

Bio-X Constellation

Vision

The BIO-X constellation aims at serving as an academic platform for the entire Missouri S&T community to facilitate interdisciplinary and trans-disciplinary research in life science. The constituents include engineering, natural science, and humanity and social sciences. Translation of basic research outcomes to innovation and entrepreneurship is the essence of this constellation.

1. Introduction

Missouri S&T has a long history of success in tissue regeneration, which has led to multiple million-dollar research grants, numerous patents, and successful commercial products such as TheraSphere and Mirragen invented by Professor Delbert Day (Slides #2-3). In FY 2019, S&T was awarded \$5.2 million by the Department of Defense to conduct traumatic brain injuries research (Slide #4). There are seven active NIH research grants in 2020 including two large, prestigious R01 grants (Slide #5). Between October 2019 and June 2020, thirteen proposals of \$11.3 million were submitted to NIH, NSF, DOD, Merck, Spencer, and MTEC for COVID-19-related studies (Slide #6). There are a few interdisciplinary teams pursuing numerous health-related topics and intend to submit research proposals to various funding agencies in the near future (Slide #7). The members in this constellation have and will continue to identify emerging areas of research (Slides #8-9).

1.1 Current Inter- or Trans-disciplinary Strengths and Examples

- Biomaterials (tissue regeneration: bone and wound)
- Bioprinting
- Traumatic brain injuries (TBI)
- Sleep biology
- COVID-19 pandemic related topics
- Drug delivery / biosensing
- Ecology / environmental science

1.2 Other Current Health-related Pursuits on Campus (Slide #7)

- Eye research (disease treatment)
- Biomarkers for disease diagnosis
- Chemistry for pharmaceuticals and agrochemicals
- Machine learning and cardiovascular diseases
- Imaging and diseases
- Metabolism and health
- Music and neurodegenerative diseases
- Sensors related to MRI or diabetes
- Artificial intelligence (AI) to enhance research instrument algorithm

- Bioinformatics / medical informatics
- Disease data modeling (mathematical and computational modeling)

1.3 What are the Emerging Areas? (Slide #9)

- Health informatics
- Biosystem automation
- Bioprinting and tissue engineering
- Drug delivery and discovery
- Mental health and pandemic (music, painting, performing arts, misinformation, etc.)
- Health intelligence and eco-canary species
- Ecological / Environmental / Evolutionary

2. Connections with University Centers, Consortia, and Other Constellations

2.1 Connection with Material Research Center (MRC) and Center for Biomedical Research (CBR)

Many members in this Constellation are affiliated with these two centers. They are active researchers in biomedical research ranging from biomaterials, sensing materials, 3-D bioprinting, and tissue regeneration to drug delivery, traumatic brain injury, and COVID-19-related topics. In addition to these outstanding human assets, the Material Research Center (MRC) and Center for Biomedical Research (CBR) possess cutting-edge analytical capabilities (<https://mrc.mst.edu>; <https://cbr.mst.edu/facilities-equipment/>) that play a pivotal role in PIs competitively acquiring external financial resources for research. This Constellation shall continue to work with these two centers to create synergy.

2.2 Connection with Center for Science, Technology, and Society (CSTS)

As biotechnology continues to evolve and advance, its impact does not stop at making our life more convenient or efficient. It also influences our social behaviors, value systems, cultures, ethics, and religions. The debates over embryonic stem cell research, human genome editing, and physician-assisted death are examples illustrating that the advancement of biotechnology plays an increasing role in social evolution. Bio-X Constellation researchers pertaining to biotech development shall embrace this fact and work with scholars at the CSTS to address this emerging area of research.

The COVID-19 pandemic profoundly affects our social life. Based on projections from NIH, vaccines will not be available to medical staff and other frontline responders until December 2020 or early 2021. However, the general public may not have access to vaccines until April 2021. Based upon the flu history, some scientists have started to anticipate that the SARS-CoV-2 may become endemic, meaning it will not go away completely and will be recurring with lower impact. Further, based upon the frequency of global infectious diseases in recent decades (SARS, H1N1, MERS, Ebola), the COVID-19 will not be the last pandemic. Although this is unfortunate for mankind, it creates opportunities for researchers in humanity and social science to study mental impact at all age levels, changes in social behaviors, and how we cope with new lifestyles via music, painting, performing arts, literature, social media, etc.

2.3 Connection with Center for Research in Energy and Environment (CREE) and Resources: Natural Energy and Water for Society (ReNEWs) Constellation

Ecology, environmental science, and evolutionary ecology can be some of the core strengths in this constellation. Many PIs in biological sciences, Geosciences and Geological and Petroleum Engineering (GGPE), and environmental engineering have been collaborating in research involving aquatic ecosystems or terrestrial ecosystems. Connecting the Bio-X Constellation with the ReNEWs Constellation can further create a synergistic research environment to address natural resource sustainability.

In addition, although one might think field biologists are irrelevant to human health issues, this is not true. For instance, the USA has a worldwide health intelligence network that relies on field biologists, such as bat or waterfowl experts, to track and monitor the origin, reservoirs, and spread of infectious diseases. This network has contributed to the success of identifying vectors for diseases such as swine flu, avian flu, and coronaviruses and mitigating their spread.

2.4 Connection with Data Science Constellation and Intelligent Systems Center (ISC)

As technologies continue to advance and high throughput methods are utilized in life science and biomedical applications, massive amounts of data are generated. The data can be in various forms such as numerical information, images, and heat maps, and graphs. Processing them requires expertise in mathematics, statistics, artificial intelligence, and computational biology. PIs at S&T can seek individual collaboration within or outside S&T.

It is important to note that hosting a data hub can give a PI or a team of PIs leadership in a certain area. This strategy can attract national and international collaborations to address universal or global problems. Scholars, in particular junior rising stars, can be attracted to S&T to develop their career in Rolla, MO. There are plenty of examples that junior scholars choose a certain institute because it hosts a data center. A few selected “Information Hubs” are listed at the end of this document. The Bio-X Constellation and Data Science Constellation and Intelligent Systems Center (ISC) can move in tandem to magnify productivity and even create new research directions through novel data management and analysis.

3. How the Kummer Institute can Make its Name in Biotech Entrepreneurship

3.1 Why Should Biotech Innovation and Entrepreneurship be Included into the Kummer Vision?

In response to the recent generous donation from the Kummer family, this section is devoted to demonstrating that the Bio-X constellation can play an important role in establishing the Kummer School of Innovation, Entrepreneurship, and Economic Development and making it a success. We believe that our constellation missions are in line with Mr. and Mrs. Kummer’s passion and vision in the context of biotech innovation, entrepreneurship, and economic development.

Biotech has been a hot area for more than 20 years. It is estimated that the biotech market size is about \$108.2 billion in 2020 (accessed on 10/22/2020; <https://www.ibisworld.com/industry-statistics/market-size/biotechnology-united-states/>). When factoring in the pharmaceutical industry, the market is astronomical. It is projected to continue to be a dominant force in academics and health-related industries as the human population continues to progress. Pursuing success in biotech is like a gold rush (Slide #10). Finding gold is the ultimate goal to become extremely rich. However, most gold rushers fail. The ones who have the highest chance of winning in a gold rush are general store managers who sell picks and shovels to gold rushers. By the same token, as long as people are interested in producing therapeutics to cure diseases, such as cancer, diabetes, COPD, Alzheimer's and Parkinson's diseases, cardiovascular diseases, multiple sclerosis, pathogen-born flus, etc., they need tools to accomplish their goals.

At Missouri S&T, we do not have a medical school, a dental school, a nursing school, a school of public health, or a school of pharmacy. Therefore, we cannot be One Health. However, we do have a wide spectrum of expertise and strengths in science and engineering to create a unique environment for biotech/pharmaceutical research. Thus, we have an opportunity to strategically carve out a special niche to enter the biotech arena. The outcome will not be less than that of One Health universities. We can have two approaches for biotech innovation and biotech entrepreneurship. The first approach is to work with universities in Missouri or neighboring states to pursue high-end biomedical products, such as biologics and small molecule drugs. This takes time and is high risk, but very rewarding if it succeeds. Our past success in Theraspheres and Mirragen was achieved by the innovation of materials in-house and then collaboration with external entities with UM-Columbia and Phelps Health.

The second approach is to invent “picks and shovels.” Below provides several case studies that we can reflect upon for subsequent plans and actions that we can implement.

The Cases of PharMigen and Clontech (Slide #11)

These two companies exemplify the “picks and shovels” concept. The founders positioned their companies to produce reagents, assay kits, antibodies, and DNA vectors for drug discovery and basic science. At the end of the 20th century, both companies were sold to BD Inc. for substantial prices.

The Case of Affymetrix GeneChip (Slide #12)

Biologists used test tubes to conduct experiments to study genetics, cell biology, drug discovery, and disease diagnosis and prognosis. The process is time consuming, laborious, and expensive. As the genomics era began in the 1990's, we realized that humans have at least 23,000 functional genes. How could scientists study/screen so many inter-related genes in an effective and low-cost way? Affymetrix Inc. came out with a solution called GeneChip which arrayed oligonucleotides on the surface of a glass. As technology continues to advance, all human functional genes can be squeezed into a very small platform for high throughput screening purposes.

The expertise involves such technology as combinatorial chemistry, photolithography, robot spotting, and computing algorithms and graphics. Due to the generation of large data sets, special

biostatistics software is needed for data analysis. Although at the onset of this technology gene chips were very expensive (e.g., > \$8,000 apiece) and not reusable, they still became popular in pharmaceutical companies because they could save a lot of manpower, reagents, and time, allowing them to develop their medical products at a much faster speed. The price of DNA chips has come down significantly over years. Affymetrix Inc. earned billions of dollars from this invention, which borrowed a simple idea from the automobile industry's assembly line concept. When a research laboratory cannot afford a chip with 23,000 genes, they can opt for a 96-well microarray for selective screening of 84 genes.

It should be noted that Affymetrix has been purchased by Fisher Scientific recently because Illumina Inc. made improvements in materials and processes of microarrays and is now the dominating force in large scale, high throughput bio-screening.

The Case of Accuri Flow Cytometer (Slide #13)

Flow cytometry is a very powerful instrument to detect fluorescent molecules in cells. This enables researchers to track labeled DNA, RNA, protein, carbohydrates, drugs, and other biologics inside cells for basic science discovery and biomedical applications. Variations of arrangement with optical filters of different wavelength allow a flow cytometer to perform multiple color detection. It can detect up to 384 samples of tens of thousands of cells per well in a very short period of time. The generation of such a large quantity of data demands a high-quality computing algorithm to process information obtained.

There have been many different models of flow cytometers on the market before the Acuri flow cytometer was invented by university scholars. The assemblage of a flow cytometer requires expertise in biology, computer science, biostatistics, optic sensor system, and system automation. An Acuri flow cytometer was sold for about \$20,000 apiece and was aimed at labs that could not afford to pay for expensive existing models, which ranged from \$50,000 to \$125,000. Later Acuri was acquired by Becton, Dickinson and Company. The current price of an Acuri flow cytometer is around \$40,000.

Slides #14-16 show additional examples that biologists and engineers worked together to automate systems for high throughput research in biological sciences and biomedical applications. Besides system automation in academic settings, another area of opportunity is improvement and integration of medical practice to reduce avoidable medical malpractices.

3.2 Plans and Actions to Achieve Innovation and Biotech Entrepreneurship

If we at S&T are going to call our research an enterprise, we need to run it like a private business and commit appropriate investments. Anything short of that will deter our progress. When other universities advance faster than we do, over years the difference will widen and it will become impossible for us to catch up with them.

Reflecting on specialties at S&T, we possess all of the necessary expertise to enter a biotech adventure. The question is how to achieve our goal. Certain mechanisms need to be in place for biotech innovation and entrepreneurship to take place at S&T. The first component is to have a team of identifiers (or facilitators) to 1) identify current needs and the future trends in biotech

and medicine, and 2) identify potential products that already exist at S&T for marketing purposes as well as further facilitate collaboration among disciplines. For instance, Apple's iPod required large memory. It was not resolved until Apple's tech chief accidentally found the technology that had been sitting on a technician's laboratory shelf in a Japanese company for a couple of years.

The second component is to hire business professionals to support the development of entrepreneurship. Most scientists and engineers are not skillful in managing business-related activities. They could fail in business finance (e.g., cash flow projection), marketing (i.e., dynamic competitive landscape), personnel management, scale-up manufacturing efficiency, federal regulations, etc. They need business consultants to help them navigate through a complex business process; otherwise they will only stay small or, most likely, fail.

The third component is to create an incentive-based model to encourage participation in biotech entrepreneurship. Only through a handsome reward system will people be motivated to deliver the best outcome. There was a billionaire in Taiwan and people thought he must be an excellent deal maker. One reporter asked him about how to achieve good business deals. He said that his business partner received 60% of the profit while he only got 40%. The reporter jokily said, "Then you are not a good deal maker at all!" The billionaire said, "My partner would go out and tell others about the deal he/she received. Nine more people would come to do business with me." In a nutshell, people are driven by high rewards.

While biotech entrepreneurship is our ultimate pursuit, the driving force to make it successful is basic research. One Nobel Prize laureate recently said that if our focus is only on translational medicine, ten years from now we will have nothing to translate. This statement reflects the importance of basic research in driving the success of biotech. Scientists, engineers, and even scholars in humanity and social science of all disciplines shall continue to thrive in basic research. Not only is basic research a critical component of scholarship, but it also informs innovation and entrepreneurship. For instance, scholars in psychological sciences can identify human behaviors in daily living, and the information can inspire innovations for better/smart living.

4. Action Plan of the Bio-X Constellation to Achieve Academic Excellence

4.1 Current Needs, Gaps, and Weaknesses

- Too few biologists or biomedical engineers to collaborate with: There are only a handful of life science researchers at S&T. Many scientists and engineers who possess novel ideas or technologies such as materials science, optic fiber sensors, click chemistry, nanoscience, microfluidic systems, artificial intelligence, etc. have had a hard time identifying collaborators on campus. We need to hire biologists or biomedical engineers. Further, a mechanism needs to be in place in order to identify the technologies that have already been on the shelves or in the making to advance technology patenting and transfer.
- An interdisciplinary Ph.D. degree program to consolidate scattered strengths and train students for interdisciplinary collaboration: S&T has in recent years hired competitive scientists and engineers who can advance the cause of the Bio-X Constellation. They are scattered in departments such as chemistry, biology, mathematics and statistics,

mechanical engineering, environmental engineering, electrical and computer engineering, and materials science and engineering. A difficulty for those hires is not having an interdisciplinary Ph.D. degree program to train graduate students for their needs in independent or collaborative research. Well-trained students are essential to faculty productivity.

- A better imaging capacity to conduct animal studies: Imaging is a crucial capacity in order to be successful in modern biological research of all sub-disciplines. The campus has been hampered by not having an adequate imaging facility for more than two decades. An Asian old saying states, “Without appropriate ingredients, a good cook cannot produce delicious dishes.” After multiple requests for 15 years, eventually, the university purchased a confocal microscope. A recent purchase of micro-CT out of the UM-System Tier-1 grant is another big plus. These are a very good start. Importantly, PIs on campus are in dire need of a couple of imaging equipment. A magnetic resonance imaging (MRI) system and an in vivo imaging system (IVIS) can certainly propel animal studies at S&T, which are an essential element when it comes to NIH funding.
- A need to structure partnerships with institutes in Missouri and neighboring states (WashU; SLU; Mizzou; Oklahoma; Illinois; Nebraska; Arkansas; NIH data/informatics centers): There is an old Chinese military saying, “If you cannot fight against your opponent, you may join them to grow yourself.” Since we do not have certain critical elements in pursuing NIH grant opportunities, we need to consider how to partner with other institutes to grow ourselves and eventually become independent.
- Lack of a structure to support biotech entrepreneurship (see the above section “How the Kummer Institute can Make its Name in Biotech Entrepreneurship”).

