miami, FL

"*Nanomedicine, successes, challenges & the frontier*"

Ratnesh Lal, Ph.D
Professor, Dept. of Bioengineering/Mechanical Engr./Material Science
University of California-San Diego, San Diego, CA

"Atomic Force Microscope & Nano-Imaging Tools"

Shyam Mohapatra, Ph.D, MBA (Chair)
Associate Dean, Graduate Programs, Taneja College of Pharmacy
University of South Florida, Tampa, FL

"*Nanotechnology and AI intersection: a new frontier"*

Keynote Speaker
Jason White, Ph.D.
Director
The Connecticut Agricultural Experiment Station

Dr. Jason C. White is the Director of the Connecticut Agricultural Experiment Station has a research program on sustainable nano-enabled agriculture. Dr. White is a member of the Connecticut Academy of Science and Engineering and the European Science Foundation College of Experts. He is a Commissioned Official of the US FDA and a Clarivate Web of Science Highly Cited Researcher (2020-2023). His Ph.D. is in Environmental Toxicology from Cornell University and has secondary appointments at Yale University and the University of Massachusetts. His h-index is 87 and has published 300 papers with 26,672 citations.

Abstract: Nanobiotechnology-based Strategies for Enhanced Crop Stress Resilience

Abstract: Low use and delivery efficiency of conventional agrichemicals is a significant impediment to maintaining global food security, particularly given that a 60-70% increase in food production is needed by 2050 to support the projected population. Further confounding these efforts is climate change, which may force cultivation of crops under more marginal and stress-inducing conditions. Thus, novel and sustainable strategies for enhancing food production are needed. Nanobiotechnology approaches to engineer crops with enhanced stress tolerance may be a safe and sustainable strategy to increase crop yield. Under stress conditions, cellular redox homeostasis is disturbed, resulting in the over-accumulation of reactive oxygen species (ROS) that damage biomolecules (lipids, proteins, and DNA) and inhibit crop growth and yield. However, delivering ROS-scavenging nanomaterials (NMs) at the appropriate time and place can alleviate abiotic stress. Importantly, ROS-production in living cells carries both costs and benefits. When present below a threshold level, ROS can mediate redox signaling and defense pathways that foster plant acclimatization against stress. We find that many NMs are ROS-triggering, such as nanoscale Cu, Fe, S, Si, and CuS, but these materials have the potential to be judiciously applied to crop species to stimulate defense systems, prime stress responses, and subsequently increase the biotic and abiotic stress resistance of crops. This knowledge can be used to engineer climate-resilient crops. It is also clear that the ability to effectively tune nanoscale material structure and composition will be critical to maximizing positive impacts, including significantly reduced amounts of agrichemical use while simultaneously enhancing yield.

Session 6 | 2:20pm – 3:33pm EST

Prem Chapagain, Ph.D.
Professor of Physics; Associate Director of the Biomolecular Sciences Institute
Florida International University

Dr. Chapagain is a Professor in the Department of Physics at Florida International University, specializing in biological physics. His research focuses on the computational investigations of biomolecules, and he has extensively published on various topics of biophysics including protein aggregation, exploring novel antimicrobial compounds against antibiotic-resistant pathogens, membrane interactions and dynamics of viral proteins of emerging viruses such as Ebola and Marburg viruses and more recently SARS-CoV-2. He has been recognized by a number of teaching and research awards, including the 2022 Faculty Senate award for Faculty Excellence in Research and the 2019 Faculty Senate award for Faculty Excellence in Teaching.

Abstract

Physics-based molecular simulations and AI-driven structural modeling have recently led to numerous applications, including the design of new drugs, enzymes, and nanomolecular structures. Recent advancements in experimental as well as computational techniques such as cryo-EM, molecular dynamics simulations, and machine learning have accelerated our understanding of biological systems at the atomistic level and have allowed us to directly confront various diseases by aiding in designing therapeutics and vaccines. I will discuss a range of examples of biophysical investigations leveraging recent state-of-the-art techniques. The topics will include computational investigations of membrane interactions, viral assembly and budding, and designing nanomolecular structures that could pave the way for drug delivery and therapeutics.

Student Oral Presentations

Belal Jahannia
University of Florida

"Binarized neural networks"

Jiachi Ye
University of Florida

"Demultiplexing structured beams using hybrid optical-electronic neural network"

Sophie Jermyn
Florida State University

"Dynamics of Rigid Achiral Magnetic Microswimmers in Shear-Thinning Fluids"

Session 7 | 2:20pm – 3:33pm EST

Swadesh Santra, Ph.D
Professor, Dept. of Chemistry
University of Central Florida, Orlando, FL

Swadeshmukul Santra, Ph.D. is a Professor at the University of Central Florida holding a joint appointment with the NanoScience Technology Center and the Department of Chemistry. Dr. Santra is the founding director of UCF Materials Innovation for Sustainable Agriculture (MISA) Center. He has been actively working in the field of Nanoscience and Nanotechnology for over 20 years focusing on nanoagriculture and nanomedicine areas. He has published over 100 peer-reviewed research articles, 8 review articles, 12 book chapters and delivered 96 invited talks. He has been awarded 35 patents including 28 US patents. Dr. Santra's research has been funded by NSF, USDA, Citrus Research and Development Foundation, California Department of Food and Agriculture, and several industries with a portfolio of over $6.0 Million research funding.

Abstract Nanotechnology-enabled agrochemicals for crop protection

Copper (Cu) bactericides/fungicides are aggressively used in the agriculture industry in the U.S and worldwide on many crops. There is an increasing concern of Cu accumulation in field soil, Cu leaching potential into the surrounding ecosystem and development of bacterial resistance. Using nanotechnology, it is possible to reduce Cu amount per application without compromising overall efficacy. Moreover, Zn and Mg based nanomaterials can be developed for potential use as an alternative to Cu bactericides/fungicides. This presentation will focus on laboratory, greenhouse and field efficacy outcome of several nanoparticle composites, challenges towards developing industrially viable formulations and approaches to minimize regulatory challenges.

Keywords: copper, zinc, bactericide, fungicide, citrus canker, bacterial spot, nanotechnology

Student Oral Presentations

Melissa Deinys
University of Central Florida

"Nanoformulation-based Intervention for Mitigating Pestalotiopsis spp. in Mangrove Die-off A Sustainable Approach for Ecosystem Conservation"

Md Zakariya Mohayman
University of Central Florida

"Exploring the Impact of Lithium Concentration on the Mechanical Properties of Li6PS5Cl Solid Electrolytes for All-Solid-State Lithium Batt"

Utkarsh Misra
University of South Florida

"Reduced Graphene Oxide A New Contender for Thermal Management in RF IC Packaging"

Session 8 | 2:20pm – 3:33pm EST

Ajeet Kaushik, Ph.D.
Assistant Professor of Chemistry, Dept. of Environmental Engineering
Florida Polytechnic University

Ajeet Kaushik, Fellow-ICS, is working as an assistant professor of Chemistry at the Department of Environmental Engineering of Florida Polytechnic University – USA. He is exploring nano-enabled technologies for health and environmental monitoring, involving efficient sensing and nanomedicine. He is an accomplished scholar (supported by over 280 publications, editorial roles, 10 edited books, 3 patents, and international collaborations) and the recipient of several international awards in support of his credentials. His research interests include green chemistry, electrochemistry, chemical sensors, biosensors, nanomedicine, point-of-care sensing, and personalized sensing. To achieve goals, Dr. Kaushik is focused on cutting-edge research and seeking collaborations.

Abstract: Smart sensor for health and environmental management

Presently nano-enabled smart sensing technology interfaced with other tools like the Internet of Things (IoT) and artificial intelligence (AI) are emerging significantly for efficient disease/problem management, even at point-of-care (POC) applications. Such systems are on the track of transformative research according to the goals of 5th and 6th-generation technology to track and manage health and the environment according to the goals of sustainability. In this direction, we are exploring electro-active electrodes for efficient bio (biosensor) and chemical sensing with the capability of POC applications. Our developed sensing prototypes are well interfaced with a miniaturized potentiostat (M-P) which can be operated using a smartphone. Recently, to develop efficient infectious disease management, we have developed miniaturized nano-enabled biosensing systems to detect targeted biomarkers for diagnostics of infectious diseases like COVID-19 infection. Further, electrochemical sensing is explored for efficient sensing of water pollutants (heavy metals) and forever chemicals like microplastics selectively and at a very low level (ppm to ppb). We believe our developed biosensing and chemical sensing systems supported by AI and IoT approaches can be a potential tool for personalized health management and environment surveillance. The outcomes of these sensing technologies can be utilized for policy and timely decision-making efforts.

Student Oral Presentations

Sawyer Chang
University of Central Florida

“Pragmatic synthesis of loaded tea-derived polymer-polyphenol particles”

Yusuf Muhammed
Florida State University

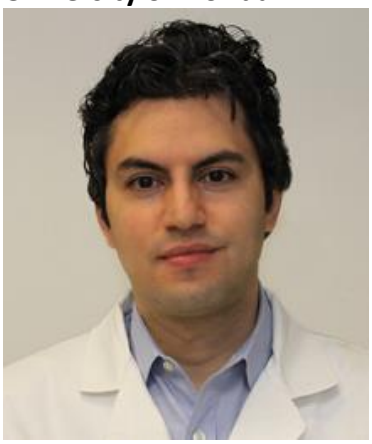
“Drug-induced Cell Death and its Heterogeneity in Single Lung Adenocarcinoma Cells Observed using Scanning Ion Conductance Microscopy”

Ana Ramirez
Florida State University

”Functionalization of Nanopipettes with Aptamers for Biosensing of Biomolecules”

9:00am – 10:20am EST

Keynote Speaker
Elias Sayour, Ph.D.
Associate Professor of Neurosurgery and Pediatrics
University of Florida



Elias Sayour, MD, PhD is a board-certified pediatric oncologist and Associate Professor of Neurosurgery and Pediatrics. He serves as Assistant Dean of Clinical Research in the UF College of Medicine, Vice Chair of the UF Health Cancer Center (UFHCC) Scientific Review Monitoring Committee (SRMC), and Co-leader of Immuno-oncology and Microbiome (IOM) Program. Dr. Sayour has extensive translational experience having served as sponsor of multiple FDA-IND submissions and as PI/Study Chair on first-in-human clinical trials (NCT03334305, NCT04573140). He serves as institutional PI for the Pediatric Brain Tumor Consortium (PBTC) and Pacific Pediatric Neuro-Oncology Consortium (PNOC) allowing him to coordinate national resources to advance promising therapeutics. Dr. Sayour has spearheaded creation of the UF Pediatric Cancer Immunotherapy Initiative (PCI2) and Large Animal Comparative Oncology Initiative and serves as principal investigator of the RNA Engineering Laboratory where he has been the primary inventor on a number of pending patent applications concerning the immunologic treatment of cancer. He received UF's 2021 Innovation of the Year Award, and recognition as a University of Florida Term Professor.

Abstract

We have developed different nanocarriers to reprogram the immune system against cancer. These involve lipid nanoparticle systems to deliver different payloads including mRNA, siRNA, and CRISPR-cas9. These RNA nanosystems can elicit rapid immunomodulation of the innate immune system through rapid increases in inflammatory cytokines and chemokines. Following systemic administration, peripheral immune cells mobilize to sites of particle localization for simultaneous reprogramming of the tumor microenvironment and induction of antigen specific T cell immunity for anti-tumor efficacy across murine and canine cancer models. These findings have been translated into first-in-human trials for gliioblastoma patients.

Industry + Education Collaboration

Shyam Mohapatra, Ph.D, MBA
Associate Dean, Graduate Programs, Taneja College of Pharmacy
University of South Florida, Tampa, FL

Shyam S. Mohapatra, PhD, MBA has had a distinguished career in academia in the areas of research, teaching and service at USF since 1996. Since 2014, he has served as Associate Dean of Graduate Programs at the USF Taneja College of Pharmacy and established a highly innovative Master of Science program in Pharmaceutical Nanotechnology with additional concentrations in Drug Discovery and Development and Biomedical Engineering. This program has grown exponentially, generating a revenue of ~$1 million in three years. He has created and is the founding president of a non-profit organization, Florida Association for Nanobiotechnology (>200 members), which encompasses all academic and industry institutions in the State of Florida engaged in the research and education of nanobiotechnology.

Ramesh Kenchappa, Ph.D.
Head of Formulation Development
Lonza

Dr. Kenchappa earned his Ph.D. in Pharmaceutical Science with more than 20 years of pharmaceutical product development experiences working at senior executive levels in reputed pharmaceutical industries. Specialist in developing various pharmaceutical dosage forms including Tablets, Soft Gel and Hard Gel Capsules, Liquids, Topical applications for IND/NDA and ANDA for Phase 1 to Phase 3 filing according to QBD guidelines. Expert in preparing CMC documents for regulatory submissions for NDA /ANDA filing. Specialist in control release novel drug delivery system, bioavailability enhancer, bilayer tableting technology, laser drilling of tablets technology, developing potent and controlled substances. Specialist in generating appropriate analytical method development, stability data review, regulatory documents, keeping projects on time and on budgeting, contract negotiation and oversight.

Session 9 | 10:25am – 11:50am EST

Nasser Nassiri Koopaei, Ph.D.
Co-Founder and Chief Executive Officer
EriVan Bio

Dr Nasser Nassiri Koopaei is a visionary leader at the forefront of biopharmaceutical innovation. As the Co-founder and CEO of EriVan Bio, he is spearheading the efforts to the development of revolutionary exosome delivery technology. EriVan Bio's platform holds immense promise for targeted drug delivery, aiming to transform therapeutic approaches across various therapeutic areas. Dr Nassiri's passion for scientific discovery extends beyond the boardroom. He also serves as an Adjunct Assistant Professor of pharmaceutics at the College of Pharmacy, University of Florida. In this role, he coordinates the Model Informed Drug Development and advocates for pharmacometrics tools applications in the biopharmaceutical industry, fostering a culture of research and innovation. This dual role exemplifies Dr Nassiri's commitment to both commercial advancement and academic excellence.

Abstract: Novel exosomes for targeted delivery of therapeutic cargos

The blood-brain barrier (BBB) is a highly selective semipermeable border that separates the circulating blood from the brain, protecting it from potentially harmful substances. This presents a challenge for delivering drugs to the brain, as the BBB restricts the passage of most pharmaceuticals, including over 98% of small-molecule drugs and all macromolecular therapeutics. The barrier allows only small molecule drugs with specific properties, such as low molecular weight and lipid solubility, to pass through via lipid-mediated free diffusion. This limitation hinders the delivery of many drugs to the brain, making it challenging to treat central nervous system disorders such as brain tumors, stroke, degenerative diseases and brain injuries. Extracellular vesicles (EVs) have shown tremendous potential as targeted delivery systems. Plant derived extracellular vesicles can serve as effective delivery systems to transport molecules to the brain via oral or intranasal routes. This technology holds several advantages related to using nanoparticles, including low production costs, superior delivery efficiency, reduced immunogenicity and anti-inflammatory properties. Further modification and customization of these EVs seems a requirement for the field to generate safe and efficient delivery mechanisms.

Student Oral Presentations

Anatasian Estephan
University of South Florida

“Potential of CBD and Nano-CBD as adjunct therapy for Epilepsy“

Mounika Aare
Florida A&M University

“CBD camel milk-derived exosome formulation with enhanced bioavailability for the treatment of Breast cancer”

Aakash Nathani
Florida A&M University

“Combined role of interleukin-15 stimulated natural killer cellderived extracellular vesicles and carboplatin in Osimertinib resistant H1975 lung cancer with…”

Stephanie Herrera
University of Florida

“Supramolecular peptide-protein granule system for intracellular codelivery of proteins”

Session 10 | 10:25am – 11:50am EST

Satya Prakash, Ph.D
Professor, Dept. of Biomedical Engineering/ Physiology
McGill University, Montreal, Canada

Dr. Prakash is a Fellow of the Royal Society of Canada, Distinguished James McGill Professor and is a Full Professor of Biomedical Engineering, Artificial Cells and Organs, Physiology, Experimental Medicine, and Experimental Surgery within the Faculty of Medicine and Health Sciences at McGill University, located in Montreal, Quebec, Canada. His research interests encompass a wide range of areas, including microbiome, probiotics, microbiome engineering, biomedicine, nanomedicine, nanotechnology, etc. Presently, his team is actively involved in the development of microbiome engineering in chronic diseases, Alzheimer, gastrointestinal conditions, cancer, and to promote healthy living and longevity. Dr. Prakash is a leading author of more than 375 research papers/abstracts.

Abstract: Nano siRNA formulation as Head and Neck, Lung Cancer Therapeutics.

Linking genes with the underlying mechanisms of diseases is one of the biggest challenges of genomics driven drug discovery research. Designing an inhibitor for any disease that effectively halts the pathogenicity of the disease is yet to be achieved. Designing siRNA with exquisite specificity may result in selective suppression of the disease linked gene. Although, siRNA is the most promising method, it loses its potency to down regulate the gene due to its inherent instability, off-target effects and lack of on-target effective delivery systems. Viral as well as non-viral delivery methods have been effectively tested in-vivo for silencing of molecular targets and have resulted in significant efficacy in cancer. To realize the full therapeutic potential of siRNA for cancer diseases, we need to overcome many hurdles and challenges such as selection of suitable tissue specific delivery vectors, minimizing the off-target effects and achieving distribution in sufficient concentrations at the target tissue without any side-effects. Cationic nanoparticle-mediated targeted siRNA delivery for therapeutic purposes has gained considerable clinical importance due to its promising efficacy in head and neck cancer and lung cancer. Details of these studies will be presented.

Student Oral Presentations

Torus Washington
University of California San Diego

"Bowl-Ing for Cancer Drug Delivery Success Striking Down Lung Cancer with Silica Nanobowls"

Sophia Claymore
University of South Florida

"Utilization of Bixen-loaded Nanoparticles to Ameliorate E-Cigmediated Dysregulation of Airway iNOS Pathway"

Yating Mao
Florida State University

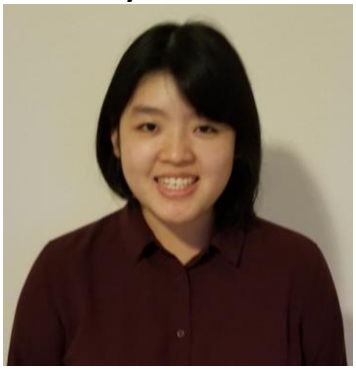
"Microrheological Characterization of Pseudomonas aeruginosa and Staphylococcus aureus Biofilms"

Qi Wang
Florida State University

"Fabrication and Propulsion of Erythrocyte-Based Micromotors in Low Reynolds Number Fluids"

Session 11 | 10:25am – 11:50am EST

Nikki Tjahjono
Ph.D. Candidate
University of California Berkeley



Nikki is a 5th year biomedical engineering PhD student in Dr. Lin Tian's lab. She joined the Biomedical Engineering Graduate Group at UC Davis and the Tian Lab, which has allowed her to push for new frontiers of optical tool development to fulfill critical unmet needs in neuroscience. She then moved with the lab to Max Planck Florida Institute for Neuroscience in 2024, where Dr. Tian is currently serving as Scientific Director. There, she is expanding upon her current research projects to engineer red-shifted glutamate sensors and develop high-throughput screening and data analysis pipelines for sensor engineering.

Abstract: Engineering a novel chemigenetic fluorescent biosensor for multiplexed glutamate imaging

Glutamate is the predominant excitatory neurotransmitter in the brain, underlying regulation of cell excitability, synaptic plasticity, learning and memory. Glutamate also interplays with many different neurotransmitter systems—including dopamine, serotonin, and GABA-- necessitating tools with high chemical and cell-type specificity to probe the diverse roles of glutamate in the brain. The development of genetically encoded fluorescent biosensors have allowed for sensitive, specific, and non-invasive detection of neurochemical dynamics in real time. However, the most well-utilized neurochemical indicators are GFP-based, enforcing spectral limitations for recording different analytes simultaneously. These indicators also require blue light excitation, which induces autofluorescence, cytotoxicity, and limits imaging depth to shallower brain regions compared to red-shifted imaging. In this study, we engineered, validated, and demonstrated the utility of a new class of fluorescent glutamate sensors, "Halo GluSnFR". Halo GluSnFR consists of a genetically encoded protein scaffold that can bind to exogenously applied bright and photostable red-shifted fluorescent dyes. In response to fluctuations in extracellular glutamate, the sensor reversibly switches between a fluorescent and non-fluorescent state, providing a readout for neuronal glutamate release. After several rounds of engineering through rational design and site-saturated mutagenesis, we created a suite of sensor versions with optimized speed, sensitivity, and dynamic range. We exploited the modularity of the sensor by characterizing different dye-sensor combinations with a palette of red-shifted dyes. We demonstrated that the sensor can be used for imaging neuronal action potentials and synaptic release events. To expand the utility of the sensor, we demonstrated that Halo GluSnFR can be used for simultaneous, multiplexed imaging of glutamate with other neurochemicals in acute brain slice and model organisms. With Halo GluSnFR, neuroscientists have a new tool for multiplexed glutamate imaging to answer previously intractable questions in behavior and disease.