4.2 Actions to Take

- Mapping expertise: Members are encouraged to deposit their research quad charts as well as facility and skill set to the Bio-X Constellation shared google drive (https://drive.google.com/drive/u/0/folders/0AO8rI_hfHukyUk9PVA). By doing this, members will know each other's strengths and complementary skills for interdisciplinary collaboration.
- Platforms to brainstorm R&D ideas:
 1. Open laboratory visits to learn each other's technical capabilities.
 2. Visit and observe Phelps Health Hospital's medical operation to improve and/or integrate medical practice for better efficiency and fewer unnecessary medical mistakes. For instance, stethoscopes have been around for more than a century. Can something, such as digitalizing the information it detects, be done to make it a more versatile and powerful device? This can lead to innovation and entrepreneurship.
- NIH research proposal mentoring program: S&T PIs tended to have more success with NIH special calls than regular programs. This affirms that we at S&T have cutting edge technologies to meet the demand of biomedical applications. We shall maintain our current achievements. To improve the success rate of NIH regular programs and even extending to other health-related agencies such as EPA, NIOSH, Health Effect Institute, DoD, USDA, and academic societies (e.g., AACR, American Lung Association, American Diabetes Association, etc.), a team of experienced NIH grantees has been assembled to mentor PIs. Dr. Nuran Ercal, Hu Yang, Chang-Soo Kim, and Pericles

Stravopolous have graciously agreed to serve in this capacity. A key difference of the program from other existing, similar programs on campus is that it will have a systematic follow-up mechanism to achieve a better outcome. We anticipate to increase the funding rate with health-related funding opportunities through this venue.

- Invite and/or visit program directors of funding agencies: NIH has more than twenty institutes and centers. Although each one has a unique mission, there are also overlapping interests, making it a bit tricky when it comes to primary institute selection. For instance, if a proposal is interested in the effects of e-cigarettes on human health, either the National Institute of Environmental Health and Science (NIEHS) or the National Cancer Institute (NCI) would be a good fit. However, the difference is whether the research interest lies in lifestyle habits or not. If it is a lifestyle issue (i.e., primary smoking), it goes to NCI. If it addresses secondary and third-hand smoking, NIEHS picks up the proposal. Thus, it is critical to call agencies' program administrators to discuss research specifics. Importantly, the OVCR has been providing travel matching funds for PIs to visit program administrators. Under the current pandemic, we can invite program administrators to have Zoom meetings with us.
- Partnerships with other institutes and universities.

Existing Resources on Campus

- Ph.D. degree program in chemical and biochemical engineering
- Ph.D. degree program in materials science and engineering
- Bachelor of Science program and Master's degree program in Biological Sciences
- Biomedical Engineering (BME) degree minor program
- Center for Biomedical Research (CBR)
- Material Research Center (MRC)
- Imaging Facility (confocal microscope; managed by CBR)
- Animal Research Facility (old; brand new vivarium in April 2021)
- Histology Laboratory (housed in biological sciences dept.)
- The Delbert Day Cancer Institute (DDCI) at Phelps Health
- The Ozark Biomedical Initiative (OBI) with Phelps Health
- Missouri S&T Field Station (ecology, evolution, environment)

Funding Opportunities (Selected; Health)

- National Institutes of Health (NIH)
- Department of Defense (DoD)
- American Heart Association (AHA)
- Susan G. Komen Foundation
- Health Effect Institute (HEI)
- National Institute for Occupational Safety and Health (NIOSH)
- Department of Energy (DoE)
- National Aeronautics and Space Administration (NASA)
- Environmental Protection Agency (EPA)
- National Science Foundation (NSF)
- Food and Drug Administration (FDA)

- Midwest Biomedical Accelerator Consortium (MBArc) – Under NIH REACH Program
- Industries (pharmaceutical companies; biotech companies, etc)

Funding Opportunities (Selected; Environment)

- US Fish and Wildlife Service (USFWS)
- US Geological Survey (USGS)
- US Environmental Protection Agency (EPA)
- US Department of Agriculture (USDA)
- National Science Foundation (NSF)
- State/region agencies:
 - MO Department of Natural Resources
 - MO Department of Conservation
 - MO Water Resource Research Center
 - St. Louis Zoo
- Industry (Doe Run, etc)

Information Hubs (Selected)

- National Center for Biotechnology Information (host gigantic databases; <https://www.ncbi.nlm.nih.gov>)
- Comprehensive Cancer Centers of medical schools in the USA
- The European Bioinformatics Institute (EMBL-EBI) (<https://www.ebi.ac.uk>)
- RCSB PDB (Protein Data Bank) (<https://www.rcsb.org>)
- The Antimicrobial Peptide Database (<http://aps.unmc.edu/AP/main.php>)

List of Bio-X Constellation Members:

See Appendix 2 (research quad charts)

Appendix 1

Slides #1 – #14

Bio-X (Constellation):

Converging Natural Science, Engineering,
and Humanity/Social Science



S&T 2020 Research Road Map

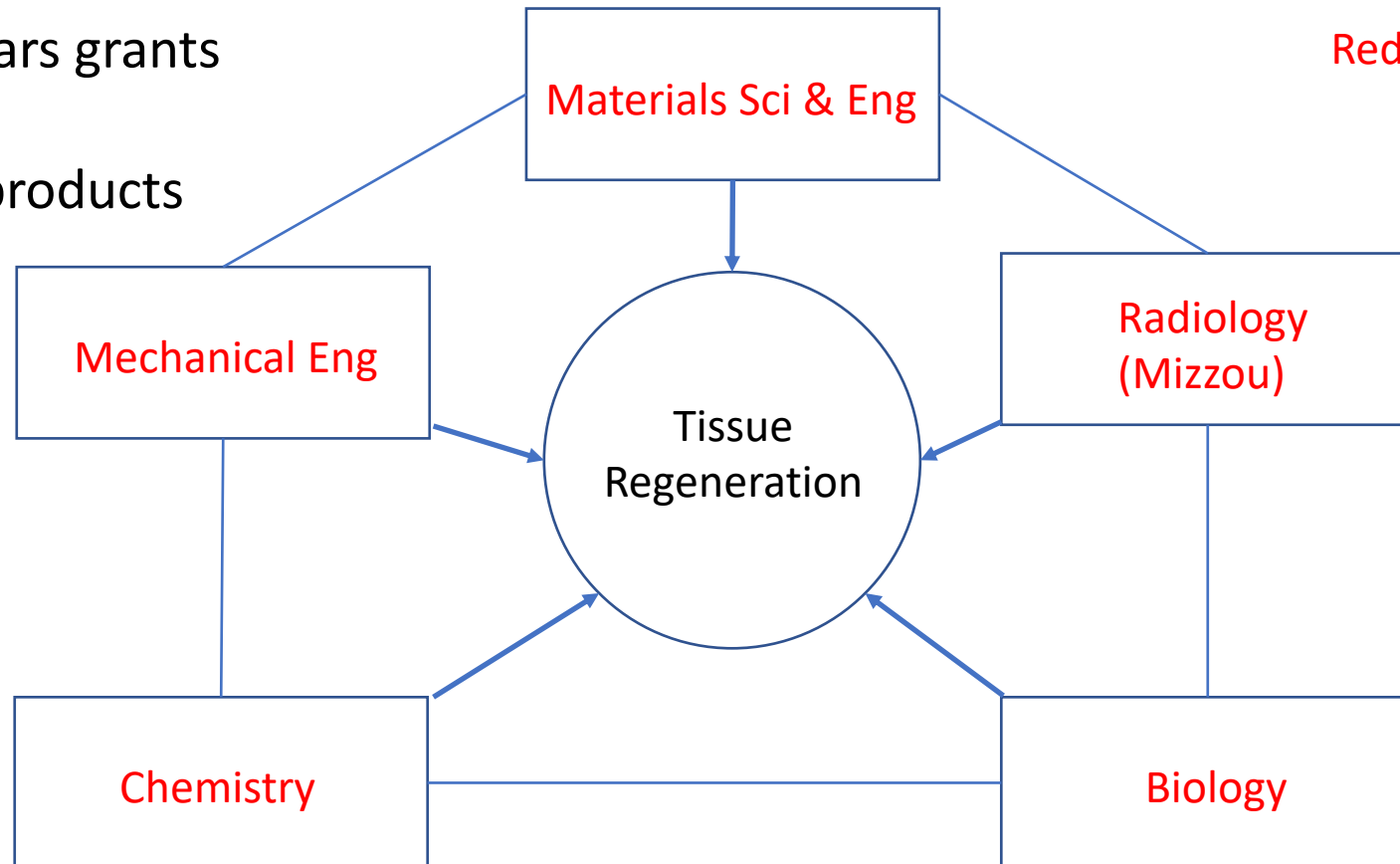
Inter- or Trans-disciplinary Strengths and Examples

- Biomaterials (tissue regeneration: bone and wound)
- Bioprinting
- Traumatic brain injuries (TBI)
- Sleep Biology
- COVID-19 pandemic related topics
- Drug delivery
- Ecological / environmental

Inter- or Trans-disciplinary Strengths and Examples

(Making the pie bigger)

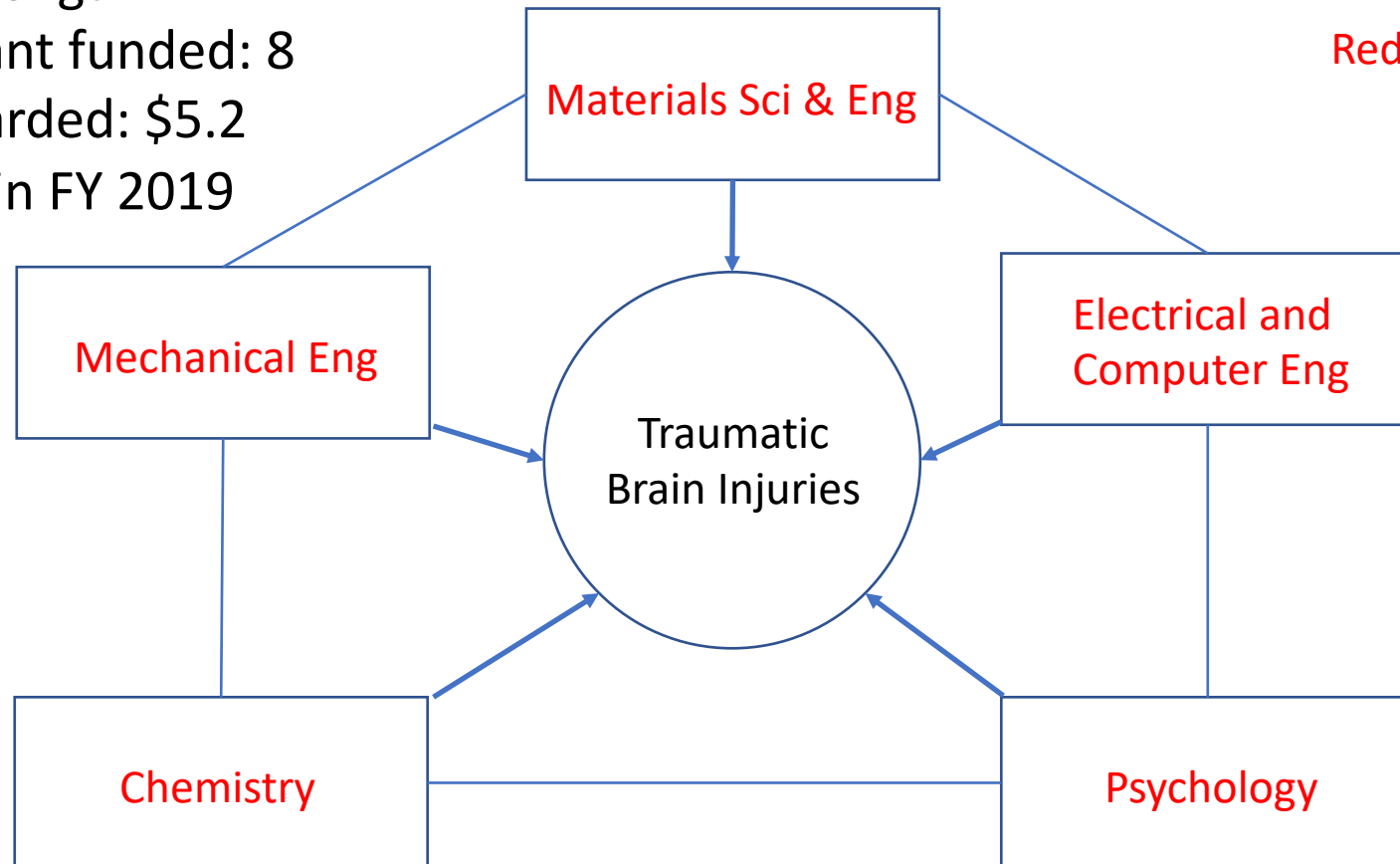
- A long history of success
- Multi-million dollars grants
- Many patents
- Commercialized products



Inter- or Trans-disciplinary Strengths and Examples

(Making the pie bigger)

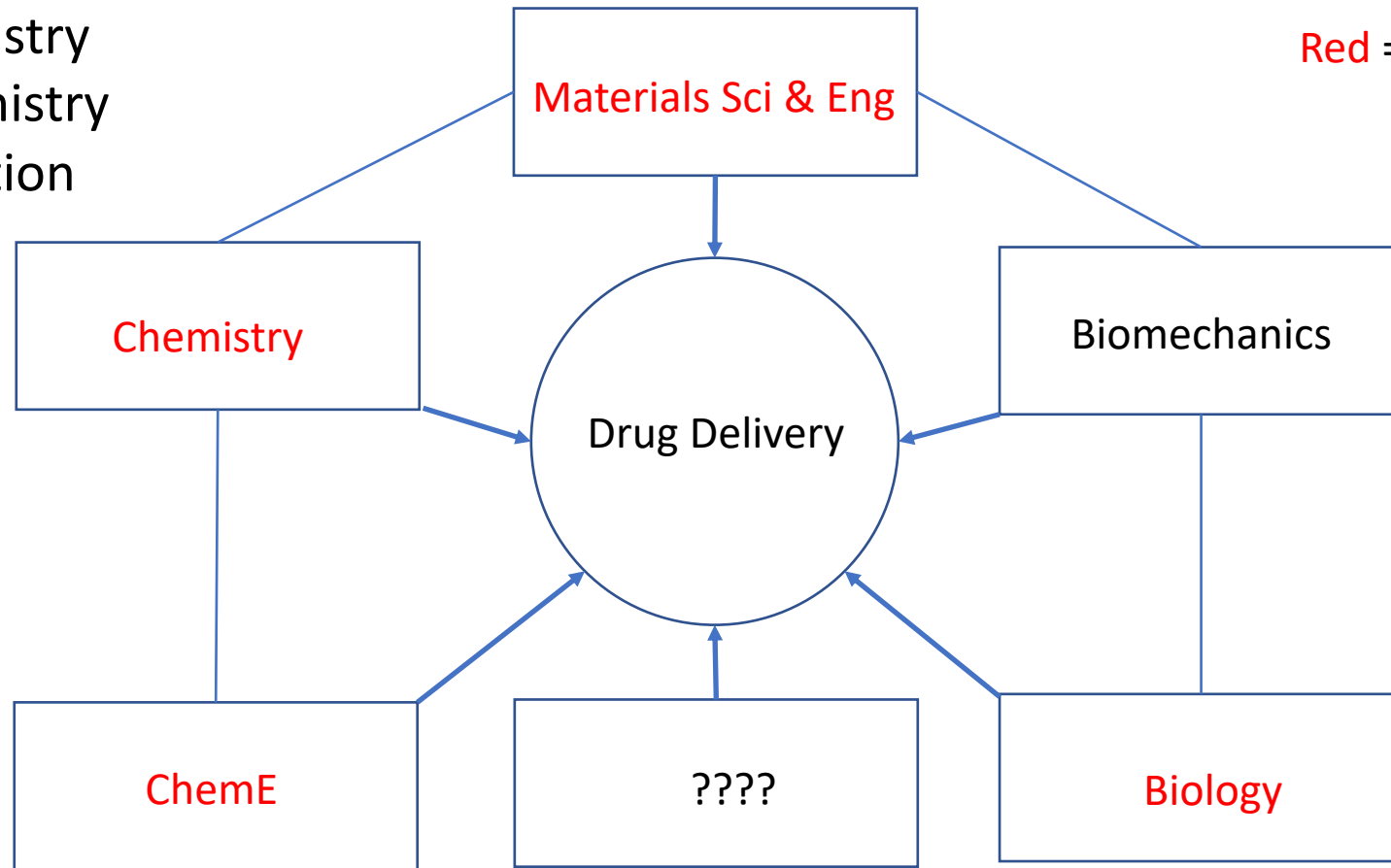
- An area of new strength
- No. of External grant funded: 8
- External grant awarded: \$5.2 million from DOD in FY 2019



Inter- or Trans-disciplinary Strengths and Examples

(Making the pie bigger)

- Two NIH R01 awards
 - Surface chemistry
 - Polymer chemistry
 - Drug formulation

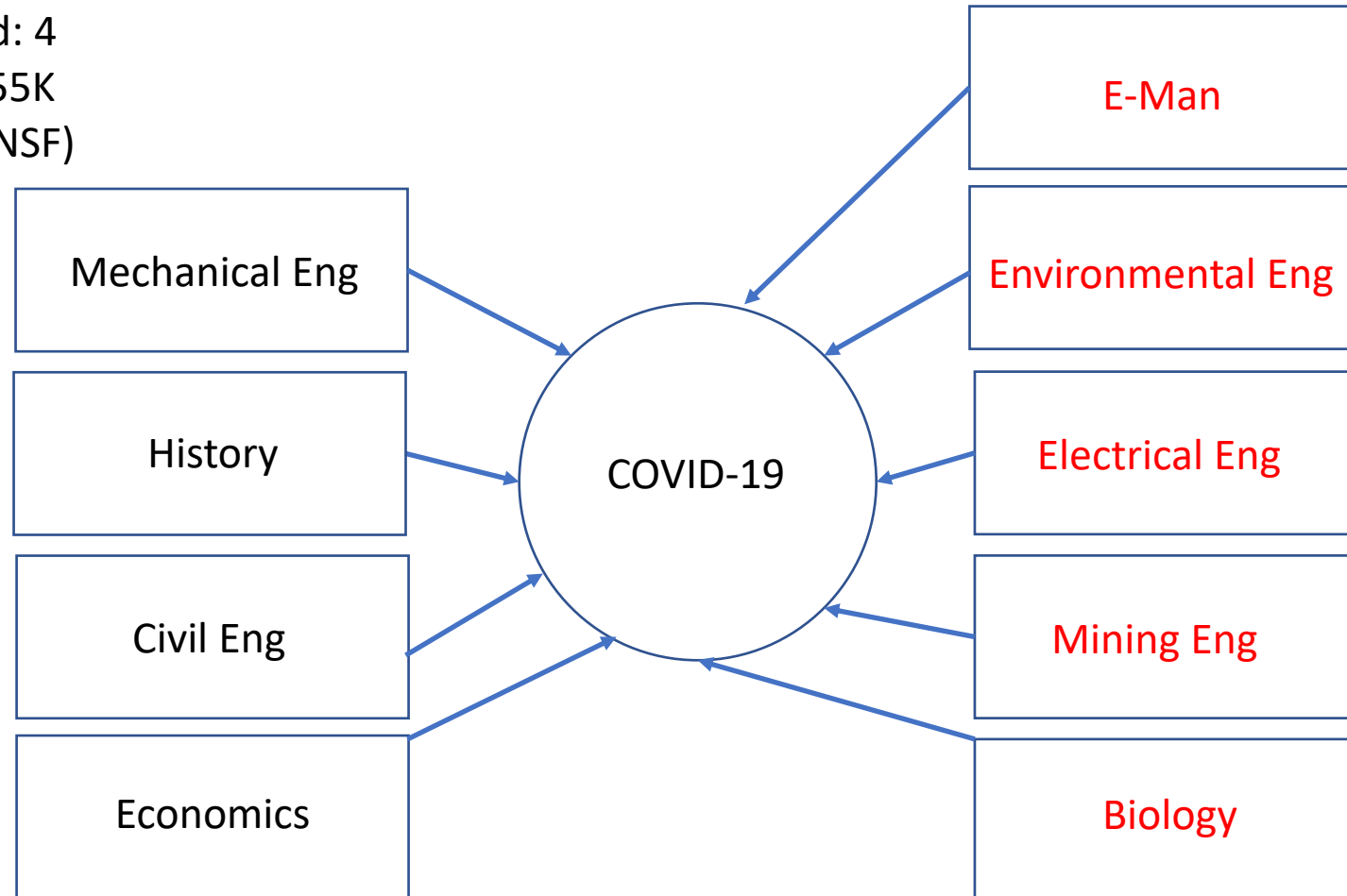


Inter- or Trans-disciplinary Strengths and Examples

(Making the pie bigger)

Red = participated & funded

- An area of new strength
- No. of external grant funded: 4
- External grant awarded: \$555K million in FY 2019 (2 major NSF)
- Pending proposals:
 - 13 proposals
 - \$11.27 million
 - DoD, NIH, NSF
 - Merck
 - Spencer Foundation
 - MTEC



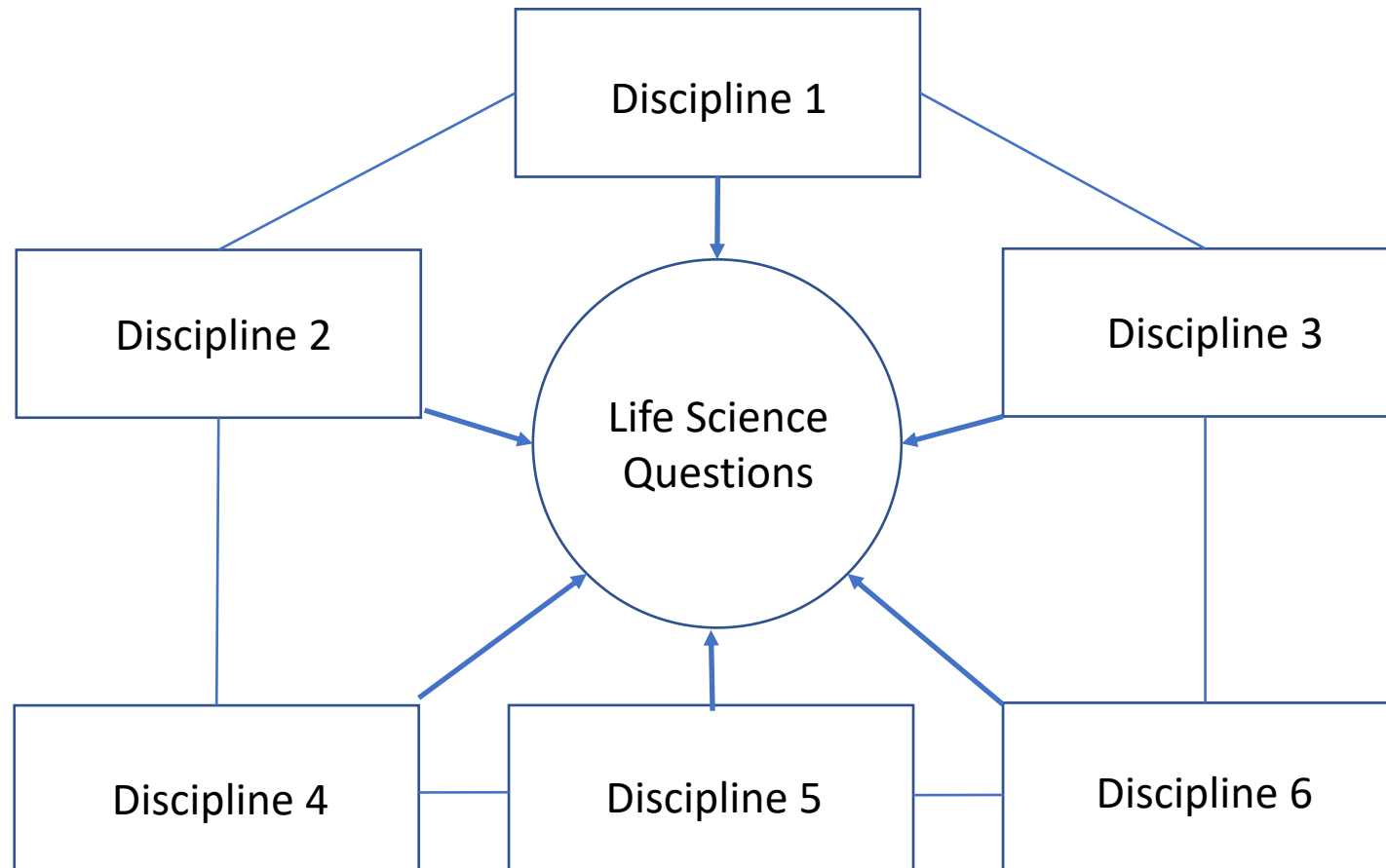
Other Health Related Pursuits on Campus

1. Eye research (disease treatment) - **funded**
2. Biomarkers for disease diagnosis - **funded**
3. Chemistry for pharmaceuticals and agrochemicals – **funded**
4. Machine learning and cardiovascular diseases - **Funded**
5. Imaging and diseases
6. Metabolism and health
7. Music and neurodegenerative diseases
8. Sensor related to MRI or Diabetes
9. AI to enhance instrument algorithm
10. Bioinformatics / Medical Informatics
11. Disease data modeling (computational modeling)

3-9 items:

- 14 NIH proposals (10/19 – 06/20)
- Total = \$7.5 million

Emerging Research Areas



Emerging Areas

- Health informatics
- Biosystem automation
- Bioprinting and tissue engineering
- Drug delivery and discovery
- Mental health and pandemic (music, painting, performing arts, misinformation, etc.)
- Health intelligence and eco-canary species
- Ecological / Environmental / Evolutionary

S&T New Area of Interest

- Intellectual property (biotech entrepreneurship)
- Biotech incubator
- Finding gold is good. But most failed.
- Providing picks and shovels is a lucrative market.

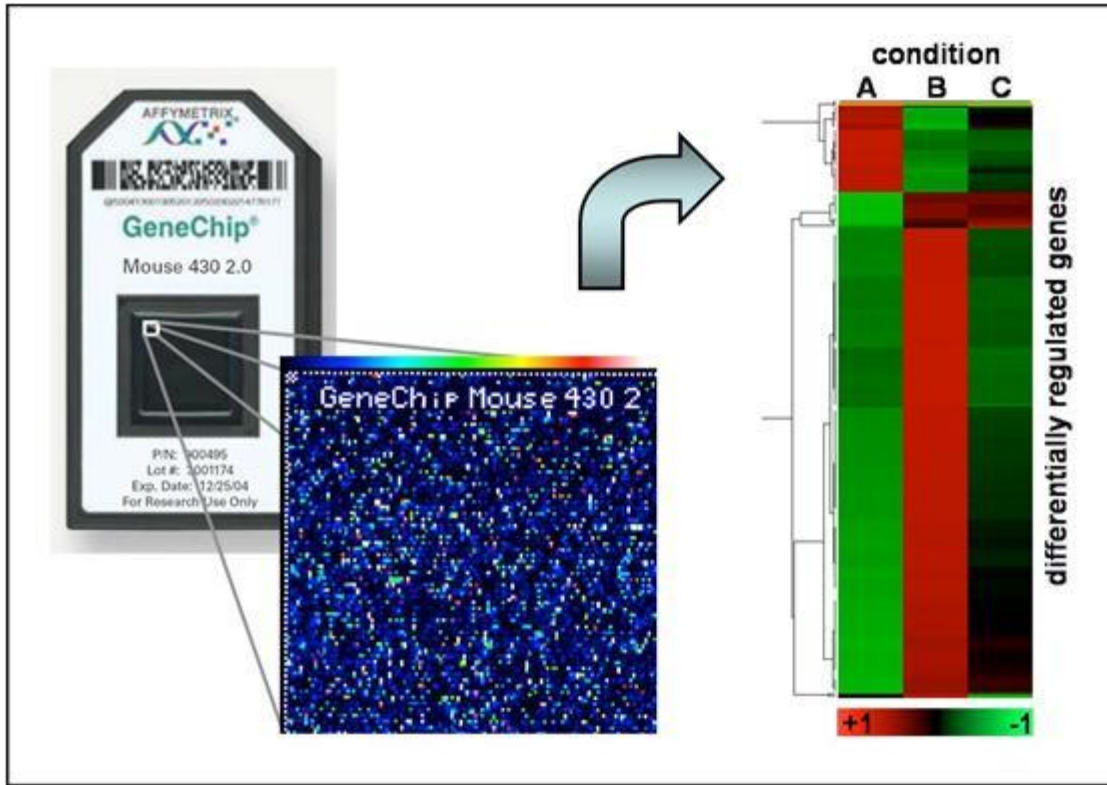


Biotech & Gold Rush

Picks and Shovels for Gold Rush

- PharMigen (California, sold to BD in 1997)
 - Founder: Dr. Ernest Chun-Ming Huang
 - Antibodies; reagents; assay kits
- Clontech (California, sold to BD in 1999; \$200 million)
 - Founder: Dr. Kenneth Fong
 - Enzymes; reagents; vectors; assay kits
- S&T cDNA Resource Center (Brought from Guthrie Res. Inst.)
 - Founder: Robert S. Aronstam
 - cDNA clones

Biotech Entrepreneurship



Affymetrix GeneChip

Multi-billion dollar adventure

- Combinatorial chemistry
- Photolithographic fabrication
- Robot spotting
- Computing algorithm/graphics



- Material science
- System automation
- Electrical engineering
- Computer science
- Biology
- Marketing (consultants)



Traditional gene studies
(one tube at a time)

Biotech Entrepreneurship



Flow Cytometer: cell sorting, fluorescent detection
Examples: viability, cell death, proliferation, cell cycle, stem cell research

Biotech Entrepreneurship



Automated Cell Counter

- Biology
- Computer science (AI?)
- Electrical engineering
- Marketing



Traditional Counting

Biotech Entrepreneurship

- Biology
- System automation (ME, Electrical)
- Marketing



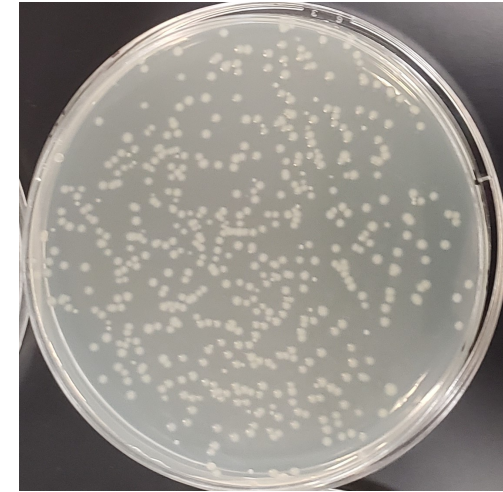
Automated Nucleic Acid Extraction Systems

Traditional Extraction

Biotech Entrepreneurship



Automated colony counting system



Traditional Counting

Appendix 2

Research Quad Charts (in alphabetical order of last name)

1. Belfi, Amy
2. Brow, Richard K.
3. Castano Giraldo, Carlos H.
4. Duvernell, David
5. Akin, Elvan
6. Ercal, Nuran
7. Fahrenheitz, William
8. Forciniti, Daniel
9. Huang, Jie
10. Huang, Yue-Wern
11. Insall, Matt
12. Kania-Gosche, Beth
13. Kueny, Claire R.
14. Leu, Ming
15. Liu, Jinling
16. Liu, Wenyan
17. Mochalin, Vadym
18. Murphy, Jason
19. Cen, Nan
20. Semon, Julie
21. Shi, Honglan
22. Wang, Cheng
23. Wang, Jee-Ching
24. Wang, Risheng
25. Wang, Yang
26. Westenberg, Dave
27. Wu, Chenglin
28. Yang, Hu

Cognitive neuroscience and psychology of music

Some Current Projects:

Autobiographical Memory

- Which memory cues (music or others) are most effective in healthy aging and Alzheimer's disease?