Student Oral Presentations

Ryan Green
University of South Florida

"Potential for Cannabidiol to Improve Lung Cancer Patient Treatment, Rehabilitation, and Quality of Life"

Supun Attanayake
University of South Florida

"Size-TunableMagnetite Superparticles for Magnetic Hyperthermia Therapy"

Ahmed Hegazy
University of Central Florida

"Wafer-scale development, characterization, and high temperature stabilization of epitaxial Cr2O3 films grown on Ru(0001)"

Samaiyah Mason
Florida A&M University

"The Development of BNNTTi2C3 Silicon Carbide Composite Nanomaterials with Enhanced Thermal and Electronic Properties"

Student Oral Presentation Abstracts

Mounika Aare

CBD camel milk-derived exosome formulation with enhanced bioavailability for the treatment of Breast cancer

Mounika Aare, Arvind Bagde, Aakash Nathani, Mandip Singh

Author's Affiliations: College of Pharmacy and Pharmaceutical Sciences, Florida A&M University, Tallahassee, FL-32303, USA,

Abstract

The potential of camel milk-derived exosomes (CMDE) to enhance the bioavailability of Cannabidiol (CBD) was investigated. CBD-CMDE formulation was prepared using a established procedure and its particle size was 93.6 ± 4.37 nm, and CBD entrapment efficiency of 56.56 ± 4.26 %. *In-vitro* release studies showed release of 78.27 ± 5.37 % and 46.42 ± 4.75 % CBD from CMDE and control CBD formulation respectively at 24 hr. The apparent permeability (Papp) of CBD-CMDE formulation was found to be enhanced by 3.95-fold with Papp of $22.9*10^{-6}$±0.34 cm/sec as compared to control CBD formulation with Papp of $5.8*10^{-6}$ ± 0.65 cm/sec in MDCK cells. CBD-CMDE formulation was found to be more potent in 2D cytotoxicity assay with IC_{50} values of 3.6 ± 0.54 µM, 3.88 ± 0.54 µM than CBD alone which had IC_{50} values of 7.53 ± 0.59 µM, 7.53 ± 0.59 µM against Doxorubicin (DOX) resistant MDA-MB-231 and Rapamycin (RM) resistant MDA-MB-468 breast cancer cells respectively. Moreover, 3D spheroids assay results demonstrated CBD-CMDE with IC_{50} values of 14 ± 0.85 µM, 15 ± 0.07µM as compared to CBD alone with IC_{50} values of 25 ± 0.93 µM, 34.7 ± 0.08 µM in MDA-MB-231 DOX RT cells and MDA-MB-468 RM RT cells respectively. *In-vivo* PK studies showed enhanced bioavailability of CBD from CBD-CMDE formulation with AUC (0-24h) of 1430.25 ± 198.10 ng/mL*h as compared to CBD control formulation with AUC of 323.39 ± 41.36 ng/mL*h. Overall, CMDE can be used to enhance the oral absorption of poorly bioavailable APIs.

Supun B. Attanayake

Size-Tunable Magnetite Superparticles for Magnetic Hyperthermia Therapy: Overcoming the Superparamagnetic Particle Size Limit

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Iron oxide (e.g., Fe_3O_4 or γ-Fe_2O_3) nanoparticles are promising candidates for a variety of biomedical applications ranging from magnetic hyperthermia therapy to drug delivery and bio-detection, owing to their outstanding superparamagnetic characteristics, non-toxicity, and bio-degradability. While particles of small size (below a critical size, ~20 nm) retain superparamagnetic at ambient temperature, these particles tend to penetrate highly sensitive areas of the body such as the Blood Brain Barrier (BBB) leading to complexities. These particles also possess a high probability of retention leading to genotoxicity and biochemical toxicity. Increasing particle size promises to solve these problems but suppresses superparamagnetism. We overcome this size limit by exploring the novel synthesis of polycrystalline iron oxie nanoparticles composed of multiple nanocrystals of 10-15 nm size while tuning particle size up to 400 nm. These so-called superparticles preserve superparamagnetic characteristics, with excellent particle-size-tunable hyperthermia properties. The Specific Absorption Rates (SAR) can reach up to 330 W/g at low concentration of 0.5 mg/mL, indicating the capability in cancer treatment with minimum dose. Our study underscores the potential of size-tunable polycrystalline iron oxide superparticles with quasi-superparamagnetic properties for advanced biomedical applications, particularly in the realms of magnetic hyperthermia, drug delivery, and biodetection.

Keywords: Superparticles, Superparamagnetism, Iron oxide, Magnetic hyperthermia

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Sawyer Chang

Pragmatic synthesis of loaded tea-derived polymer-polyphenol particles

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Teas brewed from the leaves of *Camellia sinensis* harbor a plentiful dose of polyphenols which account for much of the taste and color of black, green, white, oolong, and pu'er tea. These polyphenols are reported to also be the key factor for the antioxidant qualities that are heralded as one of the main health components of these teas. The structure of these polyphenols allows for loading of compatible molecules in many nanoparticle systems. In this work, a polymeric particle loaded with these polyphenols was formulated and aims to shield loaded active ingredients that can degrade in the harsh physiological environment of the human digestive tract. The particles were characterized by dynamic light scattering and zeta potential (DLS/Zeta) while the loading was quantified via liquid chromatography mass spectroscopy (LC-MS). The ability to load a wide range of molecules allowed for the formulation of a health-based formula and an energy-based formula. This health-based formula is focused on the nutritional needs for expectant mothers including folate and minerals. The energy-based formula is based on energy drinks that aim to provide caffeine and taurine for increased performance. These findings can potentially create a simple alternative to nutrient and even drug delivery simply by the steeping of tea.

Sophia Claymore

[Utilization of Bixen-loaded Nanoparticles to Ameliorate E-Cig-mediated Dysregulation of Airway iNOS Pathway.]

Sophia Claymore, Zhi Tian, and Diane Allen-Gipson. USF Health Taneja College of Pharmacy, Department of

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The usage of electronic cigarettes (e-cig) has risen in the past decade due to its initial promotion as a safer alternative to traditional cigarettes. However, evidence shows that e-cig usage damages cardiovascular and cerebrovascular function, particularly damaging endothelial cells in these systems. E-cig-related endothelial cell-derived and microvesicle-induced damage results in dysregulation of the iNOS pathway. This dysregulation results in an increase in nitric oxide synthase (NOS), an enzyme that catalyzes the production of nitric oxide (NO), an important cellular signaling molecule that modulate vascular tone and endothelin-1 (ET-1), a potent vasoconstrictor peptide secreted by endothelial cells that acts as a natural counterpart of NO and contributes to vascular tone and cell proliferation. They under normal condition maintain the homeostatic of the endothelium with their "yin and yang" effect on vascular function. Utilization of E-cig which consists mainly of nicotine proposes a potential mechanism for nicotine-induced endothelial vasodilatory dysfunction. There is a greater need to better understand the underlying mechanism(s) of e-cig nicotine mediated stroke and cancer risks, and its susceptibility of brain injury. Furthermore, e-cig affects endothelial permeability and pulmonary vasoreactivity independent of the presence of nicotine, therefore, an understanding of these changes in endothelial cell-derived microvesicle structure and function can provide greater insight into the damaging and long-term effects of nicotine use. The objective of this project will delineate the role of e-cig nicotine mediated damage to the iNOS pathway and/or the lung endothelial/epithelial cells. We plan to determine level of nicotine to induce endothelial and vasculature injury. We plan to conduct toxicity studies and protein and RNA analyses to measure NO levels, inflammatory cytokines (TNF-alpha, IL-1-beta, IFN-gamma). We plan to use the A549, human epithelial cancer cell line, and HUVEC, human umbilical vascular endothelial cell line, to determine the level of damage from e-cig nicotine and e-vapor. We plan to conduct metastasis experiment utilizing our ECIS biosensor to investigate the functional damage and investigate the structural changes via microscopic methods. Bixin-loaded nanoparticles (NPs) will be utilized to reverse the anticipated damage caused by e-cig by targeting cGMP activators and/or inhibitors and/or nitrates. We believe our findings will demonstrate e-cig nicotine mediated injury alters iNOS deregulation by altering NO and ET-1 tissue homeostasis, and our bixin-loaded NPs will be an ideal drug nanocarrier for treating cardiovascular and cerebrovascular injury.

Keywords: e-cigarette, e-vapor, nicotine, microvesicles, vascular tone and dysfunction, bixin, endothelial, epithelial, cytokines, nitric oxide, iNOS pathway

Melissa M. Deinys

"Nanoformulation-based Intervention for Mitigating Pestalotiopsis spp. in Mangrove Die-off: A Sustainable Approach for Ecosystem Conservation"

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Pestalotiopsis spp., a fungal pathogen, presents a significant menace to mangrove ecosystems by inducing diseases such as leaf blight and dieback in mangrove trees which are critical for marine life support and coastal environment preservation. Isolating Pestalotiopsis spp. from Red Mangrove leaves as part of a parallel study on mangrove die-off in Florida, this threat can be addressed through a sustainable solution. Our strategy entails MagSuN, a nanoformulation integrating Sodium Polysulfide (NaPs) and Magnesium hydroxide nanoparticles (MgSoL), including optimized versions of MgSoL particles to enhance efficacy. This new step likely regulates the size, shape, and surface properties of these nanoparticles, heightening crystallinity and morphological adjustments to augment reactivity and stability, thus improving MgSoL's efficacy against Pestalotiopsis spp. In our mycelium growth assays, we observed growth inhibition of up to 95% with thermally treated MagSuN at varying concentrations compared to the untreated control. Furthermore, poison food assays employing MagSuN induced pathogen stress, resulting in up to an 87% reduction in fungal growth. Preliminary studies on seed treatments reveal promising results, with seeds soaked in our material exhibiting pathogenic fungal inhibition. These study findings hold promising implications for advancing innovative and eco-friendly strategies to combat the proliferation of environmental pathogens, offering potential applications in environmental science and agriculture.

Anatasia Estephan

Potential of CBD and Nano-CBD as adjunct therapy for Epilepsy

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Abstract

Cannabinoid (CBD), also known as medical marijuana, has been FDA-approved as adjunctive therapy for the treatment of different types of epileptic seizures including Lennox-Gastaut syndrome and Dravet syndrome in patients 1 years and older. However, a majority of commercially available CBD products contain varying levels of psychoactive tetrahydrocannabinol (THC), which often results in increased myocardial oxygen demand, elevated supine blood pressure, and tachycardia. In addition, as compared with smoking tobacco, vaping CBD is associated with increased concentration of carboxyhemoglobin and tar in the blood that could lead to cardiac arrythmia, seizure, and coma. We therefore conducted a comprehensive literature review of the potential usage of purified CBD or nano formulations of CBD as adjunctive therapy in patients with epilepsy. We reviewed three epileptic clinical trials with total of 1204 patients wherein purified oral CBD was used as an adjunct therapy for the treatment and safety evaluation. The results show a significant reduction in seizure frequency and duration in CBD adjunct group versus placebo. Also, purified CBD adjunct therapy was found to be a safe treatment. Further, review of research on different oral CBD formulations including lipid nano emulsion, nanogels, and oil-based formulations shows that CBD nano formulations significantly increase solubility and bioavailability of CBD. In conclusion, our comprehensive review shows that pure CBD nano formulations when used in conjunction with standard of care treatments can significantly increase efficacy and improve safety of these epilepsy treatments.

Omair Faqah

Title: Rapid Testing Platform for HIV Detection

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Abstract: Human immunodeficiency virus (HIV) has affected 39 million people globally resulting in 630, 000 AIDS-related deaths in 2022. Being a public health issue for more than 40 years, the development of a scalable rapid-testing platform is of paramount importance to achieve the UNAIDS' target of 95% of all people living with HIV to know their status by 2025. This ambitious goal is hindered by current testing methods that are expensive, time-consuming, and less accessible which is a problem for low-resource settings. To address this critical gap, a low-cost, rapid testing platform that can accurately detect HIV in carriers is needed to link patients to appropriate care and effectively control the spread of the virus to improve public health. We present an automated Reverse Transcription Loop-mediated isothermal Amplification (RT-LAMP) based diagnostic platform for HIV detection. Our device features the use of a microfluidic chip and low-powered microheaters on a fully automated magnetic actuation platform. The microfluidic chip encompasses an all-in-one design that performs plasma extraction, sample processing, and RT-LAMP-based colorimetric analysis of the sample. Leveraging the advantages of Nucleic Acid Tests (NATs) allows us to reduce the window period of detection to as early as one week post-exposure. We have developed custom LAMP primers that make the test highly specific while being able to detect the common subtypes found in North America including subtype B. Our initial testing with the plasmid pNL4-3 has shown a limit of detection of 30 viral copies per reaction in 45 minutes. Our wax-based valves in the microfluidic chip allow the passive loading of reagents which makes it a sample in-answer-out device. The simplicity of operation positions our device as a pivotal tool in the global strategy to achieve public health objectives in mitigating the impact of the HIV epidemic.

Ryan Green

Use of Cannabidiol to Improve Lung Cancer Treatment and Quality of Life

Ryan Green, Jared Belkin, Sashank Bikkasani, Subhra Mohapatra, Shyam Mohapatra

Abstract:

There is currently a growing interest in the use of cannabidiol (CBD) to alleviate the symptoms caused by cancer, including pain, sleep disruption, and anxiety. CBD is often self-administered as an over-the-counter supplement, and patients have reported benefits from its use. Clinical trials of CBD to treat cancer pain have thus far yielded mixed results and optimal treatment of individual cancer types with CBD along with optimal combinations of CBD plus specific cancer therapies and the extent to which CBD can alleviate therapy induced toxicities are still not known. Additionally, despite the progress made, the molecular mechanisms underlying CBD's anti-cancer activity remain unclear. Herein, we provide an analysis of transcriptomic gene expression data to elucidate anti-cancer mechanisms of CBD and screening of drug combinations with CBD to identify novel synergistic anti-cancer activity and mechanisms. We aim to exploit this synergy to improve lung cancer rehabilitation and patient quality-of-life by reducing pain, anxiety, and tumor growth while also improving physical disabilities such as loss of mobility, stamina, or pain which can be caused both by lung tumors and by chemotherapy toxicity. We use behavioral models of lung cancer in mice to determine the effectiveness of CBD combination treatments for pain and physical disabilities. Our results show that CBD combination therapies have synergistic anti-tumor effectiveness with specific targeted therapies in models of lung cancer and that pain, anxiety, and mobility impairments due to both cancer and chemotherapy toxicity can be successfully reduced in mice. In future studies we will aim to create nano formulations of these combination therapies for enhanced delivery to lung tumors.

Ahmed R. Hegazy

Wafer-scale development, characterization, and high temperature stabilization of epitaxial Cr2O3 films grown on Ru(0001)

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Abstract

This work is the first demonstration of epitaxial formation of Cr_2O_3(0001) films (1.5 – 20 nm thick) on Ru(0001), where conditions suitable for wafer-scale growth are shown. Optimized growth was achieved by reactive oxidation sputtering of Cr within a 4 mTorr Ar/O_2 20% ambient at Ru temperatures ranging from 450 – 600 °C. Low-energy electron diffraction (LEED) shows that the Cr_2O_3 film adopts a 30° rotated honeycomb configuration with respect to the underlying Ru(0001) substrate, and exhibits a hexagonal lattice parameter consistent with that for bulk Cr_2O_3(0001). Further investigation by x-ray photoelectron spectroscopy (XPS) showed that heating to 700 °C within the same environment during film preparation leads to Ru oxidation, while exposure to temperatures at or above 400 °C in vacuum, Ar, or Ar/H2 3% leads to chromia film degradation. Subtle effects pertinent to these ambients were investigated by XPS for annealed vs. unannealed films of Cr2O3(0001)/Ru(0001) and Ru(0001)/Cr2O3(0001)/Ru(0001). This work will provide others with an approach to further exploring structurally-controlled, oxide-support interactions of potential high importance to works of chemical catalysis, corrosion passivation and metallic interconnect applications.

Stephanie Herrera

Supramolecular peptide-protein granule system for intracellular co-delivery of proteins.

Stephanie Herrera, Renjie Liu, Madisen Domayer, Alex Adolphson, Gregory A. Hudalla

Biomedical Engineering Department, University of Florida

The ability to deliver active proteins across the cell membrane and into the cytosol would provide access to druggable targets that are not available within the extracellular environment. However, due to their large size, charge, and hydrophilicity, proteins do not efficiently cross the cell membrane to enter the cytosol on their own. Here we will present the development of supramolecular peptide-protein granules for intracellular protein delivery. This approach utilizes charge-complementary molecules known as, “CATCH(+) peptides” and “CATCH(-) fusion proteins”. Alone, CATCH(-) and CATCH(+) remain in the soluble state, but combined form b-sheet fibrils. After introducing a crowder to the mixture, such as polyethylene glycol (PEG), Tween-80 micelles, or excess CATCH(+) peptide, 100-200 nm “CATCH(+/-) granules” are formed at peptide concentrations ~10-fold lower than the critical fibrillization limit in dilute conditions (~200 mM). CATCH(+/-) granules are rapidly internalized by various adherent and suspended mammalian cell types including fibroblasts, HEK293, T cells, dendritic cells, monocytes, and neutrophils. Using CATCH-GFP as a model protein, more than 90% of granule-treated cells possess active protein within 60 minutes without significant cell death. CATCH(+/-) granule internalization demonstrates greater delivery efficiency and lower cell death than other state-of-the-art methods, such as cell penetrating peptides or electroporation. Using CATCH-GFP, CATCH-mRuby, and CATCH-NanoLuc as model proteins, different CATCH-fusion proteins can be co-assembled into multicomponent granules with tunable composition. Multicomponent granules allow for co-delivery of both an “effector” (i.e., a protein that confers therapeutic function) along with a “selector”, where the latter can be used to enrich the sub-population of cells that have internalized the CATCH(+/-) granule. Collectively, these data establish CATCH(+/-) granules as a simple and flexible nanomaterial platform for cell engineering via intracellular protein delivery.

Mohammad Irfan

Robust Topological Surface States in YbB_{12}: A Comparative Study with SmB_6 using planar tunneling spectroscopy

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Abstract:

The emergence of topological surface states (TSS) in Kondo insulators has garnered significant attention due to their unique electronic properties. Electronic transport and the magnetoresistance measurements of single crystals and microstructures on the Kondo Insulator YbB_{12} reveal the presence of topologically protected surface states, suggesting that YbB_{12} is a candidate material for being a topological Kondo insulator [1]. Planar tunneling spectroscopic studies on YbB_{12} also support the formation of TSS in YbB_{12} as is seen in SmB_6, but data suggest that exact nature of the TSS in YbB_{12} may be different from that in SmB_6 [2]. Second harmonic measurement techniques provide higher resolution and cleaner planar tunneling spectra which help us to compare the electronic structure of these interesting materials in further detail. We will present planar tunneling spectroscopic data on YbB_{12} in the low temperature resistance plateau range (up to 0.45K) and compare it to planar tunneling data taken on SmB_6 [3]. Our studies, using second harmonic measurements, further supports that the TSS formation at lower temperature in YbB_{12} is robust as seen in SmB_6 but the mechanism by which surface state interacts with bulk bosonic excitations differ intrinsically compared to SmB_6.

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[2] A. Gupta *et al*., Phys. Rev. B 107, 165132 (2023).

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Belal Jahannia

Binarized neural networks offer substantial reductions in memory and computational requirements compared to full precision networks. However, conventional CMOS-based hardware implementations still face challenges with resilience for deployment in harsh environments like space. This paper proposes an optical XOR-based accelerator for binarized neural networks to enable low power and resilient operation. The optical logic gates rely on wavelength-specific intensity propagation rather than absolute intensity levels. This provides inherent robustness against fabrication process variations and high energy particle strikes. Simulations of an optical hardware prototype for XNOR-Net show the accelerator achieves 1.2 μs latency and 3.2 mW power. The binarized network maintained 2-4% accuracy degradation compared to the full precision baseline on MNIST and CIFAR-10. The proposed optical accelerator enables efficient and resilient deployment of binarized neural networks for harsh environment applications like spacecraft and satellites.

Sophie Jermyn

Dynamics of Rigid Achiral Magnetic Microswimmers in Shear-Thinning Fluids

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Interest in small scale swimming robots for biomedical applications has been steadily increasing over the past two decades. Critical for these systems is fundamental understanding of their propulsion kinematics in biological environments, which are most often non-Newtonian viscoelastic fluids. Classical swimming models, developed for bacterial flagella, accurately describe propulsion of helices in low Reynolds number Newtonian fluids, a geometry commonly used for microscale swimmers. However, recently rigid achiral designs have been created showing new modes of locomotion in instances where the fluid has time dependent properties. In this work, magnetically actuated 2-4 bead self-assembled achiral microswimmers are used to provide insights into swimming kinematics and flow field development in shear-thinning polymer fluids. Propulsion kinematics are explored in a Newtonian fluid, a shear thinning fluid with negligible elasticity, and a shear thinning fluid with elastic properties. Measurements of swimming dynamics reveal contrasting propulsion kinematics in shear thinning versus Newtonian fluids. Swimming enhancement is observed in specific non-Newtonian shear-thinning environments. Micro-particle image velocimetry is also used to characterize flow-fields, specifically how fluids with elastic properties impact local flows produced by microswimmers. The findings suggest that flow-asymmetry can be induced even for symmetric swimmers through confinement (Weissenberg effect).