Emotion, Preference, and Choice

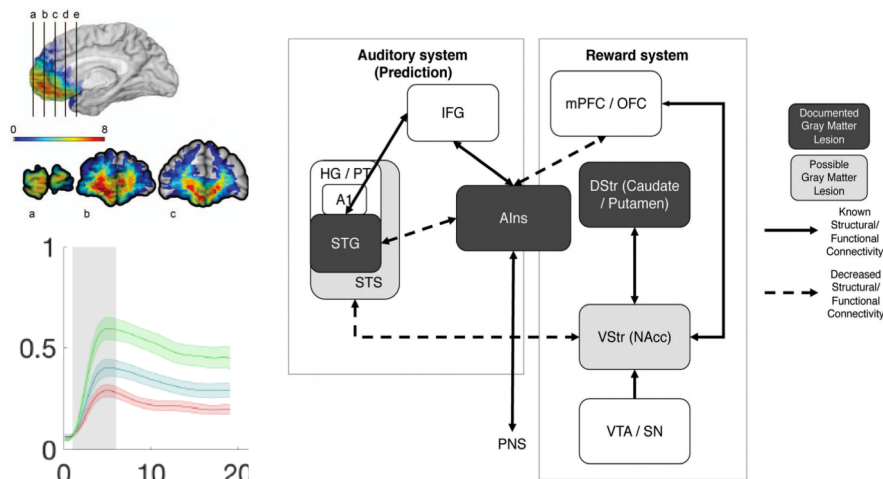
- How do individuals make aesthetic choices over time ("Why do we like what we like?")
- What are the characteristics of selective musical anhedonia, and does this change across the lifespan?

Conceptual Representations

- What are the neural correlates of lexical and conceptual retrieval for semantically unique items (e.g., songs, faces)?

Methods

- Behavior, neuropsychology, psychophysiology (ECG, EDA), fMRI



Neuropsychological studies of patients with focal brain damage (Belfi et al., 2018); continuous ratings of aesthetic preferences (Belfi et al., 2019); neuroanatomical model of musical anhedonia (Belfi & Loui, 2020)

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PhD, Neuroscience,
University of Iowa
<https://www.amybelfi.com>

Keywords

- Cognitive psychology, neuroscience, neuropsychology, music, memory, emotion, language, preferences, aging

Potential Collaboration fields

- Cognitive neuroscience, auditory perception, neurological disorders, memory, emotion, language, decision-making

[Google Scholar Profile](#)

Materials for Biomedical Applications

Bioactive Glasses for Wound Healing

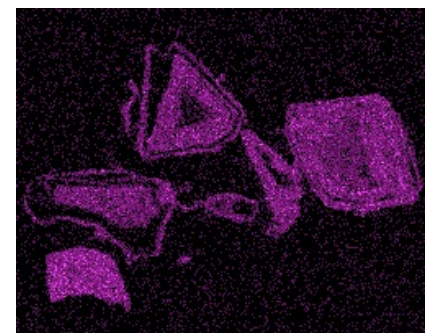
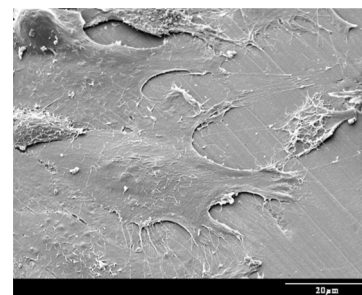
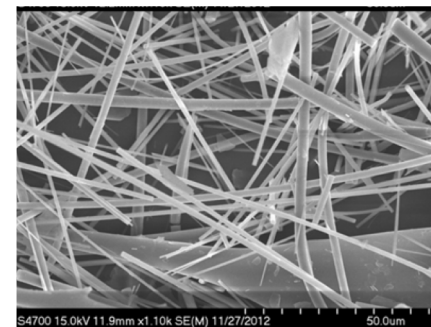
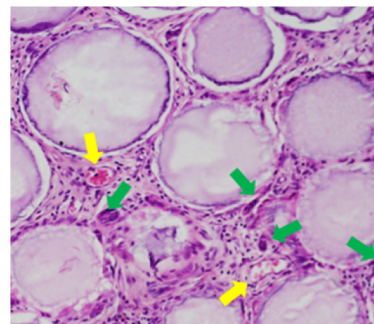
- Controlled release compositions that stimulate soft-tissue repair; technology is commercially available
- Fibers and micro-particles designed for anti-bacterial and hemostatic responses
- Clinical studies indicate reduced scarring compared with other treatments

Glass- and Ceramic-Based Scaffolds for Bone Repair

- Microstructures that simulate bone structures, with similar compressive strengths; nanoporosity for drug delivery
- Additive manufacturing techniques
- Promote bone regeneration in animal models

Composites with Hydrogels

- Bio-printed composites including stem cells to regenerate tissue for personalized care



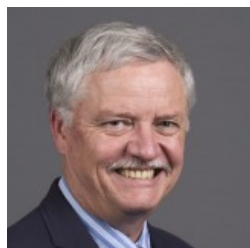
PoC: Richard K. Brow, Director, *Center for Biomedical Research*, Curators' Distinguished Professor of Materials Science and Engineering.

brow@mst.edu

573-341-6812

Prior Funding Sources

- U.S. Army Medical Research Acquisition Activity
- National Institutes of Health
- National Science Foundation



Keywords

- Tissue regeneration, wound healing, bioactive materials, composites, stem cells

Recognitions

- Fellow and Past President, American Ceramic Society
- President, 25th International Congress on Glass

Collaborative Interests

- Tissue engineering, controlled release materials, biomedical devices, bio-interfaces, dental materials

Nuclear NanoRadioIsotopes

Nanotechnology and Nuclear Radiation

- Production of Nanomaterials with Radiation
- Carbon Nanotubes Adorned with Transition Metals
- Radioactive Metal Nanoparticles for Cancer Treatment

In-Vitro Testing Facilities

- Creation of a facility to study the toxicity of Nanoradioisotopes produced at the Missouri S&T research reactor (MSTR) on cancer cells.

In-Vivo Testing Facilities

- Facility Integration for the Synthesis and testing of Radio-Nano-Isotopes At Missouri S&T.
- Testing facility for radioactive isotopes.

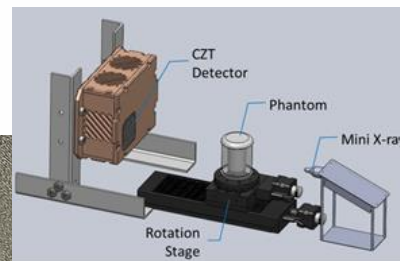
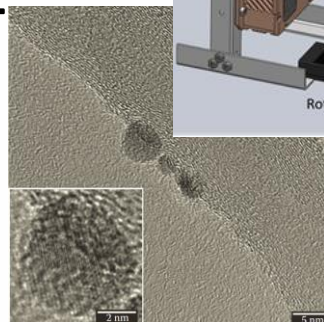
PoC

- Carlos H. Castano Giraldo, Associate Professor of Nuclear Engineering
- E-Mail: castanoc@mst.edu
- Website: <http://web.mst.edu/~castanoc>
- Phone: (573) 341-6766

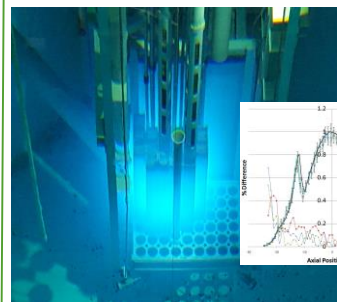


Funding

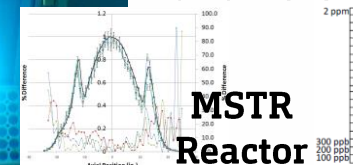
- NRC Grant HQ-12-G-38-0075: Laboratory on Corrosion of Nuclear Materials. \$194,447.
- NRC Grant 38-10-966. Creation of a Radiochemistry Teaching Program at S&T. \$125,000.
- DOE. MSTR Reactor Upgrade. \$300,000.



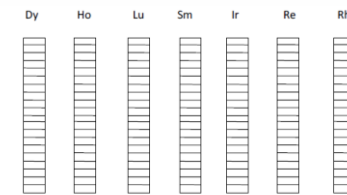
Radioactive Metal Nanoparticles for Cancer Treatment



Axial Flux Profile



MSTR Reactor Upgrade



Nuclear Barcode

Keywords: Nanotechnology (irradiation of chemical systems). Field emission for X-ray flat panel display. Modeling and validation of nuclear systems (MSTR). New shielding materials for neutrons and gammas using Chemically Bonded Phosphate Ceramics (CBPCs)

Publications and Recognitions:

- 40+ peer-reviewed journal papers, 3 book chapters, H-index: 13
- **US Patent 9299526:** "Method to Fabricate Portable Electron Source Based on Nitrogen Incorporated Ultrananocrystalline Diamond (N-UNCD)".
- **2016 US Provisional Patent Application Serial No. 62/460,927.** "Direct Synthesis of Radioactive Nanoparticles Involving Neutrons"
- **2017 US Provisional Patent Application Serial No. 62/529,907.** "Novel Explosives Identification Taggant Using Rare Elements".

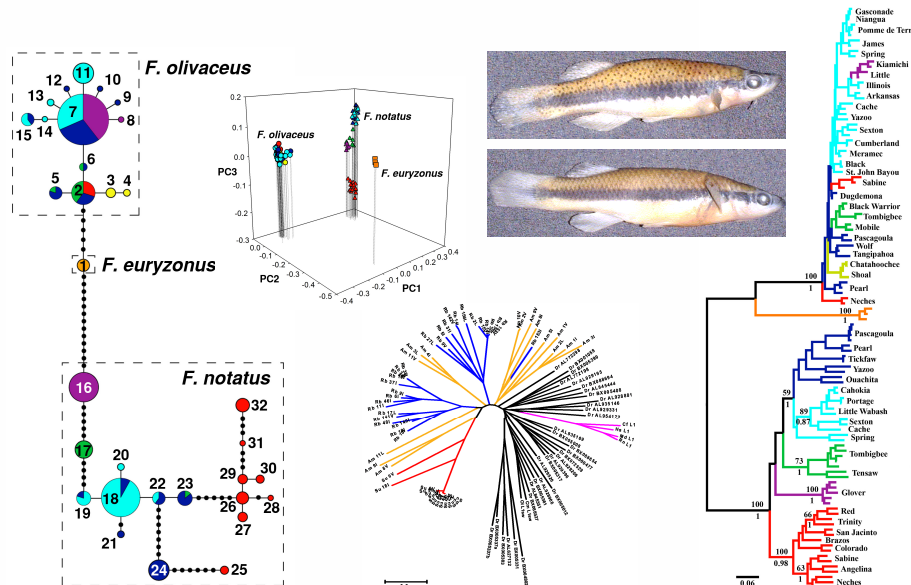
Population Genetics/Genomics

Natural Selection and Speciation Studies

- Evolutionary ecology of topminnows (genus *Fundulus*).
- Chromosomal rearrangements and reproductive isolation.
- Evolution of metabolic pathway genes in *Drosophila*.
- Retrotransposable elements in vertebrate genomes.

Environmental DNA and Metagenomics

- Methods for surveying species diversity and community structure using metagenomic DNA sequencing techniques.
- DNA sequence and assembly of mitogenomes.



Contact Information:

David Duvernell

Professor

Department of Biological Sci.

Email: duverneld@mst.edu

Phone: (573) 341-6988

[Google Scholar Profile](#)



Keywords

- Environmental DNA, metagenomics, Genotype by Sequencing, phylogenetics, population genetics, natural selection, speciation.

Funding

- NSF, NIH, Missouri Department of Conservation, Fort Leonard Wood.

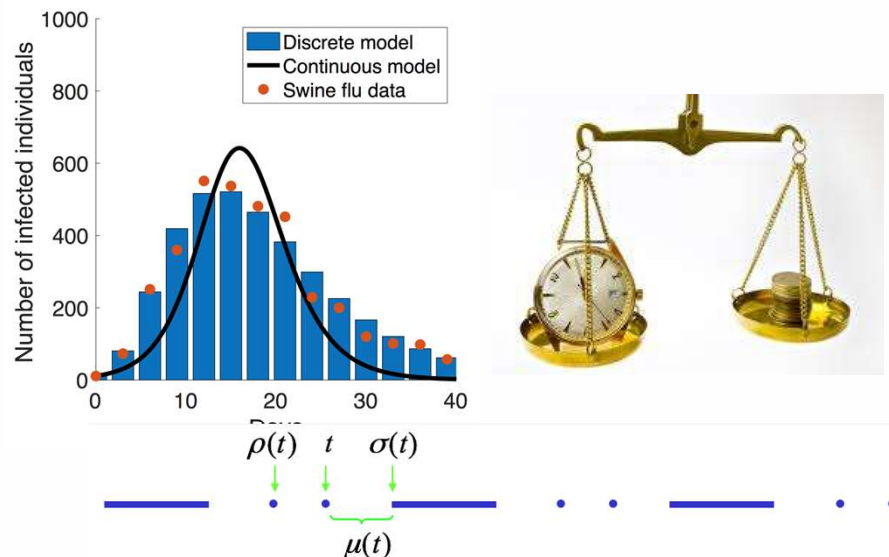
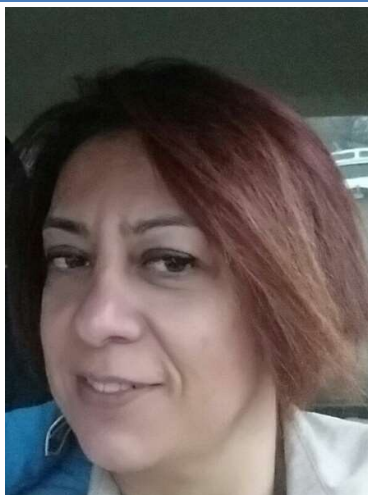
DYNAMIC EQUATIONS WITH THEIR APPLICATIONS

Research Topics

- Differential, Difference, Dynamic Equations
- The Theory of Time Scales
Unification of Continuous and Discrete Analysis
- Infectious Disease Modeling on Time Scales
HIV-1, Swine Flu, Tuberculosis, COVID-19
- Oscillation Theory
- Dynamical Systems
- Inequalities
- Stability Theory
- Boundary Value Problems
- Control Theory

Contact Information

- **Elvan Akin**, Ph.D.
- Full Professor of Mathematics
- akine@mst.edu
- 573-341 6677
- <http://web.mst.edu/~akine>



Keywords

Time Scales, Dynamic Equations, Infectious Diseases

Recognitions/Significant Achievements/Fellowships

- NSF-AWM Travel and Mentoring Grants
- University of Missouri System Leadership Development Program 2020
- Honorary Knight of Saint Patrick's 2006
- New Faculty Teaching Scholarship, University of Missouri-Rolla 2004-2005
- The Emeritus Faculty Fellowship, University of Nebraska-Lincoln 1999-2000
- Fellowship from the Ministry of Education, Turkey 1995-2000

Redox Biology, Bioanalytical Chemistry

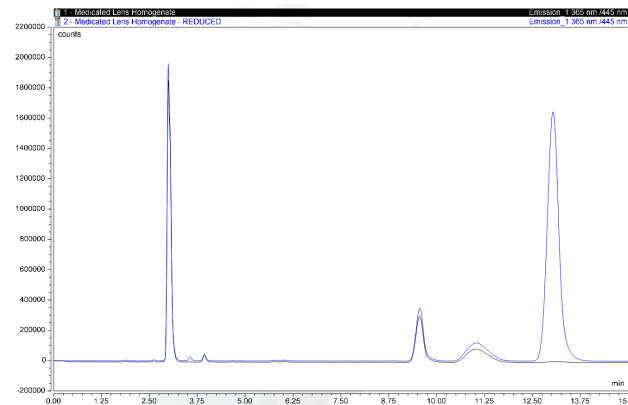
Research Topics

- Effects of free radicals and antioxidants in living systems
 - Analytical methods for detection and quantification of redox-active molecules in biological matrices
- Thiol antioxidants for the treatment of age-related eye disorders
 - Eye drop formulation for non-invasive prevention/reversal of cataracts
 - *In vivo* and *in vitro* investigations of drug delivery vehicles to increase effectiveness of thiol drug candidates for cataract therapy

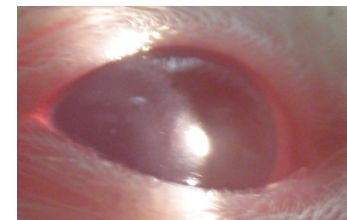
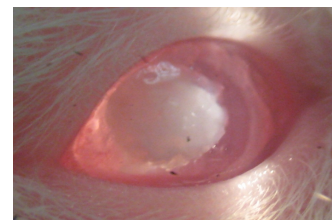
Facilities

Schrenk Hall, Room 238

HPLC investigation of thiol drug (tiopronin) pharmacokinetics in rat lens.



Novel thiol antioxidant NACA reverses cataracts in Wistar rats.



PoC

- Dr. Nuran Ercal, Richard K. Vitek/FCR
Endowed Chair in Biochemistry, Chemistry
- nercal@mst.edu (573)341-6950

Funding

- National Institutes of Health, National Eye Institute, Environmental Protection Agency



Keywords

- antioxidants, cataracts, drug delivery, bioanalytical chemistry, oxidative stress

Recognitions/Significant Achievements

- Multiple awards, Missouri S&T Outstanding Teacher Award
- Multiple awards, Missouri S&T Faculty Excellence Award
- Woman of the Year Award, Missouri S&T, 2003

Areas for Potential Collaboration

- Materials science, polymer chemistry, *in vivo* imaging, ophthalmology

Ceramics for Extreme Environments

Ultra-high temperature ceramics

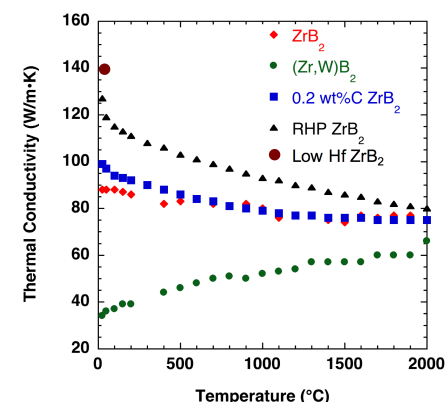
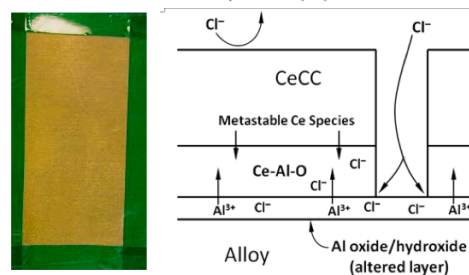
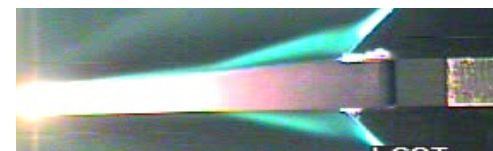
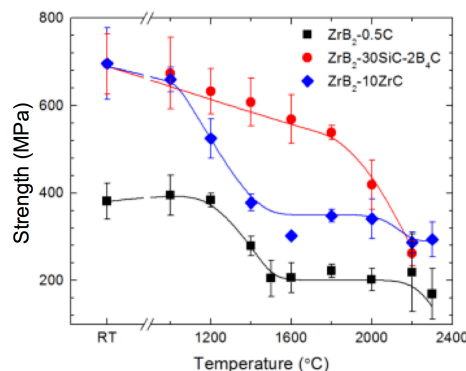
- Synthesis, processing, microstructure-property relations, and oxidation of boride and carbide ceramics
- Unique combination of facilities for characterization of thermal, electrical, and mechanical properties at temperatures up to at least 2000°C

Rare-earth based coatings for corrosion protection

- Cerium-based conversion coatings for corrosion protection of light metal alloys
- Corrosion mechanisms, deposition, electrochemical characterization,

Ceramic materials expertise

- Reactive processing, traditional ceramics, ceramic-metal composites, joining, and thermodynamic analysis



Synthesis, processing, characterization, and testing of materials for extreme environments

PoC: Bill Fahrenholtz

Curators' Distinguished Professor
billf@mst.edu, 573-341-6343



Funding

- National Science Foundation
- Air Force Office of Scientific Research
- Office of Naval Research
- Strategic Environmental Research and Development Program

Keywords

- Ultra-high temperature ceramics, zirconium diboride, ceramic processing, thermodynamics, cerium oxide, cerium-based conversion coatings, joining, structural ceramics, detonation synthesis, materials for extreme environments

Recognitions

- Editor-in-Chief, Journal of the American Ceramic Society
- Fellow, American Ceramic Society
- Director of Materials Research Center at Missouri S&T
- SERDP Project of the Year, Weapons Sys. And Plat. 2012
- Greaves-Walker Lifetime Service Award, NICE, 2013

PROTEIN AGGREGATION AND ITS CONNECTION TO DISEASE

Use of light and neutron scattering in biology

- Use of light and neutron scattering for the characterization of glycosylated and non glycosylated proteins in bulk and at interfaces.
- Use of light scattering for the characterization of amyloid fibrils form by proteins, hormones and peptides.

Computer simulations of protein and peptide aggregation

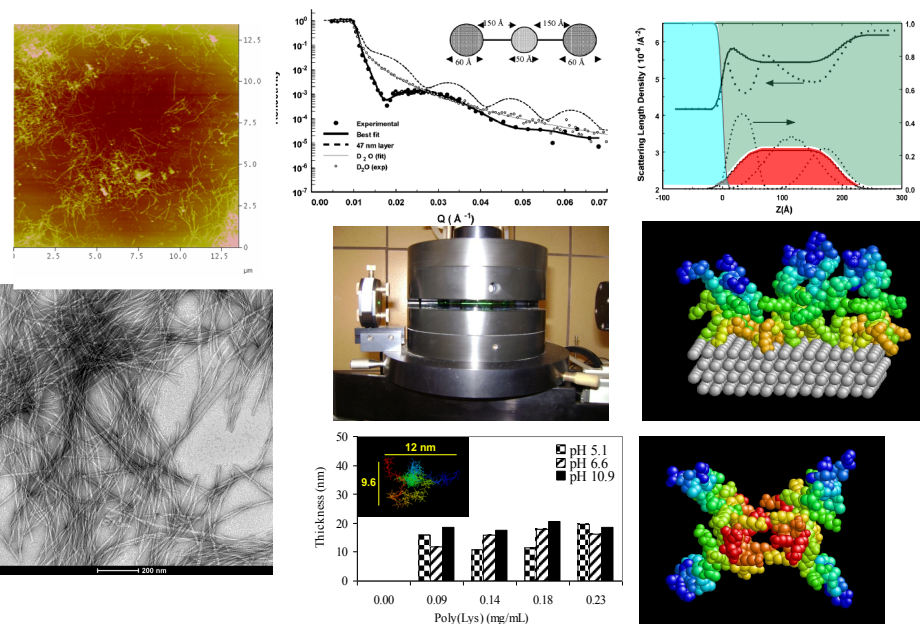
- Use of molecular simulations for the understanding of the protein aggregation process both in bulk and at solid-liquid interfaces.

Synthesis and characterization of protein fragments.

- Solid phase synthesis of short peptides to study the aggregation behavior of homologues proteins.

Neutron reflectivity studies of protein at interfaces.

- Use of neutron reflectivity to elucidate molecular level features of plasma protein deposits at solid-liquid interfaces.



Experimental and computational studies to understand the aggregation of proteins and short peptides.

PoC: Daniel Forciniti, Professor and Associate Provost, Chem. and Biochem. Eng. Department, forcinit@mst.edu
web.mst.edu/~forcinit



Funding

- NSF

Keywords

- Light scattering, neutron scattering, plasma proteins, antibodies, molecular simulations.

Recognitions

- Biomedical Engineering Award, Whitaker Foundation, 1995.

Advanced Sensors Enable New Frontiers in Basic & Applied Research

Research Thrust

➤ Innovating Advanced Fiber Optic Sensor Systems

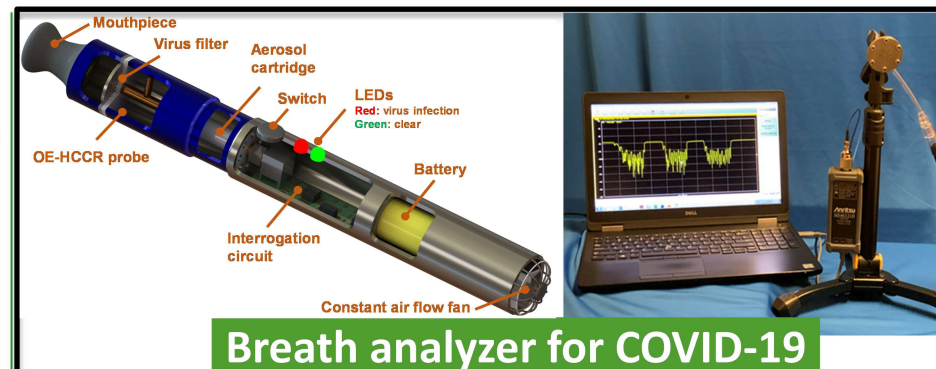
- Human hair-like sensors (small size, light-weight, immune to EMI)
- Spatially-distributed, high-speed sensing (multiple sensors per fiber)
- Diverse measurement capabilities (pressure, strain, temperature, inclination, chemical threats, flow, EM fields, etc.)

➤ Advanced Sensors for Human Health Applications

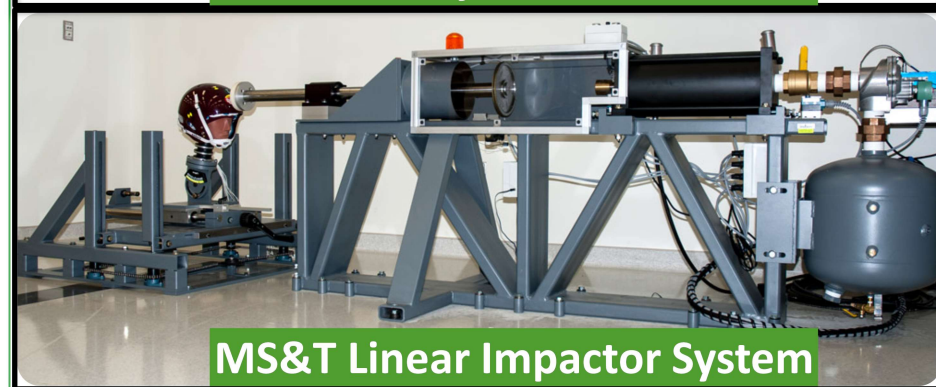
- Electronic probe for testing of SARS-CoV-2 from breath
- Breath Analysis in Disease Diagnosis
- Smart Helmet equipped with fiber-optic sensors
- Link Smart Helmet Results to Biomarker Results

➤ Applying Sensors with Ultrahigh Sensitivity and Resolution in Basic & Applied Research

- Fiber optic sensors in harsh environment (e.g., steel industry)
- Fiber optic sensors for military applications
- Fiber optic sensors for structural health monitoring applications
- Novel coaxial cable sensors for human health applications



Breath analyzer for COVID-19



MS&T Linear Impactor System

Principal Investigator

Jie Huang, Assistant Professor
Electrical and Computer Engineering
Missouri S&T
jieh@mst.edu; (573) 341-4836

Recent Funding: (~\$8M) NSF, NIH, ARL, DOE, AFOSR, National labs, PSMRC, and select private companies.



Awards

- Faculty Excellence Award at Missouri S&T 2019
- Research Momentum Award at Missouri S&T 2019
- Economic Development Award at Missouri S&T 2019
- IEEE St. Louis Section Outstanding Researcher 2019

Keywords

- #Fiber optic sensors, #Medical sensors, #Measurement and instrumentation

Nanobiotechnology and Toxicology

• Drug Delivery Platforms

Develop nanocarrier platforms to deliver biologically active molecules *in vitro* and *in vivo* for basic science research and biomedical applications such as disease treatment (e.g., cancer, brain injuries) and tissue regeneration (e.g. bone regeneration)

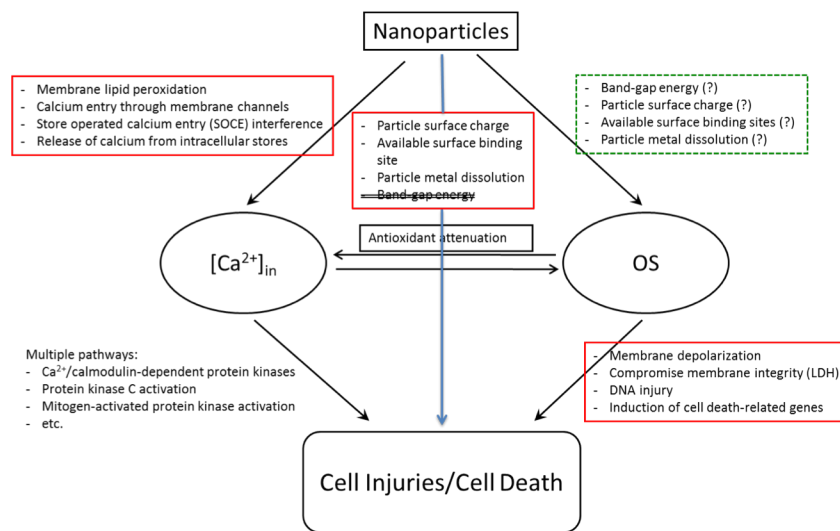
• Toxic or Injurious Effects by Environmental Stressors

Investigate adverse health effects caused by environmental physical and chemical factors. Identify pathways of injuries that lead to better and efficient disease treatment

• Environmental Toxicology

Study toxic effects of environmental chemicals such as pharmaceuticals, phytochemicals, e-cigarette, and industrial chemicals on humans and the environment

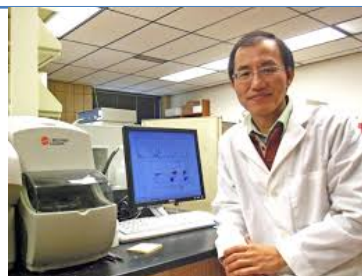
• Indoor Pathogens (Bioaerosols) and Inhalation Biology



Nanomaterial toxicity involves multiple cellular and molecular signaling pathways

PoC

- Yue-Wern Huang, Professor
- E-Mail: huangy@mst.edu
- Website: web.mst.edu/~huangy
- Phone: 1-573-341-6589



Funding

- Funding agencies: NSF, NIH, USEPA, US Fish and Wildlife Service, US Geological Survey, Missouri DNR, Missouri Department of Conservation, St. Louis Zoo, Doe Run Company