Jaideep Katuri

Control of cohesive states in colloidal chiral fluids through phoretic interactions

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Active matter systems are composed of autonomous interacting units that continuously dissipate energy, exerting mechanical forces and stresses. Typical synthetic active systems have consisted of self-propelling colloids which exhibit a variety of non-equilibrium phenomena governed by the interplay between self-propulsion, thermal fluctuations, and pairwise interactions. In contrast to self-propelling particles, spinning particles in fluids constitute a new class of active matter systems which exhibit coherent dynamical structures through inter-particle hydrodynamic interactions. An experimental realization of this system is a dense chiral fluid composed of spinning colloidal magnets driven by an external rotating magnetic field. Spinning magnetic particles interact both via dipolar and hydrodynamic interactions and collectively organize into separated circulating clusters with unidirectional edge flows. Here, we report a mechanism to externally control the collective states of spinning magnetic particles by introducing additional phoretic interactions between the colloids. The ellipsoidal hematite colloids decompose H_2O_2 in the presence of UV light and generate phoretic flows nearby, both along the surface and in the bulk. The added nanoscale interfacial flows lead to the formation of bound states between spinning colloids that are stabilized through near-field hydrodynamic and chemical interactions. At a collective level, we demonstrate that the added diffusiophoretic interaction causes a loss in structural cohesion of the circulating clusters, and promotes their expansion, while preserving global cluster inter-connectivity. The expanded cluster state is characterized by the formation of a dynamic interconnected colloidal network that limits the expansion radius. This expansion process is controllable via fuel concentration, UV intensity, and observed to be entirely reversible, therefore offering external control over the emergent dynamics in dense chiral fluids. Introduction of chemical activity-based interactions in chiral fluids paves the way for a new paradigm of self-organization routes in chiral fluids.

Navneet Kaur

Comparative Analysis of Microparticle Uptake: Role of Particle Anisotropy in 2D and 3D Cell Culture

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Abstract

The development of three-dimensional (3D) cell culture models has emerged as a promising alternative to overcome the pitfalls of two-dimensional (2D) cell culture, which fails to accurately mimic the complex conditions found *in vivo*. Tissues formed in 3D provide microenvironment that can aid in recapitulating may physiological relevant phenomena, including cell-extracellular matrix (EMC) interactions, cell-cell interactions, and nutrient gradients. Nano/microparticles integrated into 3D cell culture systems have shown great potential for various biological applications, such as drug delivery and tissue engineering. However, the cellular uptake mechanisms of these particles in 3D matrices are not well understood. Here, we investigated the cellular uptake of anisotropic hematite microparticles in cancer and normal cells cultured in 2D and within a 3D matrix. We employed a novel micro-fibrous scaffold that closely mimics natural ECM, providing porous and interconnected networks for 3D culturing of NIH3T3 and MDA-MB-231 cell lines. Hematite microparticles with various geometry were synthesized using a sol-gel method. The particles were characterized using SEM and XRD and subsequently incubated with cells in both 2D and 3D cultures for characterization of uptake and toxicity. It was observed that rod-shaped particles exhibited superior internalization compared to cubic or ellipsoidal particles in both 2D and 3D cultures, however uptake was more prominent in cancer cell lines in comparison to normal cells. Further, utilizing endocytotic inhibitors, including Cytochalasin D, we identified phagocytosis as the predominant mechanism of uptake. Moreover, we investigated the cytotoxicity of the microparticles in both cell lines, and it was observed that these particles are more toxic to cancer cells than normal cells in both 2D and 3D cultures. These insights into the cellular uptake of nano/microparticles in 3D matrices, may lead to improvements in drug delivery, tissue engineering, and regenerative medicine applications.

Yating Mao

Microrheological Characterization of *Pseudomonas aeruginosa* and *Staphylococcus aureus* Biofilms

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Biofilms are microbial derived communities that adhere to inert and living surfaces, providing bacteria with protection to cope with environmental stresses. *Pseudomonas aeruginosa* (PA) and *Staphylococcus aureus* (SA) are the most common pathogens that coexist in chronic infections. Whether their relationship is antagonistic or beneficial remains contentious. Investigating the formation and biomechanics of PA-SA biofilms will aid in our understanding of the synergistic interactions between these two species, and may led to the development of new interventions for bacterial infection strategies. Here, we use microrheology to evaluate the delicate early-stage development of submerged PA-SA biofilms *in vivo*, with the goal of determining how these two species interact and remodel their environment within the first 24 hours. We investigated PA and SA monocultures and a series of PA-SA cocultures. We observe that cocultures of specific PA and SA exhibited higher growth rates and microrheological properties than other concentrations. Additionally, scanning electron microscopy was employed to quantify the micro and nanoscale structure of biofilms. Using phase contrast imaging, we observed that PA displayed different growth patterns when cultured with different ratios of SA. These findings suggest a concentration dependent competitive or collaborative relationship between the two pathogens, which promotes their growth to the greatest extent when both populations are abundant. Thus, antibacterial agents targeting one species may potentially reduce the activity of the other.

Samaiyah Mason

Title: The Development of BNNT/Ti2C3 Silicon Carbide Composite Nanomaterials with Enhanced Thermal and Electronic Properties.

Authors: Samaiyah Mason [1, 2], Anna Huzcar[1], Aspen Reyes[2], Dr. Natalie Arnett[1], Dr. Rebekah Sweat [2], Dr. Sanjay K.D. Singh[1]

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Abstract :

Rapid technological innovation increases electromagnetic (EM) radiation, causing device failure, interruption, resource loss, efficiency loss, and quality loss. Composite materials must conduct electricity, shield EM, and encapsulate electronics. Nanocomposites outperform pure polymers in mechanical, flame retardancy, chemical resistance, thermal stability, and thermal/electrical conductivity. Ti3C2 MXene sheets absorb microwaves better than graphene oxides/magnetic particle hybrid fillers utilized in materials. Thermal, electrical, and mechanical qualities make carbon nanotubes (CNTs) excellent nano-reinforcement materials for polymeric composites. BNNTs are structurally similar to CNTs but have an exciting combination of high stiffness, electrical resistivity, thermal conductivity, and low thermal expansion. Other than hexagonal BN crystals, BNNT fillers are more thermally conductive, resist oxidation, and meet these characteristics. Silicon oxycarbide (SiOC) is desirable due to its thermal and chemical stability, ease of manufacture, and oxidation resistance. Mixed SiOxC4-x nanodomains may improve mechanical strength and minimize flaws. Polymer precursors provide defect sinks, such as grain boundaries and interfaces, boosting degradation resistance. A polymer precursor's electrical and mechanical properties change with its molecular structure. The process must be optimized to make reliable SiOC-coated BNNTs/Ti3C2 MXenes hybrid composites. In situ, graphitic carbon and Ti3C2 MXenes improve SiOC's electrical conductivity, but BNNTs boost its thermal conductivity. Silicon carbide inorganic polymers, boron nitride nanotubes (BNNT), and titanium carbide (Ti3C2) MXenes are applied for studies demonstrating how BNNT and MXene ratios affect SiOC structure-property connections. SiC polymers can be optimized by modifying microstructure and inclusion concentrations. New EM-absorbing materials and technologies were created by manufacturing SiC composites with tuneable thermal and electrical properties. This research addresses SiC composite synthesis issues, including reduced porosity, graphite formation, and functionalized BNNT and MXene inclusions to disaggregate and disperse. To enhance the multifunctional performance, structure-property correlations, and thermo-mechanical properties are examined and compared to existing ceramic polymer composites.

Utkarsh Misra

Title: Reduced Graphene Oxide: A New Contender for Thermal Management in RF IC Packaging

Authors: Utkarsh Misra[1,2,3], Vishvajitsinh Kosamiya[1,2], and Jing Wang[1,2,3]

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Abstract: The demand for smaller and denser electronic devices has led to the need for more efficient thermal management techniques in their packaging. While conventional electronics have established solutions, RF/mm wave electronics still heavily rely on copper-based ground planes or even bulkier metal fin heat sink for thermal management. However, this reliance poses limitations, particularly as RF systems become smaller and generate higher power densities.

Reduced graphene oxide (rGO) films have emerged as a promising solution due to their exceptional thermal conductivity and compatibility with back-end-of-the-line (BEOL) processing techniques. Research by Pei et al. and others have shown that rGO films can achieve thermal conductivities surpassing copper, making them compelling for RF electronics facing significant thermal challenges.

One approach to integrate rGO films is to use them as interfacial layer heat spreaders within the substrate stack of a packaging assembly. However, this method comes with a caveat: the thin rGO film's high electrical conductivity and proximity to the ground plane can affect the performance of surface RF electronics. While previous studies have examined the RF performance of graphene films in circuits, their performance as ground planes for RF electronics remains unexplored.

This study aims to fill this gap by investigating the performance of rGO films as ground planes for RF electronics using standard transmission line measurement techniques. The results indicate that the transmission loss for rGO-based ground planes is, on average, 1.71 dB higher than copper-based ground planes across a frequency range between 10MHz and 26.5 GHz. Overall, the measured transmission coefficient for the rGO film closely matches that of copper, with consistent power transmission exceeding 90% throughout the frequency range.

In conclusion, while rGO films offer thermal properties over ten times better than traditional copper, there is a slight tradeoff in RF power loss. Nonetheless, they remain a promising option for thermal management in RF electronics packaging, especially in applications where thermal efficiency and in-plane heat spreading instead of heat transfer through stacked layers is deemed critical.

Md Zakariya Mohayman

Exploring the Impact of Lithium Concentration on the Mechanical Properties of Li6PS5Cl Solid Electrolytes for All-Solid-State Lithium Batteries.

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Abstract: All-solid-state batteries utilizing sulfide solid electrolytes are considered a promising alternative to traditional lithium-ion batteries due to their high lithium-ion conductivity, modulus, and chemical compatibility with lithium metal anodes. These characteristics are anticipated to inhibit lithium penetration within the electrolyte and prevent cell short-circuiting. Nonetheless, instances of lithium penetration occurring within sulfide-based electrolytes during battery operation have been reported. Therefore, a thorough understanding of the mechanical properties of these electrolytes is crucial for enhancing their performance and reliability. This study employs first-principle atomistic simulations to elucidate the relationship between lithium concentration variations within solid electrolytes and their consequential mechanical behaviors. By constructing and deforming computational cells of LPSCl (Li_6PS_5Cl) under various lithium concentrations, the research identifies a critical linkage between lithium concentration and mechanical property degradation, potentially leading to mechanical failure of ASSBs. Through comparing stress-strain curves under compression and tension for different lithium concentrations, this paper provides significant insights into the mechanical integrity of solid electrolytes in operational conditions, laying a foundation for enhancing the durability and safety of ASSLBs.

Yusuf Muhammed

Drug-induced Cell Death and its Heterogeneity in Single Lung Adenocarcinoma Cells Observed using Scanning Ion Conductance Microscopy

Yusuf Muhammed and Robert A. Lazenby

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Lung cancer stands as one of the most lethal forms of cancer worldwide, with lung adenocarcinoma (LUAD), a type of non-small cell lung cancer, comprising 85% of lung cancers cases. Treatment approaches for lung cancer vary based on disease progression, ranging from surgical intervention to molecular therapy (such as erlotinib) and chemotherapy (such as cisplatin) options for advanced stages. However, drug resistance poses a significant obstacle in lung cancer treatment. Our study uses scanning ion conductance microscopy (SICM) and demonstrates its potential in continuously monitoring cisplatin-induced apoptosis in the same individual adenocarcinoma cells (A549) over time, due to its non-invasive and label free nature. The SICM technique is most commonly used for topography mapping, but is also able to be coupled with membrane potential measurement, electrochemical sensing, and surface charge mapping. This sets it apart from other invasive techniques for apoptosis investigation such as atomic force microscopy, electron microscopy, flow cytometry, and fluorescence microscopy. Additionally, our SICM-based investigations reveal the apoptotic effects of the less studied drug toyocamycin on A549 cells by observing morphological alterations, a reduction in apoptotic volume, the formation of membrane blebbing, and changes in membrane roughness. Therefore, toyocamycin can be beneficial in combination with chemotherapy for lung cancer. Notably, lung adenocarcinomas exhibit intra and intertumoral heterogeneity, a feature we've elucidated at the single-cell level using SICM, identifying subtypes of A549 cells undergoing necrosis alongside apoptosis. Consequently, our findings revealed SICM's utility as a robust tool for investigating late-stage apoptosis dynamics, morphological changes, and heterogeneity within A549 cells at the single-cell level.

Aakash Nathani

BRD4 protein degradation via oral delivery of ARV-825 loaded camel milk exosomes exhibit anticancer activity in p53 mutant Diffuse Intrinsic Pontine Glioma (DIPG).

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DIPGs (diffuse intrinsic pontine gliomas) are a particularly aggressive and malignant type of pediatric brain tumor. TP53 tumor suppressor protein mutations are found in 70-80% of DIPG tumors. These TP53 mutations have been linked to radiation resistance in DIPG patients. The mechanisms underlying enhanced radioresistance in p53-mutant DIPG are unknown. Our goal was to find compounds that would improve the radiation sensitivity of p53 mutant DIPG. ARV-825 is an emerging PROTAC (Proteolysis Targeting Chimera) compound which can cause rapid and persistent BRD4 protein degradation. However, delivering ARV-825 to pons is a major challenge owing to poor oral bioavailability of PROTACS. In this study, we used camel milk derived exosomes (CME) for delivery of ARV-825 to pons by both nasal and oral routes. CME were isolated using ultracentrifugation and nanoparticle tracking analysis revealed a size distribution of 112.5±2.8 nm, zeta potential of -26.38 0.12 mV. CME were cytotoxic to both SF8628 (with a H3.3 K27M mutation) and SF188 (grade-IV pediatric glioblastoma with wild type H3.3) cell lines and had 51% and 44% cell viability respectively. ARV-825 showed IC_{50} of 546.58±22.14 nM and 608.94±30.04 nM in SF8628 cells and SF188 cells respectively. ARV-825's IC_{50} was lowered when ARV-825 loaded CME were used. ARV-825 was loaded using sonication and entrapment efficiency was found to be 42.96±2.14% by HPLC analysis. CME were DiO-labelled and instilled into each nostril of SD rats daily. CME were seen under fluorescent microscope in the pons region after 5 days demonstrating the ability of CME to reach the target site. *In-vitro* permeability studies using MDCK cells had shown 58%, 77% and 98% of ARV-825 permeation in 2, 4 and 24 hours respectively when loaded into CME. Further invitro and invivo studies are undergoing to validate the results and understand kinetics and the molecular mechanisms of ARV-825 loaded CME.

Ana Ramirez

Functionalization of Nanopipettes with Aptamers for Biosensing of Biomolecules

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Abstract:

Single-cell measurements for small molecules are crucial for capturing individual cell variability and dynamics, revealing insights often masked in bulk measurements. Current analytical techniques capable of directly measuring the concentration of molecules at the single-cell level rely on fluorescent probes or other labeling approaches which can alter or harm the cells. An alternative approach lies in the functionalization of nanopipettes, offering the ability to detect small biomolecules at low concentrations without harming or altering the cell. Functionalizing nanopipette tips can be achieved with a biorecognition element such as antibodies or aptamers that enables binding to specific target molecules, resulting in signal changes attributed to ion current rectification (ICR) effects. The ionic current in the nanopipettes results from an applied voltage across two Ag/AgCl quasi-reference electrodes where rectification occurs based on the properties of the electrical double layer formed at the tip. This study focuses on developing nanoscale sensors utilizing nanopipettes with a gold-deposited inner wall supporting a self-assembled monolayer of thiolated aptamers. This setup enables the detection of various analytes such as adenosine triphosphate (ATP), serotonin, and dopamine in phosphate-buffered saline solution. To determine the sensing efficacy of the sensors, the ion current was measured and any current changes upon the addition of target molecules were tracked. Our results demonstrated the successful and reversible detection of ATP and serotonin at the nanoscale, potentially enabling concentration measurements of different analytes at the single-cell level.

Arthur Rech Tondin

Enhanced Immunomodulation in Allogeneic Transplantation: Harnessing Mesenchymal Stem Cells with a NanoFibril Rapamycin System for Targeted Inflammation Control

Arthur Rech Tondin[1], Teodora Dal Buono[1], Sofia Cochi[1], Francesca Paris[1], Camillo Ricordi[1], Diana Velluto[1*], Giacomo Lanzoni[1*]

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Abstract

In Type 1 Diabetes (T1D), an autoimmune disease, the immune system targets islet tissues, leading to inflammation and tissue destruction. Pancreatic islet transplantation has been explored as a treatment for challenging cases of T1D, but rejection by the recipient remains a significant hurdle. Novel immunomodulatory agents are being investigated, including Umbilical Cord-derived Mesenchymal Stem Cells (UC-MSCs) and nanoparticles delivering drugs like Rapamycin (Rapa), which inhibit immune responses. Combining these agents may offer more effective immunomodulation for inflamed islets and transplant sites. The study aims to develop targeted immunomodulatory agents to improve outcomes in T1D and pancreatic islet transplantation. UC-MSCs are engineered with Rapa-loaded nanoparticles to enhance their potency. The system achieves targeted drug delivery by utilizing UC-MSCs' migration and nanoparticle-carrying capabilities. Biocompatible amphiphilic block copolymers self-assemble into nanosized fibrils, effectively loading Rapa (nFIB-Rapa). *In vivo*, labeled UC-MSCs loaded with nanoparticles accumulate at inflamed sites, demonstrating targeted delivery. *In vitro* studies show that nFIB-Rapa are taken up by cells, augmenting UC-MSCs' immunomodulatory effects. UC-MSCs engineered with nFIB-Rapa exhibit enhanced inhibition of T cell proliferation and promotion of Regulatory T cell expansion. *In vivo*, fluorescently labeled UC-MSCs loaded with nanoparticles accumulate at inflamed sites within 24 hours of administration. In a pilot study of allogeneic islet transplantation, UC-MSCs engineered with nFIB-Rapa demonstrate improved graft survival, suggesting rejection inhibition. In conclusion, Mesenchymal Stem Cells engineered with nFIB-Rapa show promising immunomodulatory effects and targeted delivery to inflamed sites. Additionally, this approach may enhance the outcomes of pancreatic islet transplantation by inhibiting rejection.

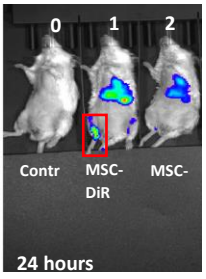

Figure 1: Balb/C mice received an injection of lipopolysaccharide (25 mL at 1mg/mL in saline solution) into the right foot paw on day 0. Mice received an intravenous infusion of Mesenchymal Stem Cells labeled with DiR (MSC-DiR) either combined with nanofibrils labeled with DiD (nFIB-DiD, mouse 1) or cells alone (mouse 2). Imaging was performed with the In Vivo Imaging System 24 hours after infusion. The imaging showed that cells preloaded with nanofibrils accumulate at the site of inflammation (mouse 1, red rectangle). An untreated mouse was used as control (mouse 0).

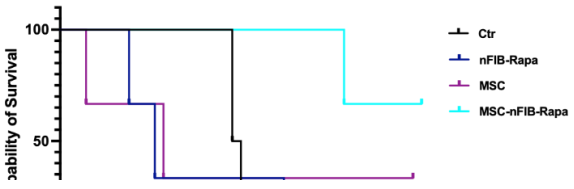

Figure 2. Allogeneic islet transplantation survival graph: C57BL/6 mice received 700 IEQ of isltes isolated from DBA/2 mice and implanted into the epididymal fat pad (EFP). Islets were pre-aggregated with either UC-MSC or UC-MSC ingineered with nFIB-Rapa. Mice transplanted with untreated islets and islets combined with only nFIB-Rapa were also used as controls. The results show that treatment with MSC-nFIB-Rapa significally prolongs the graft survival (experiment still on going).

Jorge David Tovar-Castro

Novel Nanodrug Platform for Pharmacologically Inducing Therapeutic Hypothermia (TH) After Traumatic Brain Injury (TBI)

Jorge David Tovar-Castro[1,3], Alexia L Kafkoutsou[1,3], Emre Dikici[1,3], Juliana Sanchez-Molano[2], Sapna Deo[1, 3], W Dalton Dietrich[2], Helen M Bramlett[2,4], Sylvia Daunert[1,3]

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Therapeutic hypothermia (TH) has gained widespread recognition as a neuroprotective strategy for mitigating secondary injury mechanisms resulting from traumatic brain injury (TBI). TBI occurs when an external force impacts the skull, causing damage to the brain. TH modulates neuropathological responses caused by TBI. Our approach utilizes intranasal delivery of nanoscale vanilloid drugs, specifically olvanil, to induce brain hypothermia through the activation of the transient receptor potential vanilloid 1 (TRPV1).

Through a bottom-up synthesis, we prepared nanoolvanil, demonstrating its ability to bind to TRPV1 and activate the receptor, as evidenced by calcium influx assays. Toxicity studies revealed minimal impact on cell proliferation and indicated antioxidant effects in vitro. In vivo experiments employed a custom 3D-printed intranasal spray (INS) to deliver nanoolvanil.

Characterized by dynamic light scattering (DLS), nanoolvanil exhibited an average size of 82.53 nm, a polydispersity index (PDI) of 0.25, and a zeta potential of -28.05 mV—suitable for blood-brain barrier transport. TRPV1 activation studies showed a 34% calcium influx post-injection and nanoolvanil significantly increased cell proliferation. In vivo, the 3D-printed INS successfully delivered nanoolvanil at 5 mg/kg, leading to a temperature reduction of ~2 °C for up to 100 minutes.

Nanoolvanil, falling within the optimal size range, effectively activated TRPV1 with minimal impact on cells. In vivo studies using our customized 3D-printed INS demonstrated successful head and body temperature reduction, highlighting the potential of this nanodrug delivery system for therapeutic hypothermia in TBI cases.

Qi Wang

Fabrication and Propulsion of Erythrocyte-Based Micromotors in Low Reynolds Number Fluids

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Erythrocytes, natural biomaterials found in the human body, can be modified and utilized in active autologous cell therapy by directly sourcing them from patients. This characteristic makes them attractive for micromotor design and personalized medicine. However, current erythrocyte-based micromotors face limitations, often due to complex manufacturing methods or the need for complicated control mechanisms involving multiple external fields to achieve propulsion. Here, we present a novel and simple method for fabricating erythrocyte-based micromotors using biotin-streptavidin interactions, whose attachments are stable under an applied external magnetic field. The biohybrid erythrocyte micromotors exhibit both swimming and rolling motions when driven by a single uniform rotating magnetic field. This propulsion approach offers control of micromotor motion in various physiological fluid environments, including saline solutions and plasma. We investigate the step-out frequencies and translational velocities for both motion modes and demonstrate the maneuverability of these micromotors using open-loop control. The unique maneuverability and kinematic properties displayed by these micromotors, coupled with the inherent biological properties of the underlying cells, position erythrocyte-based micromotors as promising candidates for biomedical applications.

Torus Washington II

"Bowl-Ing for Cancer Drug Delivery Success: Striking Down Lung Cancer with Silica Nanobowls"

Authors: Torus Washington II[1], Ratnesh Lal[1], David Morse[2], Shyam S. Mohapatra[3,5], Subhra Mohapatra[4,5]

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Abstract

Effective drug delivery is necessary for improved cancer treatment and reduced toxicity-- nanoparticle delivery improves these outcomes. In this work, we propose a novel nanoparticle system for drug delivery-- "silica nanobowls." Nanobowls are a Stöber synthesis silica nanoparticle with a bowl-like cavity etched out. To this point, Nanobowls have not been used as a drug delivery vehicle for cancer, and their utility requires investigation. As a contribution to material science and understanding of Stober synthesis in novel applications, varied chemical methods and protocol designs were explored to make nano bowls smaller. In addition to size attenuation, the potential to modify cavity profile, drug loading, and drug delivery abilities were investigated. Nanobowl size, porosity, cavity size, surface area, and other characteristics were revealed as a function of this work. Nanobowls were tested in 3 different lung cancer cell lines to explore the applications of these findings. Without drug, nanobowls were observed to be non-toxic to cells. For treatment, the cancer drug doxorubicin was delivered, and significant uptake and cancer cell killing was observed. This work outlines the nanobowl's utility in drug delivery for cancer treatment and lays a foundation for the potential modulation of this ability. Work remains to further investigate the behavior of these particles in vivo and to tune the parameters of the platform for targeting and enhanced drug release.

Jiachi Ye

Title: **Demultiplexing structured beams using hybrid optical-electronic neural network**

Jiachi Ye, Belal Jahannia, Qian Cai, Salem Altaleb, Hao Wang, Elham Heidari, Hamed Dalir*

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Abstract: Advancements in optical communications have increasingly focused on leveraging structured beams such as orbital angular momentum (OAM) beams for high-capacity data transmission. However, conventional electronic convolutional neural networks exhibit constraints in efficiently demultiplexing OAM signals. In this work, we introduce a hybrid optical-electronic convolutional neural network (OECNN) capable of completing Fourier optics convolution and realizing intensity-recognition-based demultiplexing of multiplexed OAM beams under variable simulated atmospheric turbulent conditions. We experimentally generate multiplexed OAM-coded beams and simulate atmospheric turbulence using phase-modulated screens. The core part of our demultiplexing system includes a 4F optics system employing a Fourier optics convolution layer with a digital micromirror device. This optical spatial-filtering-based convolutional neural network is utilized to realize the training and demultiplexing of the 4-bit OAM-coded signals under various turbulence scenarios. Results show the proposed OECNN performs demultiplexing accuracy of 86.74% under turbulence-free condition and 72.84% under strong turbulence condition. Notably, the OECNN achieves 3.2 times faster training compared to an all-electronic convolutional neural network for 4-bit OAM-coded signal demultiplexing tasks. This underscores the OECNN's potential for superior performance in comprehensive input dataset training. Furthermore, we propose integrating metasurfaces composed of subwavelength antenna arrays. This future approach could simultaneously generate OAM-coded signal arrays and enable massively parallel Fourier optics convolution, potentially leading to groundbreaking enhancements in optical neural network processing speed and data throughput.

Poster Abstracts

Vianessa Andion

Development and Characterization of Biotherapeutic Nanogel for Ovarian Cancer Treatment

Vianessa Andion[1], Gabriela Perez Alvarez[1], Andrea Raymond[1], Christia Lomas[1], Prem Chapagain[2], Marisela Agudelo,

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Ovarian cancer (OC) is one of the most lethal malignancies. Current treatments for this disease face challenges which have been attributed to the tumour microenvironment and immune evasion. resulting in resistance development, and are highly toxic. The current clinical chemotherapy fails when cancer cells become resistant or metastasize or when adverse effect impair the quality of life of patients. Hence, treatments with enhanced biocompatibility for increased tolerability and improved patient outcomes are needed. Here, we examine the anticancer potential of natural linseed polyol-based nanogel (NG) in OC. The viability of healthy human ovarian surface epithelial cells (HOSEpic) and human ovarian cancer cell line (SKOV3) was tested via XTT assay at linseed polyol concentrations of 0.02-0.08%, resulting in higher viability of healthy cells (>70% compared to control) while simultaneously impairing the survival of cancer cells (>30% decrease). Moreover, apoptotic cell death was significantly enhanced in polyol-treated cancer cells, with more than three times the function in healthy human ovarian microvascular endothelial cells (HOMEC) at concentrations between 0.004 and 0.016% polyol. NG treatment of healthy cells resulted in over 55% higher viability at 10 and 100 µg/mL NG, whereas viability of SKOV3 cells was lowered at 100 µg/mL NG. Additionally, treatment with the NG reduced macrophage-secreted pro-inflammatory cytokines- TNF-a, IFN-g, and IL-8, which have been shown to promote malignant cell growth in the tumor microenvironment. Polyol and NG treatments reduced cell transmigration as observed in wound healing assays. In conclusion, this study highlights the potential use of linseed polyol and polyol-based NGs in OC as a less toxic yet potent therapy, that could mitigate the limitations of current treatments.

Keywords: ovarian cancer; linseed polyol; chitosan; nanogel; anti-inflammatory; vegetable oil; biocompatible

A Ashokan

Simultaneous Targeting of Peripheral and Brain Tumors with a Therapeutic Nanoparticle to Disrupt Metabolic Adaptability at Both Sites

A. Ashokan,[a,c] S. Sarkar,[a,c] M.Z. Kamran,[a,c] B. Surnar,[a,c] A.A. Kalathil,[a] A. Spencer,[a] and S. Dhar[a,c,d*]

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Stage IV breast cancer frequently leads to severe health impacts, especially when its metastases to the brain, creating significant treatment challenges due to the blood-brain barrier (BBB) which limits the effectiveness of traditional therapies. In response, we propose a novel treatment strategy using a specially designed nanoparticle (NP) that can target both the primary breast tumor and secondary brain tumor by crossing the BBB. This innovative approach utilizes a single NP platform engineered to deliver drugs directly to the mitochondria within tumor cells at both sites. Our nanoparticles are specifically designed to penetrate the BBB and target the hyperpolarized mitochondrial membrane, enabling direct drug delivery to both extracranial primary and intracranial secondary tumor sites. By leveraging this dual-targeting capability, our approach aims to disrupt the metabolic flexibility that cancer cells exploit to survive, specifically by inhibiting oxidative phosphorylation and glycolysis, key energy sources for tumor growth. Through a series of experiments and genomic analyses, we highlight the potential of combining a chemotherapeutic prodrug with our mitochondria-targeted NPs to significantly reduce the metabolic adaptability of both primary and metastatic tumors. This strategy not only aims to enhance treatment efficacy but also to overcome common mechanisms of chemoresistance by targeting the mitochondrial genome. Furthermore, we assess the in vivo safety of this dual-action treatment, focusing on its implications for peripheral neuropathy and neurobehavioral outcomes, ensuring a comprehensive evaluation of its therapeutic viability. Our results indicate that this combined therapeutic approach represents a promising advancement in treating stage IV breast cancer, offering a new pathway to address the complexities of treating metastatic brain tumors effectively.

Danyale Berry

Engineering extracellular vesicles of human mesenchymal stem cell aggregates in a Vertical Wheel bioreactor

Danyale Berry[1,2] (Presenter), Justice Ene[3], Sunghoon Jung[4], Yan Li[3,*], Changchun Zeng[1,2,*]

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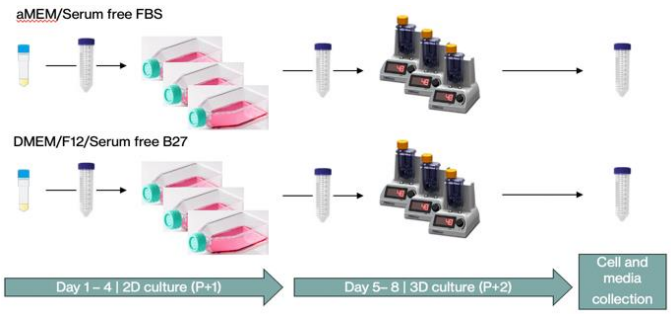
Abstract:

Background: Human Mesenchymal Stem Cells (hMSCs) have a high potential for therapeutic treatments in regenerative medicine due to the anti-inflammatory and pro-angiogenic secretome. However, due to the safety and efficacy concerns with stem cell therapy, cell-free therapy utilizing hMSC-derived extracellular vesicles (EVs) has been a promising approach to treatments of various neurological disorders. However, low yield production limits EVs in clinical applications. Through the utilization of the PBS Vertical-Wheel bioreactor (VWBR), the influence of biochemical cues and shear stress on the secretion of EVs and cargo expression toward nerve regeneration and neuropathic treatment. This project aims to advance the knowledge of dynamic aggregation and metabolic influence on EV production, and fundamentally improve the preconditioned techniques used to promote hMSC secretome production.

Methods: EVs secreted by undifferentiated hMSCs as 3D aggregates in VWBRs were investigated. Two types of EV collection media, αMEM/Fetal Bovine Serum (FBS) and DMEM/F12/Serum-free B27, exposed to three speeds of the bioreactor, at 25, 40, and 64 rpm, for three days were compared. The hMSCs were characterized by metabolite analysis and gene expression, focusing on EV ESCRT machinery markers. The isolated hMSC-EVs were characterized by nanoparticle tracking analysis and Western blot, necessary to identify EV biogenesis markers. In vitro analyses of cellular proliferation were also conducted.

Results: hMSCs exposed to 64 rpm within the VWBR, reflected the highest EV biogenesis and glycolytic gene expression compared to 25 rpm and 40 rpm. The cell number decreased within all three conditions over the course of the experiments due to typical behavior of hMSC 3D aggregates without the assistance of microcarriers. Once isolated, EV concentration increased with high agitation speed when exposed to αMEM, however the concentration decreased with higher agitation speed withing DMEM media. EV size consistently decreased with increased agitation speed within all culture conditions.



Conclusions: hMSCs cultured as 3D aggregates within the VWBR at 64 rpm, exposed to αMEM media effectively produced a much higher yield of EVs compared to DMEM media and lower agitation speed. The system of increased yield and subsequentially, enhanced capability of the generated EVs, promotes clinical applications of hMSC-EVs toward regenerative medicine.

References:

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Raviteja Bulusu

Characterization and evaluation of modified 5-Fluorouracil loaded liposomal nanoparticle on pancreatic and colorectal cancer cell lines

Raviteja Bulusu[1], Joy Okoro[1], Esther Frimpong[1], Sherise Rogers[2], Bo Han[3], Xue Zhu[1], Edward Agyare[1]

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[2]Department of Medicine, Division of Haematology and Oncology, University of Florida College of Medicine, Gainesville, Florida
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The **purpose** of the study is to characterize modified 5-FU (MFU) and investigate its anticancer activity in liposomal nanoparticles (MFU-Lnps) against colorectal and pancreatic cancer cell lines.
Methods: The synthesized MFU was characterized by NMR and elemental analysis and formulated as MFU-Lnps. The *in-vitro* studies were performed on 2D and 3D models of HCT-116 and MiaPaCa-2 cell lines. Cellular uptake of rhodamine (Rho) alone or Rho-linked-Lnps (Rho-Lnp) was determined by confocal fluorescence microscopy. *In-vitro* release of MFU from MFU-Lnps was performed using PBS and methanol (3:1) at 37° C under sink conditions. **Results:** The 1H NMR peaks at 1.02 ppm (-C-N on 2') and 1.04 ppm (-C-N on 2"), represent the amine bond between 4-NH_2 group of 5-FU and tetrahydrofuran acetate. This confirmed that the MFU was successfully synthesized. The elemental analysis of MFU showed 99.5% purity by comparing observed and theoretical values (Observed: carbon (C) = 53.57 %, hydrogen (H)= 5.64 %, and nitrogen (N) =10.44 % and, theoretical: C=53.33%, H=5.59%, and N=10.37 %). The MFU-Lnps hydrodynamic diameter was 124.9 ± 3.2 nm, polydispersity was found to be 0.16 ± 0.005, while entrapment efficiency and zeta potential values were 97.2% and -30.3 ± 12 mV, respectively. The MFU treated-2D and 3D MiaPaCa-2 cultures (IC_{50} values: 3.9 ± 0.9 μM_{2D} and 6.7±1.1μM_{3D}) was more effective than 5-FU-treated 2D and 3D MiaPaCa-2 cultures (IC_{50} values: 5.4 ± 0.8 μM_{2D} and 8.5 ± 1.0 μM_{3D}). However, MFU-Lnps treated-MiaPaCa-2 3D-organoid was 4-fold more effective compared with MFU (IC_{50} values: 9.8 ± 1.4 $\mu M_{MFU\text{-}Lnps}$ versus 42.3 ± 2.9 μM_{MFU}). A similar high cytotoxicity effect of MFU-Lnp was observed when MFU-Lnp (IC_{50} values: 2.0 ± 0.7 μM_{2D} and 3.4 ±0.8 μM_{3D}) was exposed to HCT-116 2D and 3D cultures compared to MFU (3.1± 0.8μM_{2D} and 6.8 ± 0.9 μM_{3D}). For cellular uptake, we observed an increase in the uptake of Rho-linked-Lnps compared with Rho alone. The MFU release MFU-Lnps exhibited Higuchi release kinetics model based on the coefficient of determination (R^2). **In conclusion**, we have demonstrated that MFU-Lnps improves the anticancer efficacy of 5-FU and Lnps delivery system may improve PK parameters and increases the biodistribution of 5-FU.

Sawyer Chang

Pragmatic synthesis of loaded tea-derived polymer-polyphenol particles

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Teas brewed from the leaves of *Camellia sinensis* harbor a plentiful dose of polyphenols which account for much of the taste and color of black, green, white, oolong, and pu'er tea. These polyphenols are reported to also be the key factor for the antioxidant qualities that are heralded as one of the main health components of these teas. The structure of these polyphenols allows for loading of compatible molecules in many nanoparticle systems. In this work, a polymeric particle loaded with these polyphenols was formulated and aims to shield loaded active ingredients that can degrade in the harsh physiological environment of the human digestive tract. The particles were characterized by dynamic light scattering and zeta potential (DLS/Zeta) while the loading was quantified via liquid chromatography mass spectroscopy (LC-MS). The ability to load a wide range of molecules allowed for the formulation of a health-based formula and an energy-based formula. This health-based formula is focused on the nutritional needs for expectant mothers including folate and minerals. The energy-based formula is based on energy drinks that aim to provide caffeine and taurine for increased performance. These findings can potentially create a simple alternative to nutrient and even drug delivery simply by the steeping of tea.

Trisha Chapagain

Characterization of Exosomes Involved in Vascular Calcification Using Multifunctional Nanopipettes

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Abstract

Chronic kidney disease (CKD) can lead to early cardiovascular disease, which is the leading cause of death in the world. The high phosphate imbalance present in CKD accelerates calcification nucleation in exosomes. These exosomes, in turn, nucleate pathological calcification in the arterial wall. In CKD, the stretching of the vascular smooth muscle cells (VSMCs) due to hypertension may lead to a higher number of exosomes being secreted from the cells, accelerating cardiovascular calcification. The objective of this study is to use multifunctional nanopipettes, a novel biophysical technique, to compare and characterize exosomes secreted from mechanically stretched vs. unstretched VSMCs. The multifunctional nanopipettes, fabricated by pulling quartz theta capillary tubes with a laser pipette puller, consist of a nanopore and a carbon nanoelectrode containing a pyrolytic carbon deposit. The exosomes are loaded inside the nanopore barrel and driven out with an electric potential, allowing for the nanopore to detect the size and quantity of the exosomes while the carbon nanoelectrode is able to detect its charge. This procedure is conducted for both stretched and unstretched VSMC exosomes. Compared to the exosomes collected from the unstretched VSMCs, exosomes from the stretched VSMCs exhibit a higher frequency of signals collected by the nanopipette. They also exhibit a greater charge than their counterparts. This suggests that the stretching of vascular smooth muscle cells leads to a direct increase in secreted exosomes and plays a great role in the calcification of the arterial wall.

This study was supported by a grant from the Florida Heart Research Foundation (to TC).

Harshita Chitturi

Engineering Adeno Associated Virus (AAV) mediated SiglecE Gene delivery vector for Immunomodulatory Therapies

Harshita Chitturi; Priyanka Lakhimsetti; Mownika Vepati; Arusmita Souvangini; Alekhya Ponnam; Jai Patel; Joao Silva Correia; Kirollos Armosh; Manas R. Biswal.

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Abstract: Age-related macular degeneration (AMD) remains to be the primary cause of vision loss in the elderly due to its complex etiology and limited therapeutic choices. The advancements in gene therapy offer a promising avenue for addressing this issue. In this study, we developed an adeno-associated virus (AAV) gene therapy vector expressing Siglec E, an immunoglobulin-like lectin that regulates immune responses in retinal degenerative processes. The AAV vector is capable of efficiently delivering the Siglec E gene into retinal cells. AAV vectors are chosen for their low immunogenicity, stability, and ability to target retinal cells. Siglec E gene in this vector contains a FLAG epitope tag, a common epitope tag fused to the protein. The successful expression of Siglec E in the transfected cells was confirmed by western Blot analysis, suggesting that the AAV vector was able to successfully introduce the gene into target cells. A cytokine array analysis will be used to assess Siglec E expression's anti-inflammatory effects in the retinal environment. This method provides information about the cytokine profile changes driven on by Siglec E expression by enabling the simultaneous detection of several cytokines. These data will be instrumental in assessing the vector's capacity to modulate the inflammatory pathways involved in AMD. Furthermore, to assess the variations in gene expression in treated retinal cells, real-time PCR (RT-PCR) studies will be carried out. The successful development and validation of AAV-Siglec E vector could be a major step forward for AMD treatment. This gene therapy strategy offers hope for better treatment techniques for AMD and possibly other ocular inflammatory disorders by focusing on the inflammatory part of the illness and potentially addressing a crucial feature of AMD etiology.

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Josep-Ramon Codina

Accelerating the Screening of Small Peptide Ligands by Combining Peptide-Protein Docking and Machine Learning.

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Introduction: Here we present a novel approach combining machine learning (ML) and molecular docking to accelerate small peptide ligand screening. We observe a growing importance of peptide-based therapeutics and the associated challenges in peptide-protein interaction prediction. This research leverages the computational efficiency of the Light Gradient Boosting Machine (LightGBM) algorithm to address the need for more efficient screening methodologies in the face of time-consuming traditional techniques. **Methods**: A subset of tetramers is docked and then categorized into better or worse performers. Sequence-based features for each peptide are used to train the ML algorithm. The undocked peptides are similarly processed for feature extraction and their category is predicted. A subset of peptides most likely to be better performers is chosen. These undergo a second docking to validate the selection process. **Results:** Our study evaluated eight ML methods for peptide-protein docking, using a tetrapeptide library against four viral proteins. LightGBM was the fastest, with 0.057 min processing time, compared to 0.874-1690 mins for other algorithms. Hyperparameter tuning revealed optimal groups for training and 'good binders'. Model performance was assessed across datasets, showing AUC-ROC values between 0.84-0.91. The regression approach was less accurate at extreme scores. Molecular docking followed by LightGBM outperformed conventional docking, reducing the time by up to a factor of 20. We tested four different targets, CHIKV, DENV, WNV, and ZIKV envelope proteins; and three docking software, Openeye, AutoDock FR, and AutoDock CrankPep. **Discussion and Conclusion:** We introduced a novel pipeline for peptide screening, significantly cutting time by at least 10-fold compared to molecular docking alone. The process involves initial docking of a small segment, followed by ML and final validation. This pipeline is adaptable to various targets, promising advancements in bioactive peptide screening and the development of diagnostics and therapeutics.

Melissa M. Deinys

"Nanoformulation-based Intervention for Mitigating Pestalotiopsis spp. in Mangrove Die-off: A Sustainable Approach for Ecosystem Conservation"

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Pestalotiopsis spp., a fungal pathogen, presents a significant menace to mangrove ecosystems by inducing diseases such as leaf blight and dieback in mangrove trees which are critical for marine life support and coastal environment preservation. Isolating Pestalotiopsis spp. from Red Mangrove leaves as part of a parallel study on mangrove die-off in Florida, this threat can be addressed through a sustainable solution. Our strategy entails MagSuN, a nanoformulation integrating Sodium Polysulfide (NaPs) and Magnesium hydroxide nanoparticles (MgSoL), including optimized versions of MgSoL particles to enhance efficacy. This new step likely regulates the size, shape, and surface properties of these nanoparticles, heightening crystallinity and morphological adjustments to augment reactivity and stability, thus improving MgSoL's efficacy against Pestalotiopsis spp. In our mycelium growth assays, we observed growth inhibition of up to 95% with thermally treated MagSuN at varying concentrations compared to the untreated control. Furthermore, poison food assays employing MagSuN induced pathogen stress, resulting in up to an 87% reduction in fungal growth. Preliminary studies on seed treatments reveal promising results, with seeds soaked in our material exhibiting pathogenic fungal inhibition. These study findings hold promising implications for advancing innovative and eco-friendly strategies to combat the proliferation of environmental pathogens, offering potential applications in environmental science and agriculture.