Keywords: Drug delivery; Toxicology; Nanomaterials; Tissue regeneration; Indoor pathogens (bioaerosols); Antimicrobial materials

Publications and Recognitions:

- > 60 peer-reviewed journal papers & 12 book chapters in 20 years
- Plenary speaker of two international conferences
- 23 Public media exposure; 35 invited seminars of internationally known institutes
- Three editorial boards & EPA TSCA Science Advisory Committee on chemicals
- S&T Faculty Excellence Award and Faculty Research Award

Mathematics and Logic for BioTech Modeling

Metrics for Image Classification and Data Analysis

- Integral Metrics provably more sensitive to feature variations than traditional hyperspace metrics used (e.g., Hausdorff metric) in image analysis
- Quantifying errors in proposed sketches or maps as compared to an exemplar

Algebra, Logic, & topology

- Dioid-based Neural Networks Generalize Max-Plus Algebra Approaches for Discrete Event Dynamical Systems
- Simple structures unify generalized metric notions

Economics and Public Policy

- Merely increasing emission taxes may lead to perverse incentives

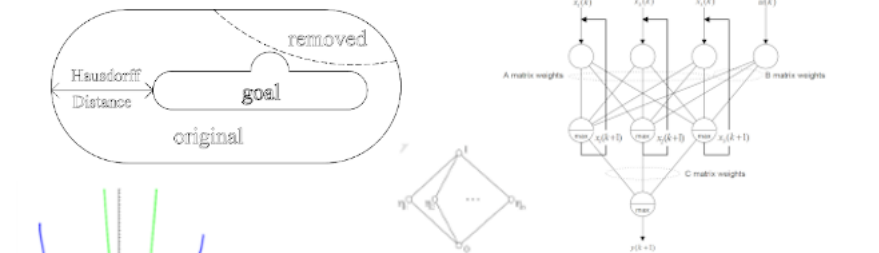
Analysis and Chemistry

- The Complete Iterative Inversion Method works very well on Lennard-Jones energy profiles, but almost exclusively so

PoC: Matt Insall, Associate Professor of Mathematics, *Department of Mathematics and Statistics*, President of Graduate Faculty. insall@mst.edu
573-341-4901; 573-340-8341

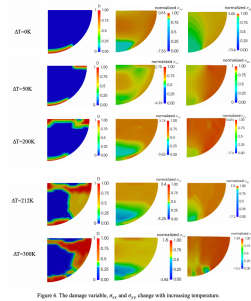
Published In:

- Top. & Applic. (ISSN: 0166-8641)
- Top. Proc. (ISSN: 2331-1290)
- Differ Equ Dyn Syst (ISSN: 0974-6870)
- Environ Econ Policy Stud (ISSN: 1867-383X)



Theorem 4.3 Let φ_0 and φ be commensurable monomial potentials. Then $CIIM(\varphi_0, \varphi)$ converges to φ in a single step.

Proposition 2 As emission tax increases the incentive to acquire also increases but not indefinitely. There is a certain level of emission tax beyond which any increase in emission tax decreases the incentive to acquire.



Keywords

- Mathematical Logic, Universal Algebra, Topology, Hyperspaces, Applications of Metrics to Image Processing and Data Analysis, Integral Metrics, Metric and Topological Methods in Chemistry, Medicine and Engineering, Education and Training

Recognitions

- President for 3 terms, S&T Graduate Faculty

Collaborative Interests

- Image Classification, Thermochemical Effects, Ethics and Philosophy, Formal Methods and Concept Analysis

Assessment, Student Engagement, and Rural Education

Research Topics

- Assessment
 - Equity
 - Accountability for educator preparation programs
 - Accreditation
 - Rubric creation and calibration
 - Survey creation and validation
 - Performance assessment rubric development
 - Curriculum mapping
- Student Engagement
 - Formative assessment techniques
 - Critical thinking
 - Technology tools to enhance teaching
- Rural Education



Assessing Student Learning

Contact Information:

- Beth Kania-Gosche, PhD
- Professor and Chair, Teacher Education and Certification
- 573-341-4120
- bkaniagosche@mst.edu



Keywords

- assessment, accountability, rural education, teacher pipeline

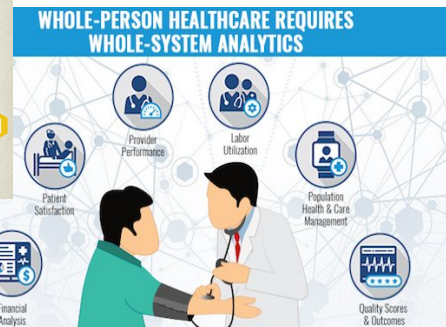
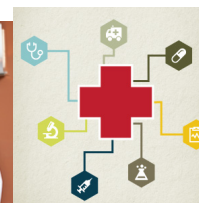
Recognitions/Significant Achievements

- President, Missouri Association of Colleges for Teacher Education
- Co-wrote statewide student teacher evaluation instrument
- Co-wrote first year teacher and principal survey used by state department of education
- 2019-20 University of Missouri System Leadership Development Program Graduate

Improving Healthcare Professionals' Work Experiences

Research Topics

- Healthcare organization processes
 - Including work on interprofessional education, practice, & research
 - Also includes expertise in healthcare organizational assessment and program implementation
- Interactions and reactions between healthcare team-members:
 - Impact on team-member experiences
 - Impact on patient transitions and communication between team-members
 - Impact on patient experience
- Demands faced by healthcare professionals



Selected Experiences

Experience working with healthcare professionals in private and university-affiliated healthcare settings as well as with small business teams. Experience working in interprofessional education & practice.

Potential Collaboration

Assessments for areas such as new medical device implementation, new patient systems, new medical technology, etc.; Impact of these changes on healthcare professionals and patient experiences.

Selected Publications

Sanner-Stiehr, E., & **Reynolds-Kueny, C.** (2017). From the top-down: Transformational leadership considerations for health care organizations. *Journal of Hospital Administration*.

Reynolds-Kueny, C., Toomey, E., Pole, D., & Hinyard, L. (2017). Uniting Saint Louis University's interprofessional education program with organizational learning: A theory-based model to guide IP education and practice. *Journal of Interprofessional Education & Practice*.

Reynolds Kueny, C., ±Majumdar, D., & Spencer, C. (2020). A qualitative assessment of the impact of the rural setting on healthcare professionals' work experiences. *Occupational Health Science*.

Contact Information:

Clair (Reynolds) Kueny, PhD

Assistant Professor – Psych. Science
Industrial-Organizational Psychology

Email: kuenyc@mst.edu

Phone: (573) 341-4732



Bioprinting and Additive Manufacturing

Bioprinting

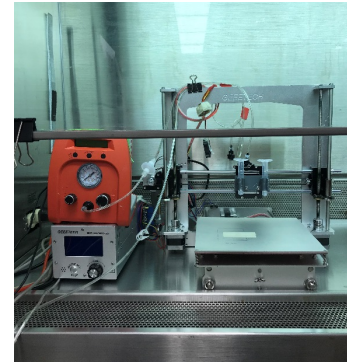
- 3D printing with biomaterials and stem cells
- *In vitro* and *in vivo* assessments of fabricated scaffolds
- Tissue engineering including bone regeneration and skin substitutes

Metal Additive Manufacturing

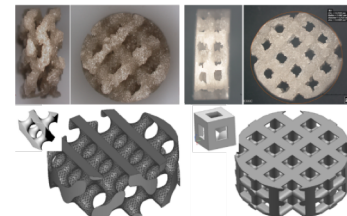
- Laser Powder Bed Fusion
- Laser Foil Printing

Non-metal Additive Manufacturing

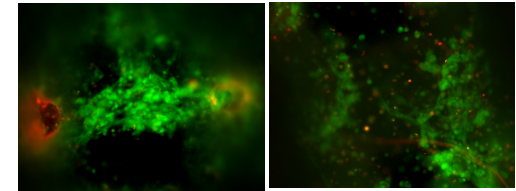
- Ceramic On-Demand Extrusion
- Fused Deposition Modeling
- AM of Carbon Fiber Composites



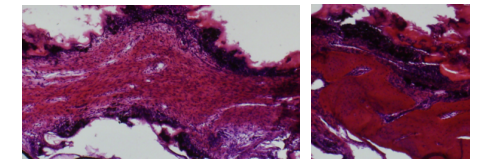
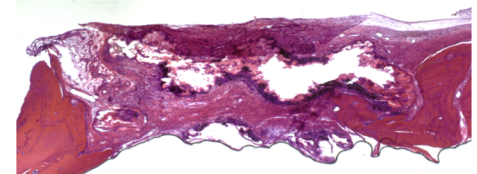
Extrusion 3D Printer



Printed Scaffolds



In Vitro Evaluation



In Vivo Evaluation

PoC: Ming Leu, Keith & Pat Bailey Professor

mleu@mst.edu, (573) 341-4482



Funding

- National Science Foundation
- Department of Energy
- Department of Education
- Honeywell Federal Manufacturing & Technology
- Clean Energy Smart Manufacturing Institute
- CAMT Industrial Consortium

Keywords

- Additive manufacturing, 3D printing, intelligent robotics, smart manufacturing, cyber-physical systems

Recognitions

- International Freeform and Additive Manufacturing Excellence (FAME) Award, 2020
- ASME Milton Shaw Manufacturing Research Medal, 2018
- Univ. of Missouri President Leadership Award, 2017
- ASME Blackall Machine Tool and Gage Award, 2014
- ISFA Hanafusa Outstanding Investigator Award, 2008

Modeling Big Data in Biology and Medicine for Precision Medicine

Causal discovery of genomic variants for diseases

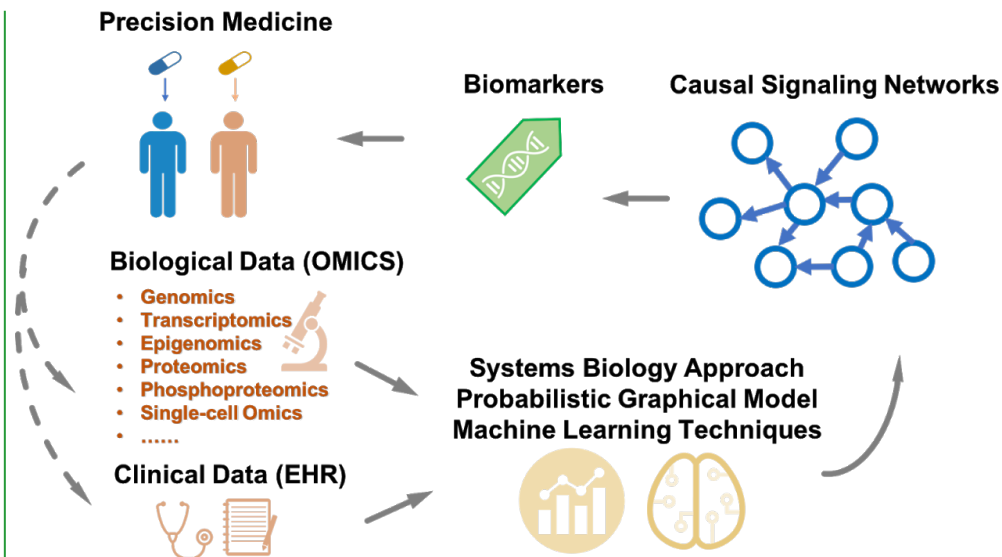
- An instance-specific causal machine learning framework
- Whole genome sequencing and SNP data from FHS

Multi-omics data analysis to reveal the causal signaling networks underlying diseases

- RPPA, mRNA, DNA mutation data from cancer patients
- Causal Bayesian Networks (CBNs)

Machine learning-assisted material design

- Apply statistical analysis and machine learning techniques in collaborators' disciplines for data mining
- Prediction of material properties with its composition and processing



Informatics and Precision Medicine

Jinling Liu, Assistant Professor
 Engineering Management &
 Systems Engineering,
 and Biological Sciences
 Missouri S&T

Jinling.liu@mst.edu; (573) 341-4150

Funding: NHLBI, NIH



Awards

- ❖ BioData Catalyst Fellow, NHLBI, NIH, 2020-2021
- ❖ National Library of Medicine Fellowship, 2017-2019

Keywords

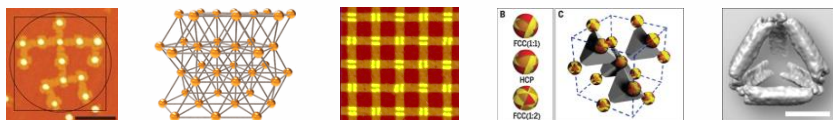
Big Data Analytics, # Machine Learning, # Biomedical Informatics, # Precision Medicine, # Systems Biology, # Causal Inference

Nanomaterials Assembly & Bioanalysis

Research Topics

- Design programmable soft materials with tailored functions
- Develop analytical strategies for applications in environment, human health, and life science *et al.*
- Fabricate electrochemical biosensor for medical diagnosis
- Nanoparticle analysis for aerospace combustion and environmental contamination

Techniques: AFM, TEM, Cyro-EM, SEM, SAXS, DLS, TOC, ICP-MS, ICP-OES, GFAA, IC, HPLC, GC-ECD/FID, GC-MS, LC-MS/MS, Fluorescence Microscopy



Contact Information

Wenyan Liu, Ph.D.

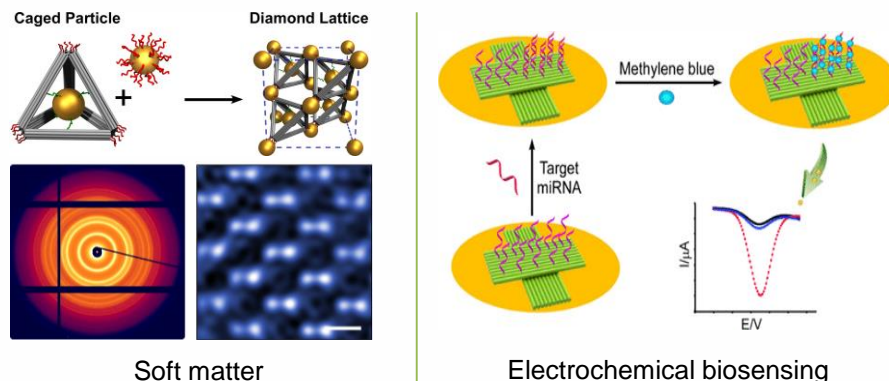
Assistant Research Professor

Department of Chemistry

Center for Research in Energy and Environment

Email: liuweny@mst.edu

Phone: (573) 341-4838



Selected Publications

- W. Liu, M. Tagawa, H. Xin, T. Wang, H. Emany, H. Li, K. Yager, F. Starr, A. Tkachenko, O. Gang, Diamond family of nanoparticle superlattices, **Science**, 2016, 351, 582.
- W. Liu, J. Halverson, Y. Tian, A. Tkachenko, O. Gang, Self-organized architectures from assorted DNA-framed nanoparticles, **Nature Chemistry**, 2016, 8, 867.
- Y. Tian, T. Wang, W. Liu, H. Lin, Y. Ke, W. Shih, O. Gang, Prescribed nanoparticle cluster architectures and low-dimensional arrays built using octahedral DNA origami frames, **Nature Nanotechnology**, 2015, 10, 637.

Nanomaterials for Composites, Biomedical, and Energy Applications

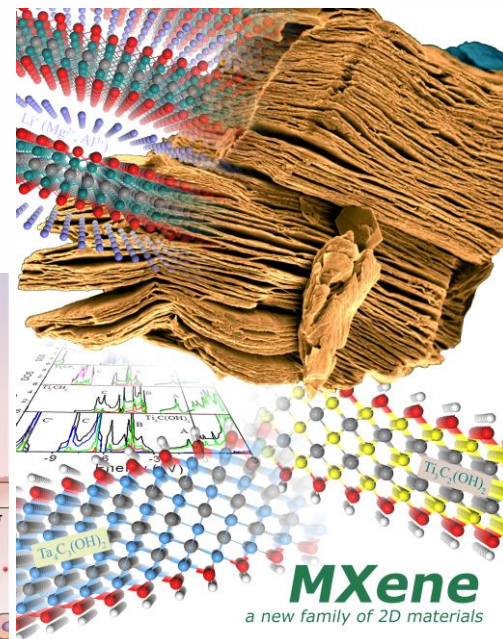
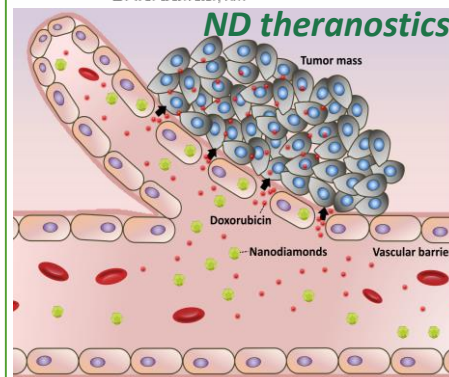
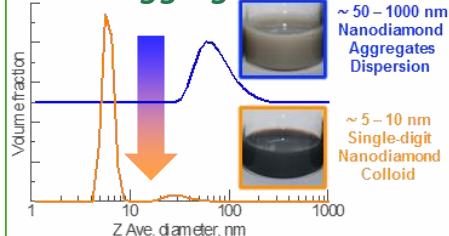
Nanodiamond and Onion-Like Carbon

- Deaggregation of nanodiamond into single-digit particles for production of pure highly stable nanodiamond colloids (patent pending)
- Metal coated nanodiamond particles for metal matrix composites
- Nanodiamond for ceramic matrix composites
- Nanodiamond for drug delivery across the blood-brain barrier and delivery of anticancer therapeutics; theranostic applications
- Graphitization of nanodiamond; onion-like carbon for supercapacitors and batteries

New 2-D Transition Metal Carbides/Nitrides - MXenes

- Development of alternative ways for MXene synthesis
- Discovery and synthesis of novel MXenes
- Modeling of mechanical, electronic, and optical properties of MXenes, MXene intercalation
- Development of MXenes for energy storage, desalination, composites, optical, and sensing applications

ND deaggregation



Contacts & Information

Vadym Mochalin

Associate Professor of Chemistry and Materials Science & Engineering

<http://chem.mst.edu/mochalin-group/>
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Phone: 573-341-6043



Funding

- DAICEL Corp. (Japan)
- Army Research Office (6/15/18-6/14/21, \$102,000, Co-PI)
- NSF (9/1/19-8/31/2022, \$407,962, Co-PI)

Keywords

- Nanomaterials; Two-dimensional materials; Zero-dimensional materials; Chemistry of materials; MXene; Nanodiamond; Theranostics; Composites; Energy storage; Supercapacitors; Li-ion batteries; Computational modeling

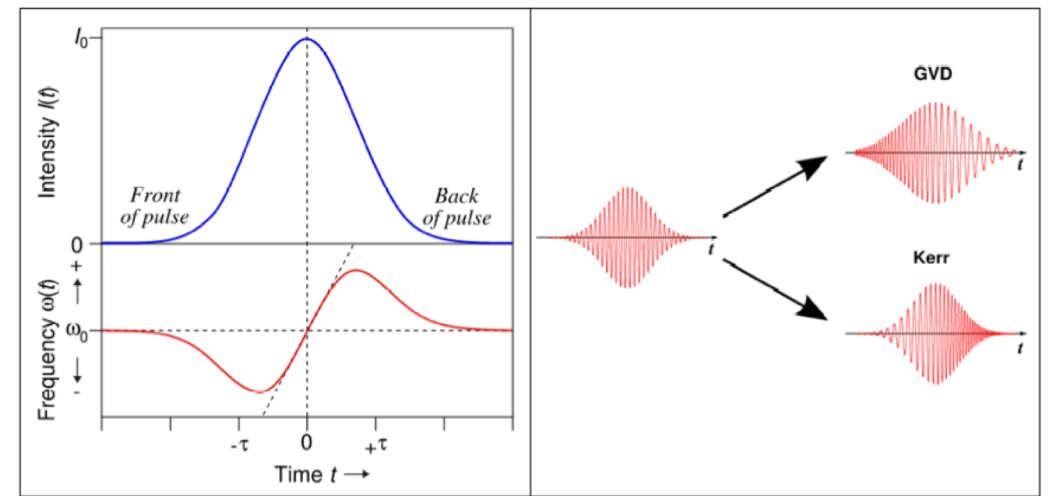
Recognitions

- Top 10 Most Read Papers in Nature Nanotechnology (The properties and applications of nanodiamonds, V.N. Mochalin, O. Shenderova, D. Ho, Y. Gogotsi, doi:10.1038/nnano.2011.209)
- G. Zhou, P.I. Lelkes, Y. Gogotsi, V. Mochalin, Functionalized nanodiamond reinforced biopolymers. United States Patent, November 17, 2015, patent number: 9,186,190.

Harmonic Analysis and its Applications

Research Interests:

- Long-time behavior (e.g. scattering, soliton stability, and statistical properties of random ensembles) for nonlinear partial differential equations, including nonlinear Schrödinger equations arising in nonlinear optics and Bose-Einstein condensation.
- Inverse problems arising in medical imaging
- Compressed sensing and signal processing
- Mathematics of machine learning



Dispersion and nonlinearity in nonlinear optics

(figure reprinted from *Elements of Optical Solitons: An Overview* by V. C. Kuriakose and K. Porsezian, Resonance (2010))

Jason Murphy

Assistant Professor
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Missouri S&T

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Keywords: harmonic analysis, dispersive equations, scattering, medical imaging, signal processing, machine learning

Potential Collaborative Fields: inverse problems, medical imaging, compressed sensing, computed tomography, analysis of partial differential equations

- Compressed sensing based multi-view coding and decoding architecture design
- Power-efficient wirelessly multi-view video streaming

- Alleviate RF spectrum crunch
- Newly-designed visible-light-channel aware protocol stack

- Learning based optimized network operations
- Software-defined experimental prototype



Internet of Things is making our lives more efficient and easier!



Dr. Yanyan Chen is an Associate Professor at the Department of Chemistry, University of California, San Diego. She received her Ph.D. from the University of California, Berkeley, and completed her postdoctoral fellowship at the University of California, San Diego. Dr. Chen's research interests are in the synthesis of functionalized polymers and their applications in materials science and biology.

- NA

- #Internet-of-Things, #Wireless Visible-Light Networks, #Compressed Sensing, #Low-power, #Low-complexity, #intelligent Wireless Systems, #Learning Techniques

- Award: 2019 ECE Distinguished Research Assistant Award
- Award: 2018 CRA-W and ComSoc Travel Grant
- Award: 2015 NSF Student Travel Grant
- Award: 2015 N2Women Young Research Fellowship

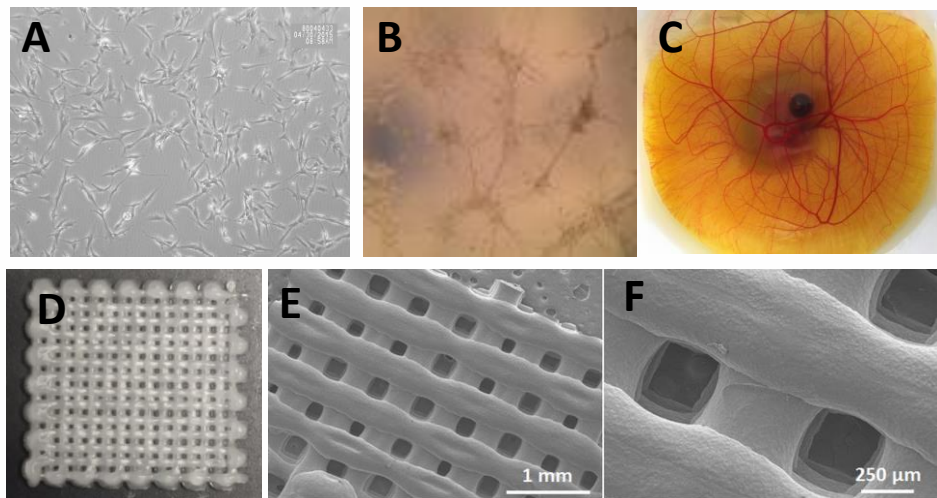
Regenerative Medicine

Cell Therapy

- Evaluating MSCs from altered states
 - MSCs from patients with chronic disease
 - Autologous vs allogeneic cell therapy
- Treatment of neural and autoimmune disease
 - Identifying the ideal source of MSC
 - Defining the ideal timing of therapy

Tissue Engineering

- Evaluating biomaterials on MSC function
 - Mechanism to increase angiogenesis
 - Changes in extracellular matrix secretion
- 3D bioprinting
 - Novel method to 3D print stem cells



MSCs grown under standard culture condition (A), with bioactive glass (B), and in an angiogenesis model (C). A novel method to 3D print stem cells (D-F).

Contact Information:



Julie Semon

Assoc. Professor

Department of Biological Sciences

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Keywords

- stem cells, MSCs, cell therapy, tissue engineering, biomedical engineering

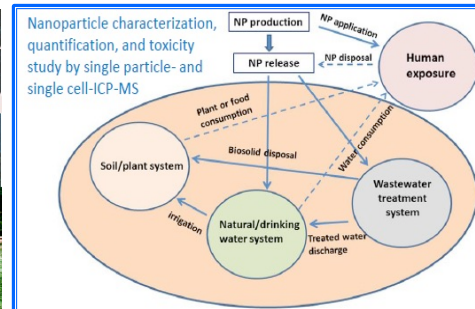
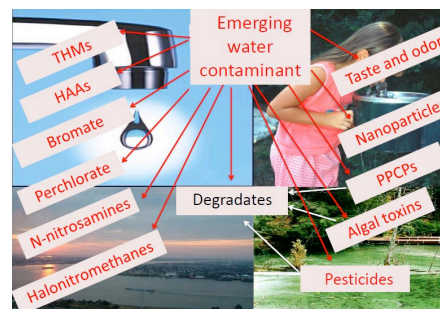
Collaborative Interests

- Bioinformatics, immunology, tissue engineering, biomedical engineering, microfluidics, biomaterials, bio-entrepreneurship

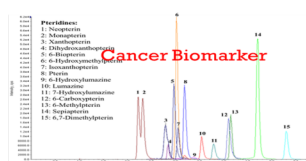
Bioanalytical and Environmental Analyses

Research Focus

- ❖ Development of analytical methods for applications in life science, biomedicine, and environmental pollutants
- ❖ Drinking water quality monitoring and improvement
- ❖ Biomarker discovery including cancer biomarker, traumatic brain injury (TBI) biomarker, seed quality biomarker, etc.
- ❖ Nanoparticle characterization and quantification by cutting edge single particle- and single cell-ICP-MS and their novel applications in life science, food safety, emerging environmental contaminant, etc.



Biomarker Discovery



Contact Information

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Research Funds

- ❖ National Institute of Health
- ❖ National Science Foundation
- ❖ Missouri Department of Natural Resources
- ❖ Environmental Protection Agency
- ❖ Leonard Wood Institute (DoD)
- ❖ Water treatment facilities
- ❖ Industries

Keywords

Bioanalysis; advanced instrumental analysis; single cell- and single particle-ICP-MS, environmental contaminants; water disinfection byproducts (DBPs); harmful algal bloom; biomarker

Significant Achievements

- ❖ Faculty achievement award, Missouri S&T, 2012, 2014, 2016
- ❖ Total 46 peer reviewed journal publications in recent 5 years
- ❖ Total >90 conference presentations in recent 5 years
- ❖ One patent issued in year 2020

Potential Collaboration fields

- ❖ Broad fields that need analytical quantification and characterization; nanoparticle analysis; biomarker discovery

The Microscale Transport Laboratory

Microfluidic technology for cell/particle separations

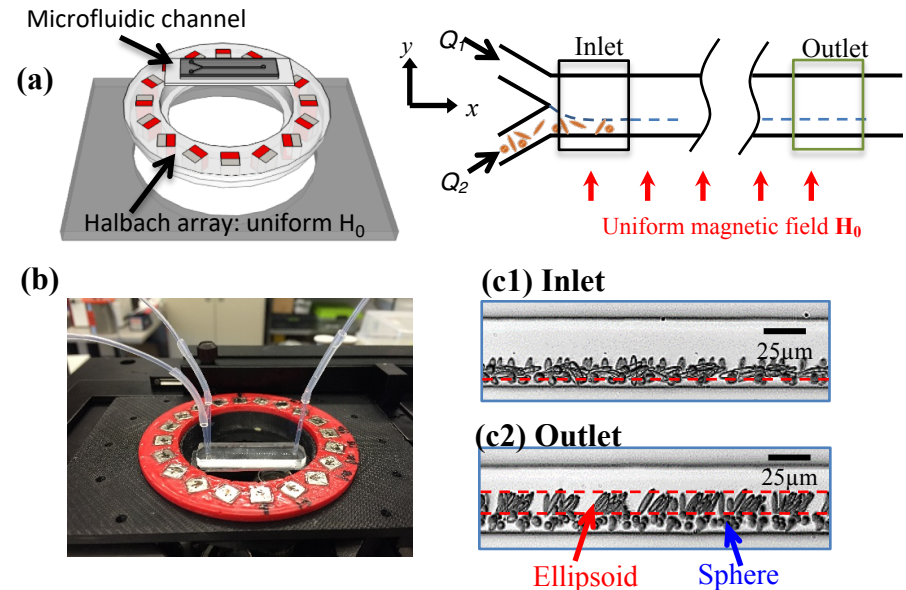
- Design, fabrication, and modelling of microfluidic magnetic separator devices
- Separation of micron/nano-sized particles and biological cells by shape using acoustic, electrical, and magnetic fields

Droplet microfluidics

- Experimental study of complex droplet formation in microfluidic devices
- Numerical simulation of multiphase flows

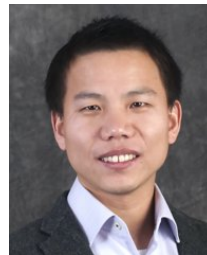
Microfluidic platforms for studying drug delivery, virus detection

- Building microfluidic devices and lab on a chip systems for testing drug efficacy, virus detection, and single cell studies



Separation of micro-particles/cells by shape and size with microfluidics and magnetic fields

Cheng Wang, Ph.D.,
College of Engr. and Computing
Associate Professor of Mechanical and
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<https://sites.google.com/view/thewangresearchgroup/>

Funding

- National Science Foundation, Center for Biomedical Research, Missouri S&T

Keywords

Microfluidics # Lab on a Chip # Microfabrication # Digital microfluidics # Single cells and bacteria # Numerical modeling of multiphase and multi-physics flows

Recent Publications

- Zhang, J., Sobecki, C. A., Zhang, Y., & Wang, C. (2018). **Numerical investigation of dynamics of elliptical magnetic microparticles in shear flows.** *Microfluidics and Nanofluidics*, 22(8).
- Zhou, R., & Wang*, C. (2016). **Microfluidic separation of magnetic particles with soft magnetic microstructures.** *Microfluidics and Nanofluidics*, 20(3), 1–11.