Madisen R. Domayer

Co-assembled Peptide-Protein Granules for Intracellular Delivery

Madisen R. Domayer, Renjie Liu, Gregory A. Hudalla

Intracellular delivery of proteins is attractive for accessing a wide variety of new therapeutic and diagnostic targets but is challenged by the inability of proteins to directly cross the cell membrane. Current methods for intracellular protein delivery use electroporation, carriers that facilitate protein escape from intracellular vesicles during endocytosis (i.e., endosomal escape), or highly charged peptides that mediate direct protein crossing of the cell membrane. [1]. Key challenges with these approaches include, low delivery efficiency, cytotoxicity, high protein doses protein, loss of protein activity during internalization, and the inability to work universally with various cell types (e.g., adherent and suspended).

Previous work from our lab developed a series of complementary co-assembling peptide pairs based on charges, also known as “CATCH (+/-)”. When combined in solution CATCH peptide pairs assemble into materials ranging from nanoscale granules to macroscopic hydrogels [1]. However, the mechanisms of granule assembly are largely phenomenological. To study granule assembly in more detail, we used the inverted florescent microscope to evaluate the effects of peptide type, crowders, and proteins on the formation of the granules over a 24-h period. Experiments were also conducted to test toxicity of granules toward 3T3 fibroblasts. The data shows that granule shape, size and assembly kinetics are impacted by a plethora of variables, including type and concentration of peptide and crowder, and can therefore be controlled. In general, granules were not cytotoxic toward 3T3 fibroblasts, suggesting their potential as vehicles for protein or cell delivery.

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Selin Donmez

Enhanced Stability and Improved PLQY of Organic-Inorganic Perovskite Nanocrystals Using Poly-Zwitterionic Ligands

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Perovskite nanocrystals, comprising organic-inorganic cores, referred to as hybrid PNCs, utilize organic cations alongside Pb^{2+} and halide ions. Primarily utilized in solar cells and LEDs, these PNCs face challenges such as lower colloidal stability and higher moisture sensitivity compared to their all-inorganic counterparts, limiting further research and stability improvement. Additionally, the room temperature synthesis method often results in mixed sizes and morphologies, impeding their further development. Our focus is on preparing methylammonium lead halide PNCs ($MAPbX_3$) using the LARP method and testing the effects of employing c-betaine ligands to passivate $MAPbBr_3$ NCs. Spectra analysis revealed heterogeneous size and/or shape distributions in native NC solutions. Introducing the ligand into the system homogenized NC dispersion, leading to a single NC population with consistent size and shape, altering absorption and photoluminescence profiles. We also observed a pronounced increase in the concentration of fluorescent species in the sample after the introduction of c-betaine ligand, slightly shifting and narrowing the photoluminescence profile, and maintaining colloidal stability and high PL quantum yields for up to 8 weeks. Our methodology, compared with existing theories on nanocrystal growth, explores whether the polyzwitterion ligand can provide the controlled growth of cubic-shaped hybrid PNCs.

Narjes Dridi

Tailoring Protein Corona Formation on AuNPs Through Surface Ligand Engineering

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Abstract

The synthesis of colloidal nanomaterials with distinctive photophysical characteristics has sparked significant interest in their integration into biomedical applications. These nanomaterials offer tunable optoelectronic and magnetic properties that have propelled the development of a wide array of therapeutic and diagnostic tools. However, their utilization in medical contexts for human subjects is impeded by the formation of the protein corona, an outcome of nonspecific protein adsorption. The complexity and abundance of proteins in biological milieus pose challenges in predicting the fate of nanocrystals within the body.

In this investigation, we explore the interactions between proteins and surface-stabilized gold nanoparticles (AuNPs) at the nano-bio interface using gel electrophoretic mobility measurements, alongside UV-Vis absorption and dynamic light scattering analyses. Our findings indicate that through the engineering of surface ligands, we can modulate the adsorption of proteins onto the nanoparticles. Specifically, we observe that while small ligands such as lipoic acid (LA) or its reduced form, dihydrolipoic acid (DHLA), exhibit non-specific interactions with proteins, ligands based on polyethylene glycol and zwitterions significantly reduce such adsorption, irrespective of ligand size and charge. Moreover, we evaluate the thermodynamic aspects of corona formation and characterize the thickness and potentially the structure of the corona. This approach holds promise for broader applications beyond gold nanoparticles.

Our focus extends to the design of ligands and the evaluation of interactions of AuNPs surface-stabilized with various combinations of LA-based ligands with serum proteins. Our results indicate that both the surface chemistry and core composition of the nanocrystal can impact corona formation. These insights could pave the way for optimizing core-plus-ligand coatings for potential clinical translation in nanomedicine.

Key words: Gold nanoparticles, surface engineering, corona, serum, proteins, thermodynamics.

Poster presentation requested: I would like to give a poster presentation for this abstract.

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Anatasia Estephan

Potential of CBD and Nano-CBD as adjunct therapy for Epilepsy

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Abstract

Cannabinoid (CBD), also known as medical marijuana, has been FDA-approved as adjunctive therapy for the treatment of different types of epileptic seizures including Lennox-Gastaut syndrome and Dravet syndrome in patients 1 years and older. However, a majority of commercially available CBD products contain varying levels of psychoactive tetrahydrocannabinol (THC), which often results in increased myocardial oxygen demand, elevated supine blood pressure, and tachycardia. In addition, as compared with smoking tobacco, vaping CBD is associated with increased concentration of carboxyhemoglobin and tar in the blood that could lead to cardiac arrythmia, seizure, and coma. We therefore conducted a comprehensive literature review of the potential usage of purified CBD or nano formulations of CBD as adjunctive therapy in patients with epilepsy. We reviewed three epileptic clinical trials with total of 1204 patients wherein purified oral CBD was used as an adjunct therapy for the treatment and safety evaluation. The results show a significant reduction in seizure frequency and duration in CBD adjunct group versus placebo. Also, purified CBD adjunct therapy was found to be a safe treatment. Further, review of research on different oral CBD formulations including lipid nano emulsion, nanogels, and oil-based formulations shows that CBD nano formulations significantly increase solubility and bioavailability of CBD. In conclusion, our comprehensive review shows that pure CBD nano formulations when used in conjunction with standard of care treatments can significantly increase efficacy and improve safety of these epilepsy treatments.

Omair Faqah

Title: Rapid Testing Platform for HIV Detection

Authors:

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Abstract:

Human immunodeficiency virus (HIV) has affected 39 million people globally resulting in 630, 000 AIDS-related deaths in 2022. Being a public health issue for more than 40 years, the development of a scalable rapid-testing platform is of paramount importance to achieve the UNAIDS' target of 95% of all people living with HIV to know their status by 2025. This ambitious goal is hindered by current testing methods that are expensive, time-consuming, and less accessible which is a problem for low-resource settings. To address this critical gap, a low-cost, rapid testing platform that can accurately detect HIV in carriers is needed to link patients to appropriate care and effectively control the spread of the virus to improve public health. We present an automated Reverse Transcription Loop-mediated isothermal Amplification (RT-LAMP) based diagnostic platform for HIV detection. Our device features the use of a microfluidic chip and low-powered microheaters on a fully automated magnetic actuation platform. The microfluidic chip encompasses an all-in-one design that performs plasma extraction, sample processing, and RT-LAMP-based colorimetric analysis of the sample. Leveraging the advantages of Nucleic Acid Tests (NATs) allows us to reduce the window period of detection to as early as one week post-exposure. We have developed custom LAMP primers that make the test highly specific while being able to detect the common subtypes found in North America including subtype B. Our initial testing with the plasmid pNL4-3 has shown a limit of detection of 30 viral copies per reaction in 45 minutes. Our wax-based valves in the microfluidic chip allow the passive loading of reagents which makes it a sample in-answer-out device. The simplicity of operation positions our device as a pivotal tool in the global strategy to achieve public health objectives in mitigating the impact of the HIV epidemic.

Kenneth Fluker, Jr.

Aluminum Sacrificial Layer Integration in Tissue-Engineered Electronic Nerve Interfaces

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Tissue response and device degradation can cause a significant reduction in the performance of microelectrode-based devices implanted into neural tissue. Reducing the thickness and width of implants can pose significant handleability challenges and reduce long-term reliability. In this work, we report on our efforts to reduce the thickness and width of tissue-engineered electronic nerve interfaces (TEENI) by 4X (i.e., from 10 µm to 2.5 µm) and 3X (i.e., 80 µm to 32 µm, respectively, without compromising their handleability, which is critical during the integration of microfabricated polymer-metal electrode arrays into the hydrogel-based tissue-engineered scaffolds of the TEENI device. To maintain handleability, we thinned the portion of the microfabricated poly-metal component that is located inside the scaffold, maintained full thickness elsewhere, and added full-thickness support rails around the thinned region. To assess long-term reliability, we used a reactive-accelerated-aging (RAA) soak test that includes H_2O_2. Soak tests were performed at 67°C in 0.1 M phosphate-buffered saline with a maintained concentration of 10 to 20 mM H_2O_2. Electrochemical impedance spectra were captured longitudinally over several days. To focus efforts to achieve longer-lasting devices, future work is needed to study the relationship between changes in impedance and structural changes in the device.

Esther Frimpong

Biological evaluation of novel stearoyl gemcitabine nanoparticles in primary pancreatic cancer cells and PDX mice tumor models

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Background: This study aimed to improve the systemic stability and enhance the anticancer activity of gemcitabine (Gem) by modifying Gem with stearic acid to form 4-N-stearoylGem (4NSG). The 4NSG compound was formulated into solid lipid nanoparticles and tested against patient-derived pancreatic cancer (PCa) cell lines and patient-derived xenograft (PDX) mice bearing subcutaneous tumors.

Methods: Gem was modified by linking the 4-amino group of Gem and stearoyl acyl derivative to form 4-(N)-stearoyl-gemcitabine (4NSG). 4NSG was characterized using high-performance liquid chromatography (HPLC), nuclear magnetic resonance (NMR), and elemental analysis. 4NSG was developed into solid lipid nanoparticles (4NSG-SLN) and characterized using a particle size analyzer. Patient-derived primary PCa cells (PPCL-46 and PPCL-68) were treated with GemHCl and 4NSG-SLN. Cytotoxicity, cell migration, and cell-cycle studies were performed to determine the effectiveness of 4NSG-SLN against primary PCa cell lines. We performed antitumor efficacy testing using GemHCl and 4NSG-SLN in PDX mice bearing subcutaneous pancreatic tumors.

Results: Analysis of the H-NMR spectra displayed an amide bond at 10.88 ppm, confirming the conjugated bond between the 4-amino group of Gem and stearic acid. The purity of 4NSG was 99.8%. The hydrodynamic diameter (particle size) of 4NSG-SLN was 82±2.3nm, while the blank nanoparticle (SLN) was found to be 35 ± 4.3 nm. The half-maximal inhibitory concentration of 4NSG-SLN-treated PPCL-46 (IC_{50} =12 ± 2.1µM) and PPCL-68 cultures (IC_{50} =22 ± 2.6µM) showed higher cytotoxic activity compared with GemHCl-treated PPCL-46 and PPCL-68 cultures respectively (IC_{50} = 56 ± 2.4 µM, IC_{50} = 57 ± 1.5 µM, p-value: $p<0.001$). Our migration study showed 4NSG-SLN treated PPCL-46 cells at 5µM concentrations significantly reduced cell mobility towards the wound area with (28 ± 3.5) number of cells migrated compared to GemHCl treatment which showed (120 ± 3.8). The cell-cycle analysis showed that 4NSG-SLN treated PPCL-46 cells at 5µM concentration had a higher G1 population (78.25%) than GemHCl (72.75%). 4NSG-SLN may have triggered apoptosis in PPCL-46 cells (2.45%) at 20µM in the S and G2/M phases compared to GemHCl treatments, which showed a higher cell population of (9.54%).4NSG-SLN treated PDX mice exhibited a two-fold decrease in tumor growth compared to GemHCl-treated PDX mice bearing tumors.

Conclusion: This study reveals that 4NSG-SLNs may potentially prolong Gem's systemic circulation, increase its bioavailability, and, most importantly, enhance the therapeutic efficacy of Gem in the treatment of PCa.

Ryan Green

Use of Cannabidiol to Improve Lung Cancer Treatment and Quality of Life

Ryan Green, Jared Belkin, Sashank Bikkasani, Subhra Mohapatra, Shyam Mohapatra

Abstract:

There is currently a growing interest in the use of cannabidiol (CBD) to alleviate the symptoms caused by cancer, including pain, sleep disruption, and anxiety. CBD is often self-administered as an over-the-counter supplement, and patients have reported benefits from its use. Clinical trials of CBD to treat cancer pain have thus far yielded mixed results and optimal treatment of individual cancer types with CBD along with optimal combinations of CBD plus specific cancer therapies and the extent to which CBD can alleviate therapy induced toxicities are still not known. Additionally, despite the progress made, the molecular mechanisms underlying CBD's anti-cancer activity remain unclear. Herein, we provide an analysis of transcriptomic gene expression data to elucidate anti-cancer mechanisms of CBD and screening of drug combinations with CBD to identify novel synergistic anti-cancer activity and mechanisms. We aim to exploit this synergy to improve lung cancer rehabilitation and patient quality-of-life by reducing pain, anxiety, and tumor growth while also improving physical disabilities such as loss of mobility, stamina, or pain which can be caused both by lung tumors and by chemotherapy toxicity. We use behavioral models of lung cancer in mice to determine the effectiveness of CBD combination treatments for pain and physical disabilities. Our results show that CBD combination therapies have synergistic anti-tumor effectiveness with specific targeted therapies in models of lung cancer and that pain, anxiety, and mobility impairments due to both cancer and chemotherapy toxicity can be successfully reduced in mice. In future studies we will aim to create nano formulations of these combination therapies for enhanced delivery to lung tumors.

Ahmed R. Hegazy

Wafer-scale development, characterization, and high temperature stabilization of epitaxial Cr_2O_3 films grown on Ru(0001)

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Abstract

This work is the first demonstration of epitaxial formation of Cr_2O_3(0001) films (1.5 – 20 nm thick) on Ru(0001), where conditions suitable for wafer-scale growth are shown. Optimized growth was achieved by reactive oxidation sputtering of Cr within a 4 mTorr Ar/O2 20% ambient at Ru temperatures ranging from 450 – 600 °C. Low-energy electron diffraction (LEED) shows that the Cr_2O_3 film adopts a 30° rotated honeycomb configuration with respect to the underlying Ru(0001) substrate, and exhibits a hexagonal lattice parameter consistent with that for bulk Cr_2O_3(0001). Further investigation by x-ray photoelectron spectroscopy (XPS) showed that heating to 700 °C within the same environment during film preparation leads to Ru oxidation, while exposure to temperatures at or above 400 °C in vacuum, Ar, or Ar/H2 3% leads to chromia film degradation. Subtle effects pertinent to these ambients were investigated by XPS for annealed vs. unannealed films of Cr_2O_3(0001)/Ru(0001) and Ru(0001)/Cr_2O_3(0001)/ Ru(0001). This work will provide others with an approach to further exploring structurally-controlled, oxide-support interactions of potential high importance to works of chemical catalysis, corrosion passivation and metallic interconnect applications.

Stephanie Herrera

Supramolecular peptide-protein granule system for intracellular co-delivery of proteins.

Stephanie Herrera, Renjie Liu, Madisen Domayer, Alex Adolphson, Gregory A. Hudalla

Biomedical Engineering Department, University of Florida

The ability to deliver active proteins across the cell membrane and into the cytosol would provide access to druggable targets that are not available within the extracellular environment. However, due to their large size, charge, and hydrophilicity, proteins do not efficiently cross the cell membrane to enter the cytosol on their own. Here we will present the development of supramolecular peptide-protein granules for intracellular protein delivery. This approach utilizes charge-complementary molecules known as, "CATCH(+) peptides" and "CATCH(-) fusion proteins". Alone, CATCH(-) and CATCH(+) remain in the soluble state, but combined form b-sheet fibrils. After introducing a crowder to the mixture, such as polyethylene glycol (PEG), Tween-80 micelles, or excess CATCH(+) peptide, 100-200 nm "CATCH(+/-) granules" are formed at peptide concentrations ~10-fold lower than the critical fibrillization limit in dilute conditions (~200 mM). CATCH(+/-) granules are rapidly internalized by various adherent and suspended mammalian cell types including fibroblasts, HEK293, T cells, dendritic cells, monocytes, and neutrophils. Using CATCH-GFP as a model protein, more than 90% of granule-treated cells possess active protein within 60 minutes without significant cell death. CATCH(+/-) granule internalization demonstrates greater delivery efficiency and lower cell death than other state-of-the-art methods, such as cell penetrating peptides or electroporation. Using CATCH-GFP, CATCH-mRuby, and CATCH-NanoLuc as model proteins, different CATCH-fusion proteins can be co-assembled into multicomponent granules with tunable composition. Multicomponent granules allow for co-delivery of both an "effector" (i.e., a protein that confers therapeutic function) along with a "selector", where the latter can be used to enrich the sub-population of cells that have internalized the CATCH(+/-) granule. Collectively, these data establish CATCH(+/-) granules as a simple and flexible nanomaterial platform for cell engineering via intracellular protein delivery.

Robert Huber

Probing the Surface States of SmB_6 Through Planar Tunneling Using Second Harmonic Detection Techniques

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Samarium hexaboride (SmB6), a candidate topological Kondo insulator (TKI), has proven itself to be a rich physical system associated with a vast array of complex physics. Below 4 K, the conductivity is dominated by surface states that appear to be topologically protected. Previous work has shown that these surface states do not span the entire gap region (as they do in conventional TIs such as Bi2Se3) [1] and display a sensitivity to Samarium deficiency [2], suggesting their topological protection is incomplete. To better understand the nature of these conducting surface states, we apply second harmonic detection techniques to planar tunnel junctions made on SmB6 single crystals, providing a higher energy resolution and cleaner spectra than planar tunneling conductance. We discuss an antisymmetric signature at ±1 meV in the second harmonic spectra that appears with the low-temperature formation of conducting surface states in the context of muon spin rotation studies [3] which correlate this low energy signature to bulk antiferromagnetic excitations.

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Paromita Islam

VEGF-loaded chitosan nanoparticles embedded in collagen hydrogel for vascular tissue regeneration.

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Vascular regeneration stands at the forefront of tissue engineering, addressing a diverse array of challenges ranging from vascular pathologies to impaired blood flow and tissue damage. Extensive research has focused on various hydrogels renowned for their capacity to combat infection, inflammation, and discomfort, offering a notable departure from traditional surgical interventions. Collagen and chitosan, both recognized for their tissue-regenerative properties alongside antimicrobial effects, have been extensively studied in the literature. In this study, a recombinant baculovirus expressing the VEGF-A growth factor was utilized, loaded into chitosan nanoparticles, and encapsulated within a collagen hydrogel matrix. Characterization of the chitosan nanoparticles revealed favorable attributes in terms of particle size, polydispersity, and zeta potential, indicative of their potential for effective drug delivery. The results showed that the nanoparticles exhibited a zeta potential of 12.75±2.02 mV and particle size of 185.8 nm with a polydispersity index of 0.34. Furthermore, FTIR analysis confirmed the interaction and compatibility between the components of the chitosan nanoparticles, enhancing their suitability for biomedical applications. The MTT assay elucidated the potent effects of the formulation on transduced HUVECs cells, with the highest activity of VEGF-A observed at Dose 1 (50ul), resulting in a notable 16% increase in cell proliferation. Additionally, the Chorioallantoic membrane (CAM) assay underscored the formulation's cytotoxicity profile in chick embryos, revealing accelerated embryo growth across all dosages, with the maximum effect observed at the highest formulation dosage of 500uL of VEGF-A. Collectively, these findings highlight the promising potential of VEGF-A embedded within a combination of chitosan nanoparticles and collagen hydrogel for the regeneration of vascular tissues, offering a compelling avenue for further exploration in tissue engineering and regenerative medicine applications.

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Belal Jahannia

Binarized neural networks offer substantial reductions in memory and computational requirements compared to full precision networks. However, conventional CMOS-based hardware implementations still face challenges with resilience for deployment in harsh environments like space. This paper proposes an optical XOR-based accelerator for binarized neural networks to enable low power and resilient operation. The optical logic gates rely on wavelength-specific intensity propagation rather than absolute intensity levels. This provides inherent robustness against fabrication process variations and high energy particle strikes. Simulations of an optical hardware prototype for XNOR-Net show the accelerator achieves 1.2 μs latency and 3.2 mW power. The binarized network maintained 2-4% accuracy degradation compared to the full precision baseline on MNIST and CIFAR-10. The proposed optical accelerator enables efficient and resilient deployment of binarized neural networks for harsh environment applications like spacecraft and satellites.

Shah Qasim Jan

Tailored Core-Shell Nanoparticles: Synthesis, Characterization, and Potential Applications

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Our research work focuses on the synthesis and characterization of innovative core-shell nanoparticles, integrating wide-bandgap, semi-conducting gallate spinel cores with ferrite spinel shells. This unique core-shell structure facilitates heteroepitaxy, enabling precise control over magnetic and optical properties. Additionally, such a nano-system holds promise for diverse applications in high-frequency electronics, catalysis, and biomedical/theranostics. Currently, we are optimizing the synthesis of the core component of the nanoparticles, which will be followed by the heteroepitaxial growth of the magnetic ferrite shell. Initial analysis via X-ray diffraction (XRD) and transmission electron microscopy (TEM) indicates successful synthesis of the core. Moving forward, we aim to optimize the growth of the shell with the goal of enhancing the nanoparticles properties and exploring additional characterizations techniques.

Ladan Jiracek-Sapieha

Title: Advancements in Liquid Crystal Polymer (LCP) Bonding Techniques for Biomedical Applications

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Abstract:

Liquid Crystal Polymers (LCPs) represent a class of high-performance engineering materials increasingly utilized in biomedical applications due to their exceptional mechanical strength, chemical resistance, and biocompatibility. Despite their promising properties, challenges such as oxidation-induced degradation and non-uniform bonding have limited their widespread adoption in biomedical device fabrication. In this study, we present recent advancements in LCP bonding techniques aimed at overcoming these limitations and enhancing the reliability and performance of biomedical devices. Leveraging state-of-the-art equipment, including the Dyconex Finetech tool, we intend to demonstrate precise control over temperature and pressure during the bonding process, resulting in improved bond strength, uniformity, and durability of LCP-based devices. Our investigation also explores the utilization of low melting temperature LCPs for encapsulation purposes, effectively mitigating substrate deformation and ensuring the structural integrity of the device. Through comprehensive characterization and analysis, we provide valuable insights into the optimization of LCP bonding methodologies, paving the way for the development of next-generation biomedical devices with superior performance and reliability. These findings hold significant implications for a wide range of biomedical applications, including neural interfaces, biosensors, and implantable medical devices, ultimately contributing to advancements in healthcare technology and patient care. This research underscores the importance of interdisciplinary collaboration and innovative materials engineering approaches in addressing the complex challenges associated with biomedical device development and translation into clinical practice.

Annu Joji

From breaking barriers to reaching the unreachable: Reimagining pancreatic cancer research with Carbon dots and Exosomes.

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Pancreatic ductal adenocarcinoma (PDAC) is a solid tumor with a dismal prognosis of 5% 5-year survival rate. Unlike liquid tumors which involve blood or lymphatic system, solid tumors are characterized by distinct palpable masses of tumor cells making them impenetrable. Even the last resort of surgical resection becomes a tedious task because of the tricky positioning of pancreas in human body. All this, along with the silent nature PDAC points to the urgent need for innovative solutions that can help researchers to reach the unreachable. *Carbon dots* (CDs) are a class of zero-dimensional nanoparticles (<10nm in size) known for their ability to break through formidable blockades like the blood brain barrier for the treatment of glioblastoma and alzheimer's disease. Their unique optical properties with the ability to have vibrant emissions ranging from blue, green to red and the promising biocompatibility proven with recent studies contribute to their growing supremacy in drug-delivery and bio-imaging. Our hypothesis revolves around the possibilities to penetrate the solid tumor vasculature by incorporating CDs with a biological nanocarrier like *exosomes* (EXOs). Leveraging on the properties of our recently discovered red-emissive carbon dots (RCDs) to keep track of EXOs loaded with CDs conjugated with an FDA approved drug called gemcitabine (GM) is the first step to tackle PDAC. Working with three different carbon dots of different emission wavelengths to image exosomes followed by the drug conjugated CDs loaded onto exosomes for delivery with improved efficacy will be a head start to topple solid tumors. The future of this innovative combination nanoplatform is huge demanding continued research and collaborative efforts for a better understanding.

Sailesti Joshi

Studying Interactions Between PEI-DNA Polyplexes and Polymer Surface Coatings in Different Media for Localized Transfection

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Introduction:

While nucleic acid delivery has shown much therapeutic promise, including clinical applications in cancer, vaccines and spinal muscular atrophy, typical systemic administration faces several limitations, including poor targeting efficiency and systemic clearance[1], [2]. Localized delivery of nucleic acid vectors from biomaterial surfaces can overcome many of these difficulties and increase transfection efficiencies by maintaining higher nucleic acid concentrations at the target site and controlling release kinetics[3]. This project aims to characterize the absorption and release interactions between a model polymeric nucleic acid delivery vector, polyethyleneimine (PEI), and surface coatings composed of bio-inspired and naturally derived polymers in different media with the long-term goal of developing a surface coating that enables localized nucleic acid delivery for tissue engineering and regenerative medicine applications.

Materials and Methods:

DNA-PEI polyplexes were formed via complexation of linear PEI (Mn = 20k) and plasmid DNA encoding GFP at several N:P ratios (0, 10, 20) in various media (PBS, DMEM). Resulting polyplex sizes and zeta potentials were characterized via Dynamic Light Scattering and ZetaPlus analysis. Surface coatings were formed at concentrations of 2 mg/mL and 5 mg/mL within tissue culture plates from the following polymers and polymer combinations: polydopamine (pDA); hyaluronic acid (HA); glycol chitosan (GLY-CHI); pDA + HA; and pDA + GLY-CHI. Uncoated wells (NC) were used as a control. Coatings were incubated with DNA-PEI polyplexes at various concentrations and N:P ratios and DNA loading efficiencies and release kinetics from these coatings were analyzed via the PicoGreen assay. Transfection efficiencies of these coatings were evaluated in NIH3T3 and HEK293 cells and cytotoxicity was evaluated via Live/Dead staining.

Results, Conclusions, and Discussions:

Although showing similar size ranges, DNA-PEI polyplexes formed in DMEM exhibited significantly lower zeta potentials than those formed in PBS. Naked plasmid DNA (N/P = 0) showed significantly lower surface loading efficiencies compared to DNA-PEI polyplexes at N/P ratios of 10 and 20 for both PBS and DMEM. Surprisingly, polyplex surface loading efficiency was higher for polyplexes formed in DMEM than PBS. Naked plasmid DNA showed significantly higher amounts of DNA release when deposited in PBS than in DMEM, whereas polyplexes at N/P ratios of 10 and 20 formed in DMEM showed significantly higher amounts of DNA release than those formed in PBS. Surface-based transfection often resulted in similar GFP levels as bolus transfection controls. Although not statistically significant, GC coatings generally exhibited the lowest levels of surface-based transfection and non-coated tissue culture plastic often showed higher levels. Bolus transfection on the same coatings combined with cell viability assays indicated that the observed differences in surface-based transfection were not only due to variations in DNA surface loading. Future work will focus on improving surface-based transfection efficiency and on studying the effects of coating composition on cellular polyplex uptake.

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Sailesti Joshi

Investigating How Cell Substrate Interaction Impact Therapeutic Nanoparticle Internalization

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Abstract

Therapeutic nanoparticle delivery is crucial for a variety of biomedical applications such as regenerative medicine, tissue engineering, biomedical implant coatings, cellular transfection, and cancer treatment. The delivery of therapeutic nanoparticles from substrates depends on cell-extracellular matrix (ECM) and cell-environment interactions, which have been demonstrated to influence nanoparticle internalization and transfection efficiency [1][2]. The capacity of therapeutic nanoparticles to be endocytosed into cells when delivered from a substrate depends on substrate surface properties including the mechanical properties [3]. However, the regulation of cellular responses to the mechanical properties of the substrate involves integrin binding, focal adhesion complex formation, and cytoskeleton rearrangement, which are also involved in cell-ECM interactions [2][4]. Thus, with long-term goal of developing substrate-based therapeutic nanoparticle delivery systems, including surface-based extracellular vesicle (EV) delivery systems for tissue engineering and biomedical implant applications, this study investigated the impact of cell-ECM interactions on nanoparticle internalization using ECM and ECM-mimetic surface coatings.

The effect of substrate coatings composed of Collagen I (Col I), fibronectin (FN), laminin, hyaluronic acid (HA), and poly-L-lysine (PLL) with and without 3-Aminopropyl triethoxysilane (APTES) on cellular uptake of fluorescently labeled poly (lactic-co-glycolic acid) (PLGA) nanoparticles was investigated using NIH3T3 fibroblasts, primary rat adipose-derived stem cells (ASCs), and RAW264.7 macrophages. Preliminary data suggest that fibronectin coatings resulted in both the highest adsorption onto substrates and the highest adhesion and/or proliferation of NIH3T3 and RAW264.7 cells, while HA coatings resulted in the lowest adsorption. Furthermore, substrates modified with a base layer of APTES showed improved adsorption of ECM coatings onto the substrate, leading to increased cell proliferation. Further studies will examine the effects of ECM coatings on nanoparticle internalization and endocytosis pathway as well as the effect of ECM coatings on EV surface adsorption, surface-based delivery, and cellular phenotype.

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Priyanka Lakhimsetti

TESTING CANNABINOID NANO FORMULATIONS (CANS) IN PREVENTING OXIDATIVE STRESS-INDUCED RETINAL CELL APOPTOSIS.

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Abstract: Retinal degeneration encompasses a group of progressive disorders characterized by the gradual loss of retinal cells, leading to impaired vision and blindness. Oxidative damage, which is caused by an imbalance in the generation and detoxification of reactive oxygen species (ROS) inside the retinal tissue, is a crucial element contributing to these degenerative processes. The aim of the study is to evaluate the protective effects of Cannabinoid Nano formulations (CANS) against oxidant-induced cell death. In the methodology, ARPE 19 cells were plated at 4,000 cells per well and incubated for 24 hours. The human retinal pigment epithelial cell line ARPE 19 cells play a vital part in research pertaining to vision because of their role in the retina. The cells were treated with different concentrations of Cannabinoid Nano formulations at 1:100 and 1:1000 dilutions after incubation. To mimic various biological and environmental situations of oxidative stress, the experiment used two different oxidative stressors to cause cell death: Hydroquinone and Paraquat. Hydroquinone was used at concentrations of 400µM, 600µM, 800µM, and 1000µM and Paraquat concentrations were 400µM, 700µM, 1000µM, and 2000µM. Cell viability was measured using WST-1 Assay after 24 hours at 450nm. The results demonstrated that the Cannabinoid Nano formulations at a 1:100 ratio did not significantly give any protection against oxidant-induced cell death. However, at a 1:1000 ratio, they showed a significant level of protection against Hydroquinone-induced cell death at several concentrations. In the Paraquat trials, Cannabinoid Nano formulations at both 1:100 and 1:1000 dilutions showed protection, especially at higher oxidant concentrations. These findings suggest a potential for Cannabinoid Nano formulations in protecting retinal cells from certain types of oxidative stress, with implications for treating retinal diseases characterized by oxidative damage.

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Seohui Lee

GeTe Spalling for 2D Fabrication at Centimeter Scales

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Abstract: Integrating flexible substrates with phase change materials (PCMs) represents the forefront of future technology. Our research focuses on GeTe within this framework. GeTe is grown on a large area through Chemical Vapor Deposition (CVD). However, to make a thin and flexible material, we demonstrate spalling using Ni-electroplating. The delamination process is facilitated by Thermal Release Tape (TRT), resulting in a material that showcases the unique properties of GeTe. Through using Raman spectroscopy and X-Ray Diffraction (XRD), we confirm the success of the GeTe delamination. Overall, our work centers on making thin and flexible materials in shaping the future of technology, particularly in the realm of phase change memory.

Keywords: GeTe, Chemical Vapor Deposition (CVD), Ni-electroplating, Spalling, Flexible electronic device

Peng Wang

High Performance Hydrogel Based on Aramid Nanofibers for Zn Ion Batterieseries

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Recently, aqueous zinc-ion batteries (ZIBs) have emerged as a focal point in the search for eco-friendly, safe, and cost-effective alternatives to conventional Li-ion batteries. They are recognized for their potential to serve as a promising substitute in various energy storage applications. However, their path to commercial success is hindered by significant challenges such as dendrite formation on Zn anodes, hydrogen evolution, and undesirable side reactions. Traditional approaches have mainly concentrated on anode protection and electrolyte additive design, overlooking the critical role of the separator. In this present, we introduce an innovative high-performance hydrogel separator, derived from the commercially available material Kevlar, a robust synthetic fiber known for its exceptional strength. This hydrogel, derived from aramid's formidable properties, exhibits superior tensile strength when compared to traditional glass fiber separators. Its effectiveness in mitigating Zn dendrite growth in Zn symmetric cells highlights its potential in enhancing anode protection. Furthermore, when combined with a MnO_2 cathode, the hydrogel-infused cell demonstrates outstanding electrochemical performance. Our findings pave the way for the exploration of hydrogel electrolytes based on aramid fibers, marking a significant advancement in the development of aqueous ZIBs.

Mercedes Lozano- García

Localized and sustained delivery of a chemotherapeutic drug from polymeric implants for the treatment of solid tumors

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Chemotherapy is a widely used modality in cancer treatment. However, the use of certain chemotherapeutic agents in the clinic is hindered by their poor solubility in aqueous excipients, chemical instability, and potent toxicity and adverse effects when systemically delivered. The delivery of chemotherapeutic drugs from an implantable system is promising as it can potentially overcome these challenges by providing localized and sustained drug release to improve efficacy in the tumor while minimizing side effects. To that end, we prepared an implantable and biodegradable biopolymer loaded with a model chemotherapy drug by employing a combination of 3D-printing, freeze-drying, and crosslinking techniques. The biopolymers exhibited tailored 3D-porous structures was characterized by SEM and drug loading tests confirmed the incorporation and retention of the chemotherapeutic agent within the polymeric matrix of the implants. In vitro release profile studies at 37ºC showed that the biopolymer exhibits a 3-month long sustained drug release. Animal studies were performed in mice xenografted with human colorectal carcinoma (HCT116) cells where the implant was localized in the tumor by using a minimally invasive deployment method. The studies showed effective localized and sustained delivery of chemotherapy in the tumors. Survival, weight loss and tumor growth reduction (monitored by IVIS and ultrasound) revealed significant differences between non-treated and mice implanted with our biopolymer, demonstrating up to 80% tumor growth inhibition rate without observable systemic toxicities ($N=15$, $p<0.001$). We believe that the localized and sustained release of the drug can improve therapeutic outcomes by placing the biopolymer nearby or into the tumor and targeting the pharmacological effect to the desired location. Our polymeric implants are versatile in that they can be tailored to deliver other cytotoxic drugs for the treatment of other types of solid tumors.

Samaiyah Mason

Title: Fabrication and Characterization of High-Weight Percent Carbon Nanotube-Polyethylene Composites

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Abstract I:

Polymer-based nanocomposites are among the most popular nanocomposites and have been investigated with the use of different polymers, fillers, and methods. According to reports, the market for polymer nanocomposite for industrial applications is expected to be worth approximately 27 billion dollars (USD) by 2028. Polymer nanocomposite research aims to maximize the "nano-effect" from the nanoparticles while minimizing the polymer's drawbacks by incorporating nanoparticles into polymeric matrices. One synthetic polymer with remarkable tensile and processing properties is high-density polyethylene, more commonly known as HDPE. Inadequate performance limits the use of HDPE in various applications, despite its attractiveness and low cost. The addition of nanofillers to HDPE could enhance its processing and physical qualities. Carbon nanotubes (CNTs) are widely recognized in the scientific community for their remarkable thermal, mechanical, electrical, and optical properties. These attributes have propelled CNTs to the forefront of the nanomaterials and composites field, where they have found several practical uses. Increasing interest in incorporating CNTs into polymer matrices has prompted efforts to make CNT/polymer nanocomposites. It is demonstrated that the composite strength is enhanced by increasing the weight ratio of CNTs. However, the increase of mechanical properties is hindered when the amount of CNTs in the composites is higher than 10 wt% because of CNT aggregation during the fabrication processes. This work developed a new process to construct a uniform CNT/polymer nanocomposite with desirable CNT weight percent without aggregation and investigated the effect of CNTs in the composite when CNTs content is varied from 1 wt% to 50 wt%. The CNT/PE nanocomposites were prepared via filtration and hot press processes. The influence of process parameters including hot-press temperature and pressure was investigated. The experimental, statistical, and analytical investigations of the thermal, mechanical, electrical, and CT characteristics of CNT/PE composites (CP) were evaluated via TGA, DSC, SEM, CT, and various other methods. The detailed results will be presented and discussed in the conference.

Karthick Mayilsamy

Novel Nano-gene therapy targeting tau accumulation in brain caused by SARS-CoV-2 infection

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Abstract: The SARS-CoV-2 (CoV2) pandemic has left large numbers (>100 million) of Americans suffering from post-acute sequelae of CoV2 (PASC, or long-COVID). A majority of PASC patients report ongoing neurological sequelae known as neuro-COVID. Specifically, the role of CoV2 infection-triggered changes in the brain that increase the risk of neurologic disorders, such as tauopathy remains unclear. *We hypothesize that heightened inflammatory response in the brain due to severe SARS-CoV-2 infection drives the early onset of tauopathy leading to dementia.* Our gene expression studies with the SARS-CoV-2 infected brains led to the identification of a hub gene Fkbp5 that is linked to microtubule-associated protein tau (MAPT) expression, which is key to tauopathy. The Fkbp5 gene encodes for FK506-binding protein 51 (FKBP51) protein. FKBP51 and Heat shock protein 90 (Hsp90) synergize to induce tau hyperphosphorylation and tau oligomerization promoting tau accumulation in the brain. Gene silencing by shRNA is a powerful RNAi strategy that offers a safe, target-specific attenuation of protein expression. However, the efficacy of the gene therapy depends on the successful delivery of the gene to the target site. Hence we developed a novel nano-gene-delivery platform using dendrimers complexed with plasmids encoded with shRNA. We treated (intranasally) SARS CoV2 Mouse Adapted 10 infected C57BL6 mice with dendriplexes (DPX) comprising PAMAM dendrimers (polyamindoamines) and plasmids encoding 4 different shRNAs targeting Fkbp5 (pshFkbp5) as the payload. The downregulation of Fkbp5 expression significantly reduced GFAP expression and IBA1 expression in the olfactory bulb, cortex, and hippocampus of pshFkbp5 DPX treated mice when compared to the infection group. Pathological evidence also revealed that pshFkbp5 DPX treatment significantly reduced tau phosphorylation (pTauT231) and oligomerization (Tau T22) in the olfactory bulb, cortex, and hippocampus when compared to the infection-only or pshScr DPX group. Currently, we focus on understanding the long-term neurological sequelae of CoV-2 infection in a PS19 transgenic mouse model that expresses a mutant form of human MAPT. In summary, our approach has the potential to ameliorate the SARS-CoV-2 infection-induced abnormal tau accumulation using the novel nano-gene-delivery of pshFkbp5 nanodendriplexes to the brain.

Key Words

COVID-19, SARS-CoV-2, Alzheimer's disease, FKBP51, Tau, Nanodendriplexes.

Kyle Meerbott

Insights into Catalytic Short Peptides: Key Reactive Residues

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Biological proteins perform many complex functions due to the versatility and side chain diversity of amino acids. The variety of amino acid residues gives rise to many interactions both intramolecularly and with substrates. Subtle differences in amino acid composition affect the tertiary structure of proteins, which in turn enable them to perform their specific functions whether enzymatic or otherwise. If the tertiary structure of these proteins is compromised (*e.g.*, denatured due to solution conditions), their innate functionality can be destroyed. To this end, proteins are exceptionally efficient at their given function in their specific biological conditions, but rendered inactive outside of those conditions. Some peptides, or short proteins of relatively fewer amino acids in length, rely less on tertiary structure for functionality, exhibiting more random conformations that can maintain functionality. For example, dodecapeptides were discovered through bacterial phage display that exhibited catalytic reactivity towards amide and ester hydrolysis. For instance, the CPN3 sequence (SEQ) was shown to have the highest rate constant for catalyzing the ester hydrolysis reaction; however, the mechanism of how it functions was not explored. In our study, the CPN3 was investigated for its catalytic reactivity towards a model ester hydrolysis reaction. Factors that were identified to affect the catalytic capabilities were explored such as solution environment and substrate type. Mutation studies were also performed which provided insight into the primary reactive residues responsible for the catalytic behavior. In the increasing interest of using biocatalysts for greener industrial applications, the understanding of how such peptides perform their catalytic functions is an important step toward greater synthetic biocatalysts.

Lucas Melgar

TITLE: Peptide-hydrogel properties influence the development of anti-drug antibody against immobilized biopharmaceuticals

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Biomaterial approaches for biopharmaceutical delivery can directly address first-pass challenges including targeting to disease site and extending half-life. However, prolonged drug exposure time also increases the likelihood of emergence of anti-drug antibodies (ADAs) against the foreign biological molecule, compromising its therapeutic effects. We have developed a hydrogel platform for protein immobilization based on pairs of cationic and anionic peptides that co-assemble into supramolecular fibrils known as "CATCH(X+/Y-)". Changing the number (X,Y = 2, 4, or 6) or identity (X = K/R; Y = D/E) leads to changes in CATCH(X+/Y-) stiffness and structure. CATCH(+/-) hydrogels are injectable and retained at subcutaneous injection sites for more than 2 weeks with weak, rapidly resolving inflammation. Using a subcutaneous repeated injection model to deliver a therapeutic enzyme, we show that ADA development depends on CATCH(X+/Y-) material properties and formulation conditions. In contrast with similar systems, increased ADA was not associated with a particular CATCH(X+/Y-) hydrogel charge state; instead, net neutral pairs were more immunogenic than net cationic or anionic pairs. Increased stiffness of CATCH(X+/Y-) hydrogels also correlated to higher antibody titers than did softer gels, irrespective of overall charge. CATCH(X+/Y-) in a free-flowing "sol state" nanofiber formulation resulted in lower antibody titers compared to the hydrogel state, although, this was accompanied by a decreased residence time at ~7 days. CATCH(6K+/6D-) mixtures formed unique spherulitic structures in the sol state (i.e., "microspheres"), which had increased residence time on par with that of the hydrogel state. CATCH(6K+/6D-) microspheres showed the lowest ADA titers even with this increased residence time. Collectively, these data demonstrate that antibody development against an immobilized enzyme is highly dependent on the characteristics of the CATCH(X+/Y-) carrier including its charge, stiffness, residence time, and architecture, which can be ultimately tuned to increase pharmacokinetics of the biopharmaceutical without negative impacts on immunogenicity.