Modeling-Riven Design and Characterization

Mechanism-Based Molecular and Multi-scale Modeling

- Develop in-house versatile molecular modeling program codes based on fundamental insights and understanding
- Connect methodologies of different scales using mechanisms as guide to perform multi-scale modeling

Design and Characterization of Polymeric Porous Media

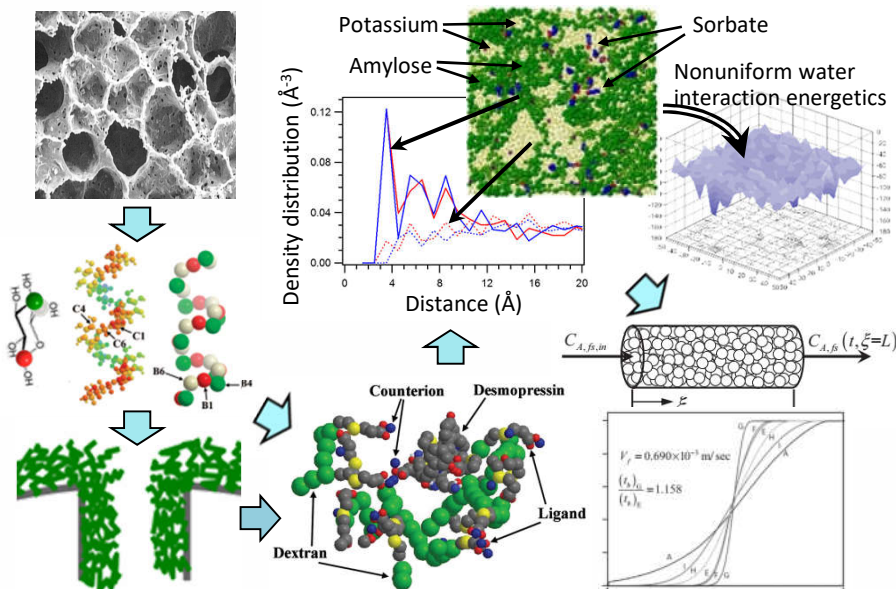
- Simulate ligand functionalization and biomolecular absorption in biopolymeric porous media, and structural formation and transitions of hydrogels and membranes

Transfer Phenomena in Porous and Interfacial Systems

- Molecularly model food dehydration, surface deposition and migration, thin-film boiling, and reactant diffusion through catalyst nanoporous layer

Nanoparticles, Nanofluids, and Nanotribology

- Characterize factors affecting nanoparticle self-assembly and nanoparticle additives for tribological applications



By varying underlying factors and characterizing outcomes systematically, rational design can be achieved

Jee-Ching Wang, Associate Professor
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Recent Funding

- National Science Foundation
- NIIMBL

Keywords

- #MultiScaleModeling, #MolecularDynamics, #PorousMedia, #BiomolecularAbsorption, #FoodDehydration, #SurfaceDiffusion, #Nanoparticles, #Nanoconfined Fluids, #Nanotribology

Biochemistry, Biomaterials, and Biomedical Engineering

Research Topics

- Developing novel DNA-based drug delivery systems for cancer therapy and super sensitive biosensors for early disease diagnosis
- Studying biomolecular interactions at the single molecular level
- Fabricating plasmonic metamolecules and investigating their novel properties
- Designing environmental stimuli-responsive smart biomaterials

Contact Information

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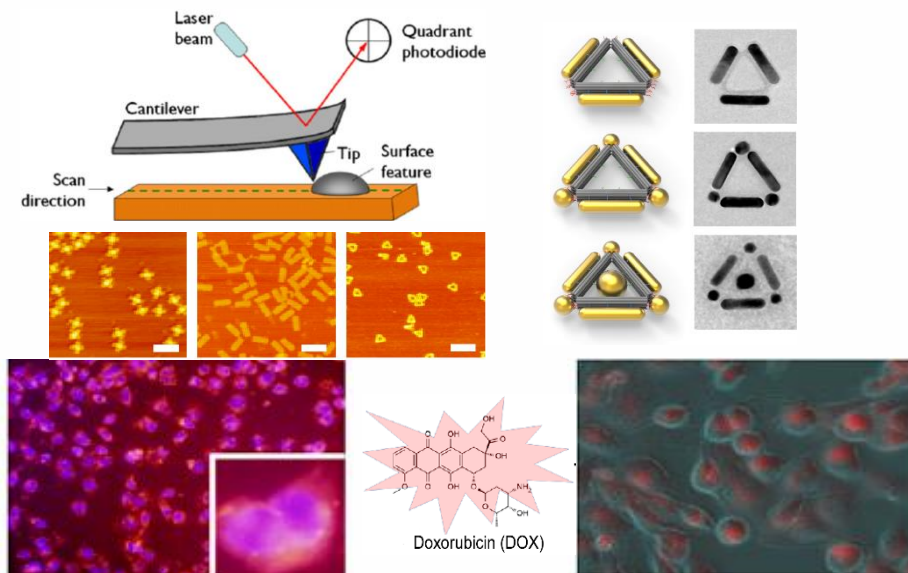
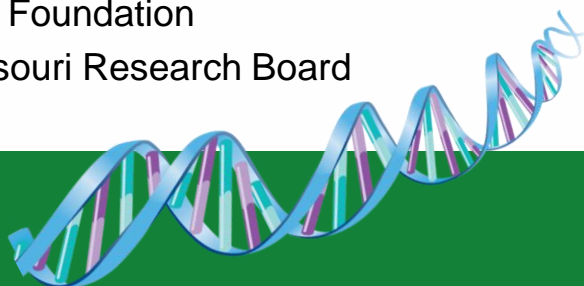
Phone: (573) 341-7729

Funding

National Science Foundation

University of Missouri Research Board

AFMworkshop



Biomaterial application in cancer therapy and biosensing

Keywords

- DNA nanotechnology; Precision biomedicine; Drug delivery; Plasmonic nanoparticles; self-assembly; Nanofabrication

Significant Achievements

- 2016 & 2017 Tappmeyer Teaching Excellence Award
- Time-lapse live cell imaging to monitor doxorubicin release from DNA origami Nanostructures, Y. Zeng, et al, J. Mater. Chem. B, 2018, 6, 1650 (front cover image)
- Label-free and ultrasensitive electrochemical DNA biosensor based on urchinlike carbon nanotube-gold nanoparticle nanoclusters, S. Han, et al, Anal. Chem. 2020, 92, 4780 (front cover image)

Aerosol and air quality research

Bioaerosols in indoor environments

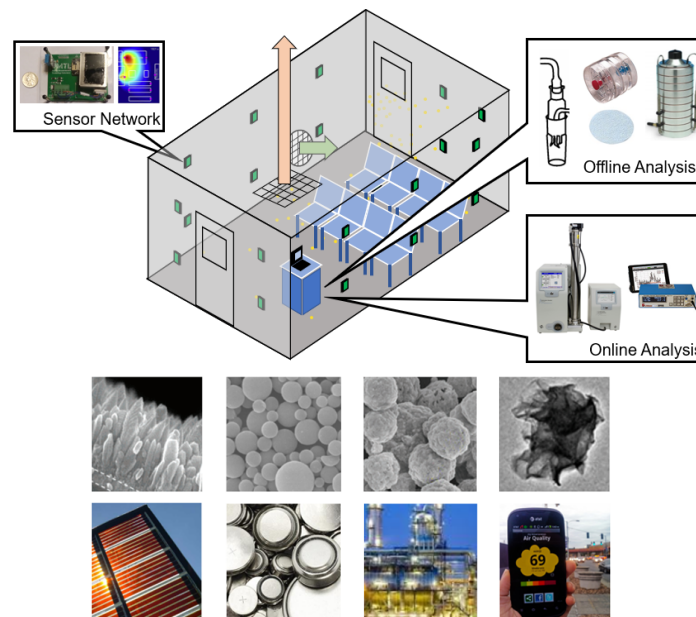
- The airborne transmission of indoor pathogens is a critical public health concern
- We deploy a series of online and offline bioaerosol measurement techniques to study indoor bioaerosol transport and evolution

Combustion aerosols and their health impact

- Fossil fuel combustion is a major source of inhalable aerosols
- We characterize the physical, chemical, and toxicological properties of various types of combustion aerosols

Development and evaluation of low-cost air quality sensors

- Low-cost air quality sensors offer monitoring with high spatio-temporal resolution
- We calibrate and deploy low-cost air quality sensors in workplaces (e.g. offices, mines) to monitor the emission and transport of air pollutants



PoC: Yang Wang, Assistant Professor

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www.yangwangpmtl.wordpress.com

573-341-4597

Funding Sources

- National Science Foundation
- Department of Energy



Keywords

- Aerosol, Air quality, Bioaerosols, Combustion, Sensors, Health impact

Recognitions

- European Aerosol Assembly Ph.D. Award (2019)
- Editor's selection of notable papers in Aerosol Sci. Technol.

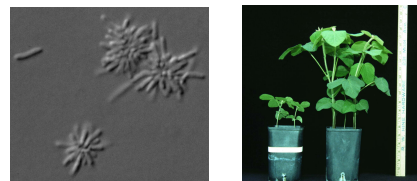
Collaborative Interests

- Reactive oxidative species, nanotoxicity, combustion, Indoor air quality, drug delivery, functional nanoparticles

Plant-Microbe Interactions and Antibacterial Treatments

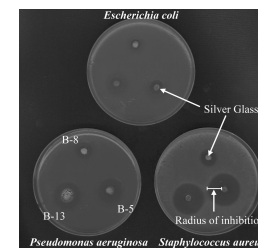
Research Topics

- Soybean/*Bradyrhizobium japonicum* symbiosis
 - Bioenergetics of nitrogen fixation
 - Drought tolerant symbiotic bacteria
- Cell-Cell communication
 - Quorum sensing in symbiotic bacteria
 - Novel quorum sensing molecules
- Plant-microbe interactions in rhizoremediation
 - Isolation of novel symbiotic bacteria
 - Rhizosphere microbiome analysis
- Anti-bacterial treatments
 - Characterization of anti-bacterial materials
 - Development of anti-bacterial materials
- Biological treatments towards high-efficiency and complete recycling of concrete demolition waste



Soybeans are a major crop for the state of Missouri and plant associated bacteria play a significant role in productivity.

Bioactive glasses can fight infections while healing wounds. Oil smoke vapors can disinfect contaminated materials.



Dave Westenberg

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Funding

- USDA, Missouri Soybean Merch. Council, Department of Higher Education, DOW Chemical Co.

Keywords

- Symbiosis, Quorum sensing, Synthetic biology, Antibacterial materials

Recognitions/Significant achievements

- American Society for Microbiology Carski Award
- UM System President's Award for Community Engagement
- UM System Presidential Engagement Fellow
- HHMI Biointeractive Teaching Ambassador
- Academy of Sciences St. Louis Science Educator Award 2017
- DAAD Research Ambassador/Humboldtian on Campus

Multifunctional Nano Materials and Manufacturing

Nanomechanics and nanomaterials

- Mechanics of low dimensional materials
- Deformation mechanism of nanostructured organic and inorganic materials.
- Atomistic structure dependent material behaviors

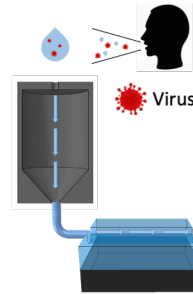
Bio, Chemical Sensor and self-sensing materials

- Wireless bio and chemical sensing platform using nanomaterials
- Functional nanocomposite enabled self-sensing materials

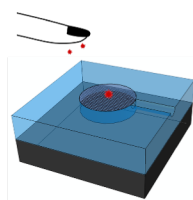
3D Printing composites

- 3D printing graphene-nanofiber composite
- 3D printing strong FRP laminates and CFRP-concrete interface
- 3D printing of functional coating and energy storage composites

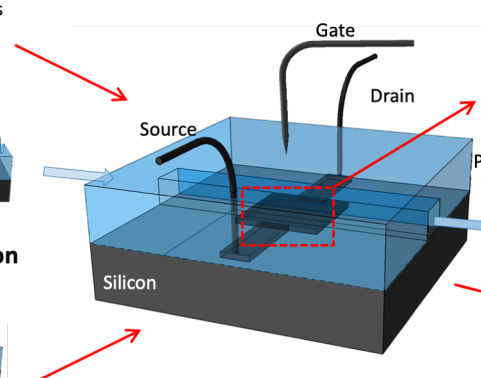
(a) Bioaerosol Collection



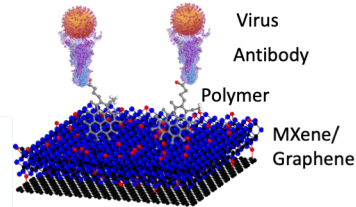
(b) Touch Collection



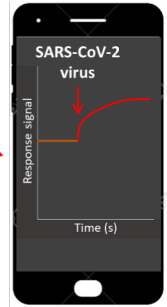
(c) FET Sensing



MXene-Graphene VSTM



(d) Touch Screen Device



Integrated Bio-Sensing Platform

PoC: Chenglin Wu, Ph.D..

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<https://care.mst.edu/people/faculty/profiles/wu/>

Research Lab Webpage: <https://web.mst.edu/~wuch/>



Keywords

#Nanomechanics
#Nanomaterials,
#Nanotechnology
#Multi-functional Nanocomposites,
#Sensors and Self-Sensing Materials
#3D Printing Composites

Biomaterials, Nanomedicine, Drug and Gene Delivery

Polymers and biomimetic systems for Drug and Gene Delivery

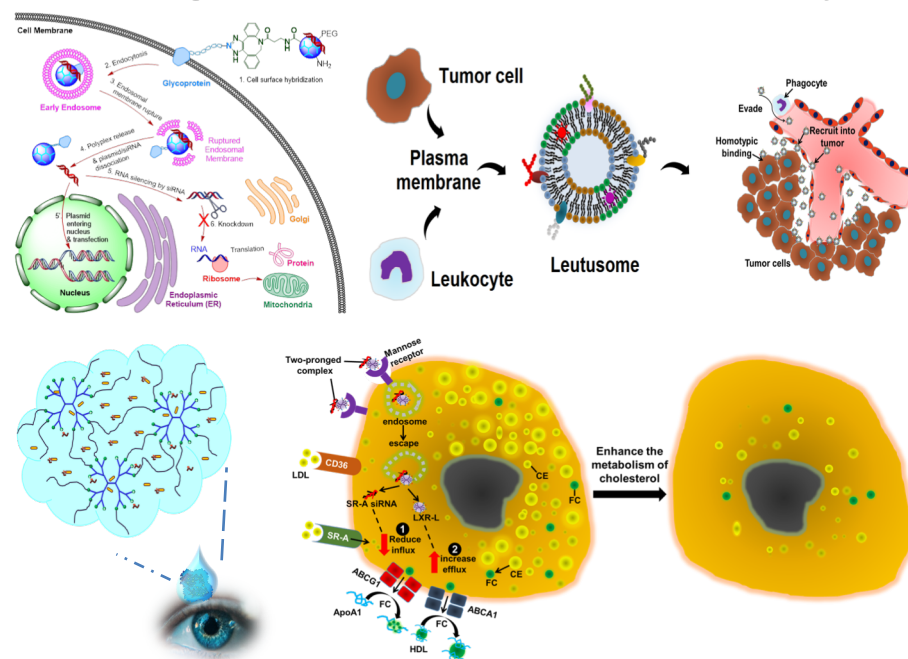
- Controlled release
- Targeted delivery
- Pre-clinical studies

New Chemistries and Methods for Safe and Scalable Fabrication

- Additive manufacturing
- Continuous production
- Bioorthogonal chemistry, click chemistry, bioconjugation techniques

Various Delivery Platforms

- Nanomedicine, polymer-drug conjugates
- Nanofibers
- Hydrogels
- Gel particles



PoC: Hu Yang, Chair, Professor of Chemical and Biochemical Engineering. huyang@mst.edu
573-341-4854



Funding Sources

- National Institutes of Health
- National Science Foundation

Keywords

- Biomaterials, Polymer, Drug and Gene Delivery, Nanomedicine

Recognitions

- NSF CAREER Award
- Wallace H. Coulter Young Investigator Award

Collaborative Interests

- Tissue engineering, Cancer therapy, Atherosclerosis, Glaucoma, Imaging, Biomanufacturing, Artificial Intelligence