Umar Mohammad

Enhanced stability of Curcumin-borate complexes through nanoparticle loading

Polyphenols have been widely studied for their antitumor, antimicrobial, antioxidant, and anti-inflammatory properties. In recent years, Curcumin specifically has gathered a lot of attention in the medical area as a treatment for several diseases. Nevertheless, Curcumin possesses low bioavailability due to its poor water solubility and hydrolysis. Although many nanoparticle systems have been developed to overcome this challenge, several Curcumin-derived molecules remain unexplored. For instance, Curcumin-borate complexes (CBC), like Rosocyanine, have been understudied for their medicinal benefits, and instead are used in colorimetric assays. Due to its precursors' properties, it is hypothesized that such molecules may possess synergistic antimicrobial, antiproliferative, and anti-inflammatory properties. In this work, CBC loaded nanoparticles are compared to previously reported Curcumin nanoparticles. The stability of CBCs under different conditions was studied through UV-Vis and Fluorescence spectrophotometry. Furthermore, liquid Chromatography-Mass Spectrometry (LCMS) was used to identify the CBCs. Finally, these molecules were loaded in polyphenol-based nanoparticles and their particle size and surface charge were characterized through Dynamic Light Scattering and Zeta potential (DLS/Zeta). The results show that CBCs were stabilized in aqueous conditions by loading them into the nanoparticles. This work creates the opportunity to study these unstable compounds more in depth and to compare their properties to that of the precursors.

Michael Moraskie

Title:

Engineering quantitative bioluminescent biosensors for the novel quorum sensing molecule 3,5-dimethyl-pyrazine-2-ol (DPO) and revelations from its quantified presence in humans, animals, and bacteria.

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Abstract:

Investigations on the microbiome, the community of microorganisms living on and within multicellular organisms, have seen remarkable growth in the past two decades. While important correlations between microbial community structure and host outcomes have been made, there is a growing need for mechanistic investigations on the molecular interactions between a host and its microbial tenants. The study of quorum sensing (QS), a form of microorganismal communication

based on small chemical molecules to coordinate gene expression in a population-dependent manner, offers a unique window into the molecular underpinnings of microbial behavior and interactions. As the field of QS continues to expand, its critical role within the microbiome and the host it inhabits is becoming increasingly clear. As such, there is a growing need for tools that enable the study of QS in microbiome investigations. Microbial Whole-Cell Biosensors (MWCBs) consist of engineered microbial species which produce, or limit the production of, a quantifiable reporter protein in a dose-dependent manner in response to a target analyte. Recently, the novel quorum sensing molecule (QSM), 3,5-dimethylpyrazin-2-ol (DPO), was identified in *Vibrio cholerae* to regulate biofilm formation and virulence factor production. Herein, we report on the development, optimization, characterization, and deployment of a MWCB for the detection and study of DPO. With the developed biosensor, we identify for the first time the presence of DPO in rodent and human stool and further support the speculation that DPO is produced by other bacterial species beyond *Vibrio cholerae*.

Christopher Muñoz

Title: Mechanical, Thermal Stability, and Electrical Properties of CNT/Thermoplastic Nanocomposites: A Comparison of Varying Weight Ratios

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Abstract:

In the study of nanotechnology, polymer-based nanocomposites have emerged as a prominent field of contemporary scientific research and industrial application. Polymer nanocomposites exhibit better characteristics at low loading levels than standard polymer composites. These qualities are often improved with nanofillers. Modifying the mechanical, thermal, and physical properties of polymers is a common application for nanoparticles such as carbon nanotubes and silica. With its atactic structure, amorphous nature, and optical transparency, poly(methyl methacrylate) (PMMA) is an exceptionally strong and weather-resistant polymer. Due to its weak thermal stability, usage is limited at higher temperatures. Carbon nanotubes (CNTs) are widely used in various industries due to their superior thermal, mechanical, electrical, and optical properties, as evidenced by considerable scientific literature. Adding CNT as a nanofiller greatly improves the material properties of the PMMA polymer matrix, which has potential uses in mechanics and electronics. Higher CNT percentages improve composite strength. Beyond an effective content threshold, CNT aggregation prevents further mechanical property enhancement. The present study aims to focus on the mechanical, thermal, and electrical characteristics of polymer-based composites enhanced by carbon nanotubes. It examines the integration of high weight percents of CNTs into polyethylene nanocomposites and how this integration might enhance the mechanical efficiency of CNT/PMMA composites. Common characterization techniques such as scanning electron spectroscopy (SEM), differential scanning calorimetry (DSC), thermos-gravimetric analysis (TGA), and mechanical testing are discussed to study the influence of CNTs on physical and mechanical properties of CNT/PMMA composites. Moreover, the study compares various CNTs dispersion techniques to achieve the most efficient weight ratios within a CNT-integrated polymer composite.

Laureana Muok

Curcumin-loading Human Choroid Plexus Organoid-derived Extracellular Vesicles to Alleviate Neuro-inflammation

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Neuroinflammation is a common symptom of aging and often caused by several components such as, overexpression of pro-inflammatory factors by the microglia. An increase in the production of these factors can have detrimental effects in neurodegenerative diseases like Alzheimer's disease, Parkinson's disease, and brain tumors. Curcumin is a natural polyphenol sourced from turmeric and is most reputable for its anti-inflammatory, antioxidant, and anticancer properties. Curcumin suppresses inflammation by blocking the nuclear transcription factor-kB, which is responsible for regulating tumor necrosis factor α, a mediator for inflammation. Several in vitro and in vivo studies have indicated that curcumin has various medicinal properties such as antioxidant, anti-carcinogenic, and anti-inflammatory. Despite all the benefits of curcumin, its clinical application has been hindered due to its low solubility and stability in vivo. A possible solution for this is loading curcumin into exosomes. The goal of this study is to determine the loading efficiency of curcumin into choroid plexus (ChP) organoid derived extracellular vesicles (EVs) using sonication, incubation, and freeze-thaw cycling. Preliminary data has been collected to determine the loading efficiency of loading curcumin into mesenchymal stem cell (MSC) and ChP organoid-derived isolated exosomes via sonication. This was done as proof of concept in order to examine the loading capabilities of curcumin, to develop an effective curcumin solution, and to test loading protocols. An average loading efficiency of 25.92% was determined, which is in line with previous studies that show a loading efficiency of 8-30% for sonication. Additional trials will be conducted to determine the loading efficiency of incubation and freeze-thaw cycling. Finally, the curcumin-loaded exosomes will be introduced to cells that have been exposed to amyloid beta 42 oligomers, and the inflammatory response will be determined. This study has significance of design cell-free therapeutics to treat neural inflammation in various neurological disorders.

Dallas Nash

Investigation into the effect of APOE4 iPSC derived astrocytes on the blood brain barrier through in vitro models.

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Astrocytes are the most numerous cell type found in the central nervous system (CNS), performing an abundance of complex functions integral to the brain's-maintained health. However, the activation of astrocytes during neurological insults or neurodegenerative diseases negatively impacts the CNS function. In Alzheimer's disease (AD) the strongest risk factor is the APOE4 gene. The APOE4 variant has been suggested to play an active role in the pathogenesis of AD, especially in impairing neurovascular integrity, and the deciphering of which would provide enhanced understanding of this CNS pathology and preferably reveal desirable therapeutic targets. This research aimed to investigate the roles of APOE4 astrocytes in AD pathogenesis by developing *in vitro* models through the use of induced pluripotent stem cells (iPSCs). The iPSCs were generated from a normal subject (WT line, APOE2/3) and a subject with APOE4 genetic variant following an established protocol, alongside primary human astrocytes for comparison. The differentiation stages were characterized through immunocytochemistry. iPSC derived APOE4 astrocytes displayed a higher proliferation rate & earlier astrocyte activation with high expression of GFAP. The effect of APOE4 astrocytes on neurovascular integrity was investigated in an *in vitro* blood-brain-barrier (BBB) model in which the astrocytes were cultured on a synthetic membrane with iPSC-derived brain micro-vascular endothelial cells (BMECs) on the opposite side. Primary and WT iPSC-astrocytes maintained trans-endothelial electrical resistance (TEER) similar to physiological values while APOE4 BBB systems demonstrated much lower TEER values indicating impaired BBB integrity. A transport assay, utilizing the facilitative glucose transporter GLUT-1, displayed a significant loss in BBB functional glucose transport in the APOE4 BBB system compared to the primary and WT iPSC-astrocyte systems. This research will provide novel understanding about the roles of mutated astrocytes in pathogenesis while serving as a nanomedical application for future drug evaluation platform designed for toxicity & effectiveness studies.

Aakash Nathani

Combined role of interleukin-15 stimulated natural killer cell-derived extracellular vesicles and carboplatin in Osimertinib resistant H1975 lung cancer with EGFR mutations.

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Extracellular vesicles (EVs) derived from immune cells may be able to treat malignancies that are resistant to other treatments relying on the hypothesis that EVs carry almost the same cargo of the parent cells. The objective of this study is to combine immunotherapy with chemotherapy for enhanced anticancer activity as one is not better than the other. In this study, we evaluated IL-15 stimulated natural killer cell-derived EVs (NK-EVs) as therapeutic agents invitro and invivo in Osimertinib resistant lung cancer with EGFR mutations(L858R). NK-EVs were isolated by ultracentrifugation and nanoparticle tracking analysis revealed size distribution of 89.5±3.4 nm, zeta potential of -31.38±0.25 mV. Western blotting demonstrated presence of regular EV markers along with specific NK markers (perforin and granzyme). EVs were also characterized by using proteomic analysis which demonstrated that EVs had proteins for NK cell-mediated cytotoxicity (Granzyme B) and T cell activation (Perforin and Plastin-2). Gene oncology (GO) analysis also showed that these are differentially expressed proteins (DEPs) that are involved in programmed cell death and positive regulation of cell death. Further, isolated NK-EVs were cytotoxic to H1975R cells invitro. Carboplatin's IC_{50} was reduced by approximately 1.9 and 1.7-fold ($p<0.001$) in 2D and 3D cell culture respectively when combined with NK-EVs. The EVs were then combined with carboplatin (25 mg/kg) and administered by i.p. route to H1975R tumor xenografts and significant reduction in tumor volume invivo was observed after 10 days. Our findings show for the first time that NK-EVs target the PD-L1/PD-1 immunological checkpoint and induce apoptosis and anti-inflammatory response by downregulation of SOD2, PARP, BCL2, SET, NF-κB and TGF-ß. MicroRNAs regulating the cytotoxic proteins were also identified using sequencing and the miRNAs: hsa-miR-5193/149-5P/3133/193-5p are picked for further studies. These miRNAs are directly involved in T cell or NK cell mediated cytotoxicity and are being currently investigated.

Aniela Nozka

Scalable formulation of magnetic particle imaging tracers via flash nanoprecipitation

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Magnetic particle imaging (MPI) is a novel imaging modality through which an applied alternating magnetic field can sweep the subject and detect the presence of magnetic particles. The output of this is a gradient map correlating to the spatial distribution of the concentration of the magnetic particles. Using magnetic particle tracers *in vivo* allows for tracking of drug delivery, blood profusion imaging, and more with no signal attenuation due to tissue. Iron oxide nanoparticles (IONPs) are not colloidally stable in aqueous phases, therefore, the addition of a hydrophilic shell is needed to transfer them. Current methods focus on ligand exchange; however, this is typically timely and not easily scalable. Flash nanoprecipitation (FNP) prepares nanocarriers that kinetically trap hydrophobic components inside a block copolymer shell that is stable in the aqueous phase. Size is controlled through several formulation parameters. Drugs, particles, and other hydrophobic constituents are stabilized in the core. Minimal work has been done to utilize FNP for the coating of hydrophobic IONPs. Previous work studied FNP formulation parameters' effect on size and polydispersity of particles without the inclusion of inorganic nanoparticles, focusing on changing the percent core of the formulations and the total solids concentration. Others prepared FNP formulations with the inclusion of inorganic nanoparticles, however, little attention was given to the potential of these for MPI tracers, as very little MPI characterization was reported. Herein, we demonstrate the formulation of magnetic composite nanocarriers characterized for use as MPI tracers. Size was recorded via dynamic light scattering and MPI characterization was done in both RELAX and 2D scan modes. Size was controlled between 100-300 nm by varying FNP conditions. MPI RELAX scan measurements indicate that maximum signals of about 77 $mgFe^{-1}$ can be obtained, with FWHM of 12 mT, indicating that MCNCs formulated using FNP are suitable for use as MPI tracers.

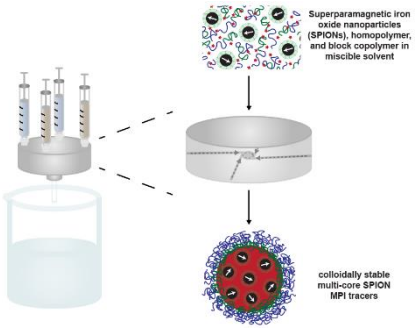

Figure 1. Formulation of MCNCs through flash nanoprecipitation using a multi-inlet vortex mixer (MIVM) allows for coating of multi core particles.

Kevin Núño

Title: Quorum Sensing Modulation in Microbiota by Endogenous Hormones and Neurotransmitters

Authors:

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Abstract: Quorum sensing (QS) is a biological process that is integral to the survival of all microbiota. QS is known to play an important role in biofilm formation and virulence factor production in pathobionts. Specifically, the gut and vaginal microbiota have been known to be phenotypically affected by endogenous hormones and neurotransmitters, as some of these endogenous compounds can modulate QS circuits. Multiple hormones and neurotransmitters were screened using whole-cell biosensors for the 3,5-dimethyl-pyrazin-2-ol (DPO), long chain acyl homoserine lactones (AHLs), short chain AHLs, and autoinducer-2 (AI-2) QS circuits. Estradiol, estrone, estriol, and progesterone modulated the AI-2 QS circuit while GABA modulated the long chain AHL QS circuit. Further elucidation of microbial endocrinology will help us thoroughly understand host-microbiome interactions and how hormones specifically interact with microbiota at typically nanomolar levels. This will lay down the groundwork on quorum quenching therapeutics, ideally as part of a nanoscale drug delivery system, by reducing the virulence and pathogenicity of the microbiota.

Florida Owens

Implication of the Autophagy-Related Protein Beclin1 in the Regulation of EcoHIV Replication and Inflammatory Responses

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The protein Beclin1 (BECN1, a mammalian homologue of ATG6 in yeast) plays an important role in the initiation and the normal process of autophagy in cells. Moreover, we and others have shown that Beclin1 plays an important role in viral replication and the innate immune signaling pathways. We previously used the cationic polymer polyethyleneimine (PEI) conjugated to mannose (Man) as a non-viral tool for the delivery of a small interfering (si) Beclin1-PEI-Man nanoplex, which specifically targets mannose receptor-expressing glia (microglia and astrocytes) in the brain when administered intranasally to conventional mice. To expand our previous reports, first we used C57BL/6J mice infected with EcoHIV and exposed them to combined antiretroviral therapy (cART). We show that EcoHIV enters the mouse brain, while intranasal delivery of the nanocomplex significantly reduces the secretion of HIV-induced inflammatory molecules and downregulates the expression of the transcription factor nuclear factor (NF)-kB. Since a spectrum of neurocognitive and motor problems can develop in people living with HIV (PLWH) despite suppressive antiretroviral therapy, we subsequently measured the role of Beclin1 in locomotor activities using EcoHIV-infected BECN1 knockout mice exposed to cART. Viral replication and cytokine secretion were reduced in the postmortem brains recovered from EcoHIV-infected *Becn1*$^{+/-}$ mice when compared to EcoHIV-infected *Becn1*$^{+/+}$ mice, although the impairment in locomotor activities based on muscle strength were comparable. This further highlights the importance of Beclin1 in the regulation of HIV replication and in viral-induced cytokine secretion but not in HIV-induced locomotor impairments. Moreover, the cause of HIV-induced locomotor impairments remains speculative, as we show that this may not be entirely due to viral load and/or HIV-induced inflammatory cytokines.

Alejandra Planells-Devesa

Design of BPA Binding Peptides Employing a Molecular Docking and Machine Learning Approach: Incorporation of the Binding Peptides in the Development of Biosensing Methods for BPA

Alejandra Planells-Devesa [1], Sandra Rodríguez-Varillas [2], Josep R. Codina [1], Mercedes Lozano-García [1], Emre Dikici [1,3], Sapna Deo [1,3], and Sylvia Daunert [1,3]

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Bisphenol A (BPA) has emerged as a deeply concerning environmental contaminant attributed to its widespread utilization in plastics, affecting both human health and ecological systems. BPA is an endocrine disruptor, which has heightened the risks of infertility and cancer upon exposure. Consequently, accurate, selective, and sensitive detection methods for BPA are essential not only for safeguarding public health safety, but also for preserving the integrity of our environment. Our study employs an integrated computational-experimental approach for the design of sensing peptides for BPA detection. Molecular docking was combined with machine learning to query a library of pentameric peptides. The goal of the computational design was to identify peptides showing strong interactions with BPA. Screening of 3.2 million pentamers highlighted those rich in tyrosine and tryptophan, indicating potential binding to BPA due to their aromatic ring structures and potential π-π interactions. The peptides with the highest predicted binding scores were prepared using a solid-phase peptide synthesizer, and their high purity and correct identity were validated by high-performance liquid chromatography (HPLC) and (mass spectrometry) MS/MS, respectively. The presence of aromatic amino acids in the peptides allowed for monitoring of fluorescence emission of the peptide at 335 nm by exciting at a wavelength of 280 nm. Binding of BPA to the peptide revealed significant spectral shifts indicating plausible conformational changes within the peptides upon interaction with BPA molecules and/or π-π interactions. This preliminary work resulted in a novel sensing method selective for BPA employing AI designed sensing peptide molecules which can detect BPA down to micromolar levels. In conclusion, the integrated computational-experimental approach marks a significant advancement in bridging computational predictions with practical applications in the sensing of small molecules, such as BPA. Further, this research has implications in environmental monitoring, showcasing a pathway for innovative sensor design strategies to advance contaminant detection.

Alekhya Ponnam

FABRICATION OF NIOSOMAL NANOFORMULATIONS IN THE TREATMENT OF AGE-RELATED MACULAR DEGENERATION

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Abstract: Age-related macular degeneration (AMD) is a progressive ocular disease that primarily affects the central part of the retina, leading to significant vision loss in the elderly. It is characterized by the deterioration of the macula, which is crucial for sharp and central vision. Niosomes offer a groundbreaking approach in addressing this issue. Niosomes, non-ionic surfactant-based vehicles, offer several advantages in ocular drug delivery. Their ability to encapsulate a wide range of drugs, including acetazolamide, briomodine tartarate, naltrxone hydrochloride, fluconazole, flupirtine maleate, diclofenac sodium, and levofloxacin, demonstrates their versatility in delivering various therapeutic agents to the eye. Furthermore, niosomes have been shown to enhance bioavailability, increase precorneal residence time, improve ocular tolerability, reduce irritation, and increase permeability, thus addressing critical issues in ocular drug delivery. Specifically, in AMD therapy, niosomes enhance drug delivery to the retina, improving efficacy while minimizing systemic side effects. Studies indicate that niosomes can improve the stability and bioavailability of various AMD therapeutics, including anti-VEGF agents and antioxidants. *In vitro* and *ex-vivo* studies have demonstrated the sustained and prolonged release of drugs from niosomes, leading to sustained intraocular pressure (IOP)-lowering activity. This sustained release is crucial for achieving therapeutic concentrations of drugs in the eye over an extended period, thereby improving treatment outcomes for various ocular conditions. Crucially, niosomes address the challenge of delivering drugs to the retina, a region hindered by barriers like the blood-retinal barrier. Their small size and structural adaptability allow them to bypass these barriers, ensuring direct drug delivery to the degenerating macula. This targeted approach is vital in AMD where localized treatment is necessary. Niosomes' role in AMD treatment is thus multifaceted, offering improved drug stability, enhanced bioavailability, targeted delivery, and reduced systemic side effects. Their use in AMD therapy signifies a significant step forward in managing retinal degenerative diseases.

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Sherwin Reyes

An Intact Cell Bioluminescence-Based Assay for the Simple and Rapid Diagnosis of Urinary Tract Infection and Antimicrobial Resistance

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Abstract: Urinary tract infection (UTI) is a prevalent infection that contributes significantly to the number of visits made to outpatient hospitals and clinics. The conventional method of diagnosing UTI through culture and sensitivity testing often requires a minimum of eighteen hours before a final diagnosis. An inaccurate diagnosis can result in a rise in antibiotic resistance after treatment. In order to overcome these limitations, rapid bioluminescence tests were created and assessed for the identification of urinary tract infections (UTI) utilizing either live cells of *Photobacterium mandapamensis (USTCMS 1132)* or previously freeze-dried cells of *Photobacterium leiognathi (ATCC 33981™).* Two platform technologies, TuBETUr and CUBET, were developed and standardized using artificial urine to detect four commonly isolated UTI pathogens: *Escherichia coli, Proteus mirabilis, Staphylococcus aureus, and Candida albicans*. In addition to detection, these assays can also offer insights about the concentration or amount of the pathogen, which can assist in making informed decisions about treatment. These technologies successfully identified microorganisms linked to urinary tract infections (UTIs) at concentrations below 10^5 cfu/mL, which is often the minimum threshold for confirming a positive UTI diagnosis. Out of the 30 UTI samples with pathogen concentrations ranging from 10^5 to 10^6 cfu/mL, TuBETUr successfully identified 29 urine specimens as positive for UTI within a 15-minute detection window. Using single-pot settings and cell phone-based monitoring, the fast CUBET technique successfully distinguished urinary tract infections (UTIs) from normal samples with a high level of confidence (p = <0.0001). These technologies have the ability to meet the demand for UTI diagnosis at the point of care while also minimizing the risk of antibiotic resistance that can occur due to misdiagnosed instances of urinary tract infections, particularly in low-resource settings.

Keywords: Urinary Tract Infection, Bacterial Bioluminescence, Antimicrobial resistance, Biosensor

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Orr Riley

Optimizing electro-active electrode and electrochemical systems for point-of-care sensing applications

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In the support of 5th and 6th-generation sensing technology, there is a significant focus on developing highly sensitive electro-active electrodes (to achieve low-level detection) and smartphone-assisted electrochemical sensing systems (to perform point-of-care testing of a target analyte). In this direction, we have optimized the electrochemistry of a nano-enabled sensing electrode and further, the interfacing of such an optimized electrode with a miniaturized potentiostat (MP), operated using the smartphone. Customized Screen-Printed Carbon Electrodes (SPCEs) compatible with PalmSens4 and PalmSens Sensit Smart were functionalized with graphene oxide (GO). The results of the electrochemical studies (by both the systems) confirmed that SPCE and GO@SPCE exhibit surface-controlled electrochemical behavior and the addition of GO accelerates the electron transport which is useful to achieve a wide detection range and a long detection limit. During cyclic voltammetry (CV), The effect of the scan rate showed a strong relationship to the peak current where its square root is linear with the peak current confirming the surface-controlled nature of the electro-active electrode. The GO coating was similarly successful showing about a 45% increase in peak voltage compared to the bare counterpart. Considering comfort, easy operation, data sharing, and timely analytics, we believe that Sensit-PalmSens@smartphone can be a potential electrochemical system to perform sensing for point-of-care applications. In the future, we are working in a direction to utilize this system for the detection of microplastic and PFAS in water samples using MIP technology.

Keywords: *Sensors, nano-enabled electrodes, point-of-care sensing systems,*

Justin Sanchez-Almirola

Electrochemical detection of micro/nano plastic for on the field environmental surveillance.

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Every day used plastics degrade into smaller chains of their original polymer, creating micro/nano plastics (MN-Ps) which are particles of diameter 1μm - 1mm / 0.001μm - 1μm respectively. These MN-Ps are extremely persistent molecules found at alarming rates in the environment, drinking water, and our bodies. These particles are linked to a wide range of health problems including cancer, neurotoxicity, reproductive toxicity, and hormonal dysregulation. Due to both their ubiquity and threat to human health, it is important to be able to accurately measure the amount of MN-P that is present in any given media. Therefore, detecting MN-Ps selectively and at a low level is necessary for environmental surveillance. However, the current methods of detecting these particles involve laboratory expertise and expensive equipment, limiting the ability and frequency at which we can detect MN-P. To address these issues, this research is exploring a molecularly imprinted polymer (MIP) based sensing approach for the detection of MN-Ps. MIP of monomer o-phenylenediamine is fabricated on screen-printed carbon electrodes (SPCE). The MIP@SPCE is developed concerning MN-Ps and further sensing using electrochemical sensing was performed using a system that is optimized for point-of-care (POC) and on the field applications. MN-Ps@MIP@SPCE sensors were tested to detect some of the most common micro/nano plastics, polystyrene particles of diameter 100 nm and 500 nm, and polyethylene at 50 μm. These sensors were also interfaced with a miniaturized potentiostat (M-P), operated using a smartphone, to perform electrochemical detection of MN-Ps at a point-of-location setting, suitable for environmental surveillance applications.

Keywords: *Sensors, nano-enabled electrodes, microplastic, point-of-care sensing systems, environmental monitoring*

S. Sarker

Patient Derived Glioma Stem Cell Modulation for Improved Therapeutic Outcome

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Glioblastoma Multiforme (GBM), one of the most lethal malignant primary brain tumors largely due to the presence heterogenous glioma stem cells (GSCs) endowed with self-renewal properties. Specific targeting of GSCs through maximal surgical resection and radio/chemotherapy aiming to eliminate GSCs still remains a major challenge. Being highly invasive, residual GSCs persists post-conventional treatment leading to tumor recurrence rendering glioblastoma resistant to potential therapies. Glioblastoma impairs cognitive functioning of patients resulting in poor quality of life. This demands alternative treatments to specifically target GSCs. Brain targeted therapeutics encounter challenges at the blood brain barrier (BBB), thus, we aim at developing a nanoplatform which can cross the BBB, diffuse across the distant brain regions, and target the hyperpolarized GSCs. Our results indicate that metabolic modulation can be a promissory way to reduce the stemness of the GSCs while impairing their proliferative potential. Preliminary lab studies reveal that patient derived GSCs from varied background rely on fatty acid oxidation (FAO) for energy, however, inhibiting FAO alone cannot eliminate the residual GSCs. Metabolic plasticity, where cells shift towards glycolysis when FAO is inhibited, plays a pivotal role in cell survival. To overcome this limitation, we develop a combinatorial nano-formulation to effectively target both FAO and glycolysis in a sequential manner. Leveraging our lab's discoveries, Platin-L, a cisplatin prodrug with FAO inhibitory capacity and Mito-DCA, a DCA prodrug with glycolysis inhibitory capacity, we developed brain targeted nanoparticles encapsulating either Platin-L or Mito-DCA to administer in a sequential manner and achieve complete metabolic shutdown of GSCs. Our findings suggest that this combinatorial nanotherapeutic strategy potentially reduces stemness and proliferation while showing significant reduction in tumor progression *in vivo*. This presentation will delve into our detailed observations using the nano-formulations, emphasizing metabolic inhibition as a promissory target for attacking the residual GSCs and affecting glioblastoma tumor progression.

Arusmita Souvangini

Design and Testing of an Adeno Associated Vector (AAV) plasmid vector driving Methionine Sulfoxide Reductase A (MSR A) for tissue repair.

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Abstract: Oxidative stress induced tissue damage is associated with different retinal degenerative diseases causing blindness. The antioxidant enzyme methionine sulfoxide reductase A (MsrA) is reported to support retinal tissue repair. The purpose of this is to develop an Adeno Associated vector (AAV) to express MsrA so that it can be exploited in tissue repair under oxidative damage. We cloned human MsrA gene into self-complementary AAV (scAAV) plasmid vector under a ubiquitous small chicken beta-actin (smCBA) promoter. Further to track exogenous expression, a FLAG epitope sequence was further cloned into the 3' end replacing the stop codon. As a comparison, a control plasmid driving green fluorescent protein (GFP) was also developed. We transfected these plasmids into HeLA cells (1.5 x 10^5 cell/ well in a six well plate) using polyethyleneimine (PEI) as a transfection reagent and cell lysates were analyzed by western blotting. Our result showed efficient expression of GFP fluorescence suggesting 70% efficiency of plasmid transfection. We analyzed 20ug proteins isolated from cellular lysates (three replicates) by western blotting and use of FLAG antibody showed MsrA protein expression of 28KD size. The designed scAAV-MsrA plasmid vector can be used in cellular and animal models of retinal degenerations. Upon successful testing its efficiency, it promises to revolutionize the treatment of retinal diseases, potentially offering new hope to repair retinal tissues patients facing vision impairment due to oxidative stress mediated retinal degenerations.

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Jacqueline Tejada

Polymeric nanoscale system to enhance water stability of auxins delivery to promote plant growth as a crop management strategy.

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Over the years, a common agricultural practice to promote plant growth has been the use of phytohormones such as Auxins (e.g. Indole Acetic Acid, IAA). Although, this phytohormone is known to play a key role in plant growth involved in multiple biochemical processes in cell division, fruit development, and elongation, among others. There are major limitations associated with the delivery of this active ingredient regarding its water insolubility and lower bioavailability for plant uptake. For this reason, we developed a polymeric nanoscale delivery system to overcome the current disadvantages of IAA delivery. Herein, we report a one-step synthesis protocol for capturing IAA in the nanoscale to provide water solubility and enhance bioavailability. In order to characterize the size and morphology of the IAA nanoformulation we performed Scanning Electron Microscopy (SEM), Fourier-transformed Infrared (FTIR), Dynamic Light Scattering (DLS), and Zeta Potential. Furthermore, we performed Liquid Chromatography with Time of Flight (LC-TOF) to quantify the active and determine the encapsulation efficiency of the nano-delivery system. Lastly, we studied the effects on plant growth, phytotoxicity, and germination of tomatoes (*Solanum Lycopersicum*). In sum, we demonstrated the potential use of nano-enabled delivery of agrochemicals as a promising strategy toward more sustainable agricultural practices.

Giancarlo Tejeda

Anti-inflammatory Scavenger Nanoparticles Induce Macrophage Phenotype Shift in Inflammatory Conditions

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Damage in the central nervous system (CNS) such as traumatic brain injuries and spinal cord injuries are extremely serious due to the limited regenerative potential of these tissues, and the intense inflammatory reaction. Inflammation after injury in the CNS leads to further damage known as secondary injuries, driven by inflammatory cytokine signaling and innate immune infiltration. Macrophages, innate immune cells, quickly localize to the injury and exacerbate the inflammation by releasing inflammatory cytokines in a harmful positive feedback loop. We developed an anti-inflammatory scavenger nanoparticle (NP) system with a polymeric core decorated with glycosaminoglycans (GAGs) on the surface. We crosslink the polymer with the GAG and verified the formation of GAG-polymer using Fourier transform infrared spectroscopy. The GAG-NPs were formed using nanoprecipitation method, then characterized using dynamic light scattering and transmission electron microscopy. The binding affinity of the GAG-NPs were assessed using fluorescent spectroscopy (FLS) after the NPs were incubated with inflammatory and anti-inflammatory cytokines. FLS showed that the GAG-NPs had preferential binding affinity to the inflammatory cytokines in solution. Immortalized bone marrow-derived macrophages (iBMDMs) were used as an inflammatory *in vitro* model. The effect of the GAG-NPs on the inflammatory phenotype on the iBMDMs was analyzed with flow cytometry. Enzyme-linked immune assays (ELISA) were used to assess GAG-NP impact on the macrophage inflammatory cytokine signaling. The ELISAs showed that the GAG-NP-treated iBMDMs reduced the amount of the inflammatory cytokines released in an inflammatory environment. The physical and electrostatic properties of the GAG-NPs allow it to scavenge inflammatory cytokines and reduce inflammatory signaling in inflammatory environments. This GAG-NP platform could be used to reduce inflammation after CNS injuries and other inflammatory conditions.

Sradha Mariya Thomas

Photocatalytic Degradation of Bisphenol-A using an Exfoliated g-C_3N_4/Pd Nanoarchitecture

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Environmental pollution caused by emerging pollutants has become a major hazard to human health and aquatic life in recent decades.[1] Even very low concentrations of these emerging contaminants can have a significantly negative influence on the ecosystem.[2] Bisphenol-A (BPA) is an emerging organic pollutant that is extensively used in the production of flame retardants, polycarbonates, epoxy resin, insecticides, and food packaging.[3] BPA exposure has the potential to alter endocrine disruptors, impede the nerve conduction system, and also impact cellular activity by attaching to estrogen receptors.[1] The use of semiconductor photocatalysis to degrade BPA in water is a promising strategy that could be highly sustainable.[4] In this work, the photocatalytic degradation of BPA using an exfoliated g-C_3N_4/Pd photocatalyst was investigated. The photocatalyst was synthesized by exfoliating bulk g-C_3N_4, which was prepared by a thermal condensation polymerization reaction of melamine. The photocatalytic performance of exfoliated g-C_3N_4 was further improved by the addition of Pd nanoparticles. The degradation results showed that faster reactivity was observed for ex-g-C_3N_4/Pd samples compared to those prepared without Pd co-catalyst. In addition, the BPA degradation pathway was explored, which involved radical intermediates that were identified using LC-MS. From this analysis, a photodegradation mechanism was proposed based on the intermediates identified.

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Kristina Tosi

Traumatic Brain Injury Induces Neuroinflammation Leading to Dysregulation in Tau Metabolism

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Traumatic Brain Injury (TBI) initiates a cascade of detrimental events, contributing to a host of neurological diseases relating to dementia. In this study we performed a meta-analysis comparing differentially expressed genes (DEG) in specific cell types (neurons and microglia) revealing inflammation as a common driver of neurological deficiencies post TBI. The molecular mechanism causing tau hyperphosphorylation via tauopathy associated genes (TAG) in TBI is currently being studied. Using publicly available data sets from the NCBI Gene Expression Omnibus (GEO) database, we compared DEG expression in mouse brain tissue from TBI vs sham injury at 24hr to 14 months post injury. Ingenuity Pathway Analysis (IPA) software was used to investigate the regulatory networks containing DEG's, identify central "hub genes", and predict downstream effects of the observed expression changes. There are limited *in-vitro* neuroinflammatory models that mimic primary and secondary TBI. We hypothesize that induction of hypoxia and inflammation will mimic TBI *in-vitro*, revealing up-regulated tauopathy associated genes in neuronal and microglial cell lines. These TAG will be targeted to ameliorate the hyperphosphorylation of tau. To verify hub genes, neuronal and microglial cell lines are treated with various lipopolysaccaride (LPS) and cobalt chloride dosages revealing changes mimicking secondary TBI. This will be further investigated using RT- PCR and western blot to confirm the appearance and quantify of TAG. A nano-formulation will be constructed to target two TAG that will downregulate the hyperphosphorylation of tau. In conclusion, the findings of this project include a comparison of short vs long term pathology correlating an early inflammatory response to later dysregulated tau metabolism.

Jorge David Tovar-Castro

Novel Nanodrug Platform for Pharmacologically Inducing Therapeutic Hypothermia (TH) After Traumatic Brain Injury (TBI)

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Therapeutic hypothermia (TH) has gained widespread recognition as a neuroprotective strategy for mitigating secondary injury mechanisms resulting from traumatic brain injury (TBI). TBI occurs when an external force impacts the skull, causing damage to the brain. TH modulates neuropathological responses caused by TBI. Our approach utilizes intranasal delivery of nanoscale vanilloid drugs, specifically olvanil, to induce brain hypothermia through the activation of the transient receptor potential vanilloid 1 (TRPV1).

Through a bottom-up synthesis, we prepared nanoolvanil, demonstrating its ability to bind to TRPV1 and activate the receptor, as evidenced by calcium influx assays. Toxicity studies revealed minimal impact on cell proliferation and indicated antioxidant effects in vitro. In vivo experiments employed a custom 3D-printed intranasal spray (INS) to deliver nanoolvanil.

Characterized by dynamic light scattering (DLS), nanoolvanil exhibited an average size of 82.53 nm, a polydispersity index (PDI) of 0.25, and a zeta potential of -28.05 mV—suitable for blood-brain barrier transport. TRPV1 activation studies showed a 34% calcium influx post-injection and nanoolvanil significantly increased cell proliferation. In vivo, the 3D-printed INS successfully delivered nanoolvanil at 5 mg/kg, leading to a temperature reduction of ~2 ℃ for up to 100 minutes.

Nanoolvanil, falling within the optimal size range, effectively activated TRPV1 with minimal impact on cells. In vivo studies using our customized 3D-printed INS demonstrated successful head and body temperature reduction, highlighting the potential of this nanodrug delivery system for therapeutic hypothermia in TBI cases.

Unaisah Vorajee

Surface Passivation and Long-Term Stabilization of Blue-Emitting Perovskite Nanoplatelets with Polysalt Ligand Complexes

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Colloidal $CsPbBr_3$ nanoplatelets (NPLs) possess unique photophysical properties, including narrow and blue emission, rendering these materials an ideal candidate for applications in light-emitting diode fabrication. Despite their advantageous characteristics, these two-dimensional nanocrystals exhibit low photoluminescence quantum yields (PLQYs) due to the presence of surface defects. Furthermore, they are colloidally and structurally unstable under ambient storage conditions.

In this work, we present the development and utilization of Br-based polysalt-complex ligands to enhance the PLQY while preserving the morphology and crystal structures of these NPLs. We observed that while application of the polysalts (containing imidazolium or ammonium bromide motifs and solubilizing alkyl chains) alone improves fluorescence properties, it simultaneously etches the nanocrystal surface, thus compromising structural integrity. However, by combining bromide-based salts ($PbBr_2$, $SnBr_2$, $CoBr_2$, $MnBr_2$, and $ZnBr_2$) with the polymer prior to ligand substitution, we form polymer-salt complexes that not only facilitate electronic passivation but also maintain the morphological stability of the NPLs. Optical characterization techniques demonstrate a remarkable enhancement in photoluminescence, approximately one order of magnitude higher than that of pristine NPLs, with exceptional color purity profiles at ~ 460 nm. In addition, structural analysis and long-term monitoring of NPL dispersions indicate the preservation of their colloidal stability and structural integrity.

Peng Wang

High Performance Hydrogel Based on Aramid Nanofibers for Zn Ion Batterieseries

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Recently, aqueous zinc-ion batteries (ZIBs) have emerged as a focal point in the search for eco-friendly, safe, and cost-effective alternatives to conventional Li-ion batteries. They are recognized for their potential to serve as a promising substitute in various energy storage applications. However, their path to commercial success is hindered by significant challenges such as dendrite formation on Zn anodes, hydrogen evolution, and undesirable side reactions. Traditional approaches have mainly concentrated on anode protection and electrolyte additive design, overlooking the critical role of the separator. In this present, we introduce an innovative high-performance hydrogel separator, derived from the commercially available material Kevlar, a robust synthetic fiber known for its exceptional strength. This hydrogel, derived from aramid's formidable properties, exhibits superior tensile strength when compared to traditional glass fiber separators. Its effectiveness in mitigating Zn dendrite growth in Zn symmetric cells highlights its potential in enhancing anode protection. Furthermore, when combined with a MnO_2 cathode, the hydrogel-infused cell demonstrates outstanding electrochemical performance. Our findings pave the way for the exploration of hydrogel electrolytes based on aramid fibers, marking a significant advancement in the development of aqueous ZIBs.

Torus Washington II

"Bowl-Ing for Cancer Drug Delivery Success: Striking Down Lung Cancer with Silica Nanobowls"

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Abstract

Effective drug delivery is necessary for improved cancer treatment and reduced toxicity-- nanoparticle delivery improves these outcomes. In this work, we propose a novel nanoparticle system for drug delivery-- "silica nanobowls." Nanobowls are a Stöber synthesis silica nanoparticle with a bowl-like cavity etched out. To this point, Nanobowls have not been used as a drug delivery vehicle for cancer, and their utility requires investigation. As a contribution to material science and understanding of Stober synthesis in novel applications, varied chemical methods and protocol designs were explored to make nano bowls smaller. In addition to size attenuation, the potential to modify cavity profile, drug loading, and drug delivery abilities were investigated. Nanobowl size, porosity, cavity size, surface area, and other characteristics were revealed as a function of this work. Nanobowls were tested in 3 different lung cancer cell lines to explore the applications of these findings. Without drug, nanobowls were observed to be non-toxic to cells. For treatment, the cancer drug doxorubicin was delivered, and significant uptake and cancer cell killing was observed. This work outlines the nanobowl's utility in drug delivery for cancer treatment and lays a foundation for the potential modulation of this ability. Work remains to further investigate the behavior of these particles in vivo and to tune the parameters of the platform for targeting and enhanced drug release.

Adriana Yndart

Development of Magnetic electric Nanoparticle based liposomes to deliver AMG315, an endogenous cannabinoid analog to alleviate Neuro-AIDS.

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Abstract

Antiretroviral therapy has decreased the morbidity and mortality of HIV-1 infection. However, HIV reservoirs persist in the central nervous system (CNS), causing chronic neuroinflammation and cognitive problems. Conversely, endocannabinoids positively influence neuronal synaptic plasticity, improving learning, memory, pain, and inflammation. However, their neuroprotective effects are ameliorated by their rapid catabolism, low levels, and short half-life. AMG315 ((13 S, 1' R)-dimethyl Anandamide) is a potent metabolically stable anandamide analog recently synthesized with demonstrated anti-inflammatory properties by suppressing some proinflammatory cytokines and HIV infection. Moreover, magnetic electric nanoparticles demonstrated an increased effectiveness of the cargo drugs and reduced the off-target toxicity effects. Therefore, in this study, we developed multifunctional magnetic electro-nanoparticle-based liposomes (MENPL), a system combining liposomes and magnetic electro-nanoparticles for drug delivery to the brain. Nanoformulation containing AMG315-Liposome-MENP was characterized to estimate hydrodynamic size in PBS (232.1 nm), zeta potential (-2.67), encapsulation efficiency of AMG315 (MENPL 78.6%), transmigration efficiency after applying the externally ac-magnetic field (17.35%), Blood-brain barrier (BBB) disruption, and oxidative stress protection. The MENPL showed higher transmigration efficiency across the BBB concerning the control liposome nanoformulation-containing AMG315 and preserved the transendothelial resistance and paracellular transport. Furthermore, AMG315 reduced oxidative stress in microglia cells treated with TAT-HIV protein in a dose-dependent manner. In summary, our developed MENPL has the potential to deliver endocannabinoid analogs across BBB to treat neurological impairments in HIV-infected patients.

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Welcome to the Integrative NanoScience Institute (INSI).

INSI is an interdisciplinary organization at Florida State University founded in 2009 by a proposal led by Dr. Stephan von Molnár. As he put it, "Bionanotechnology will transform our lives because it can yield entirely new classes of products with unique, unprecedented functions and applications." The institute was founded to bring together researchers at the interface of materials science, device engineering, synthetic chemistry, and molecular biology.

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