1. Introduction

First, thank you Chairman Obernolte, Chairman Weber, and Chairman Babin as well as Ranking Member Stevens, Ranking Member Weber, and Ranking Member Lofgren and the rest of the committee for the opportunity to testify before you today. I am Steve Techtmann, an Associate Professor of Environmental Microbiology and Associate Director of the Great Lakes Research Center at Michigan Technological University. Founded in 1885, MTU's authorizing statute charges the university to promote the welfare of industry. At MTU, my lab aims to harness the power of biology to develop biotechnological solutions to many challenges facing society today. In a drop of water or a teaspoon of soil there are millions of microbial cells representing thousands of microbial species. These diverse and ubiquitous microorganisms perform many chemical reactions that are of interest in biotechnology. We are now able to harness these biological catalysts to more efficiently create products, break down pollutants, and improve manufacturing. My colleagues and I explore the fundamental principles that govern behavior of microorganisms and how to apply these biological tools to develop industrial processes that can benefit society.

2. Emerging biotechnology as a driving force for innovation across sectors

Emerging biotechnology is pushing the boundaries of what is currently possible with biotechnology. Biology has an incredible ability to perform chemical transformations and produce unique products from low-cost or waste input streams. Industrial biotechnology seeks to identify and engineer microorganisms to grow using low-cost feedstocks and produce compounds of value. While many biotechnological products are produced from highly purified input streams, there is a growing number of applications where high-value products can be produced from waste streams using biology. For example, low cost plant biomass can be turned into biofuels. Gas emissions from industrial processes can be harvested and used for production of precursors for generating plastics and other materials. Leveraging biology's unique ability to break down low cost inputs and produce specific high value products in a renewable manner is central to many emerging biotechnologies.

One example is that my research group has been working on projects funded by DARPA and other federal agencies to contribute to tackling the problem of excess plastic waste by developing biological methods for converting mixed plastic waste into high-value products such as petroleum, lubricants, and even food. This technology leverages biology's ability to consume diverse and complex inputs and produce highly specific compounds. As an example, we have taken the packaging materials from Meals Ready to Eat, or MREs, and successfully converted them to Pyrolysis gas to be used as a fuel, lubricants, and edible protein powder. Rather than burning the waste in the field, this process produces a value-added resource. In these projects, we have found communities of bacteria from the environment that can be used in industrial processes for breakdown and conversion of plastic wastes. We are also working on other projects developing processes and systems that use both microbial microorganisms and biological materials such as waste wood as an input to generate materials that could be used as a construction material.

In addition to technology for waste to chemical production, biology can also be used in recovery of critical minerals. We are collaborating on projects that use microbial communities derived from natural settings and plants for recovery of critical minerals from low-grade ores. Using biology we are able to efficiently recover purified minerals with limited energy and chemical inputs. Picture the ability to take a waste pile from an old mine and use microbial communities to extract high purity critical minerals. The renewable nature of biology makes biomining an appealing emerging biotechnology for recovery of critical minerals.

All of these technologies have the potential to revolutionize how to treat wastes and use biotechnology to produce high-value products such as foods, materials, and critical minerals. In all of these examples there is a strong connection between fundamental understanding of microbiology and biochemistry that is then linked with engineering principles to engineer and scale biological processes.

Emerging biotechnology also seeks to leverage advances in data science such as AI to better study, predict, engineer, and apply biology for biotechnology. There is great potential for data-driven studies to provide deep insights into biology and its applications. However, as in many disciplines, to fully realize the power of AI for biotechnology, we need additional high-quality data to train models and inform future predictions. It's therefore important to continue to support efforts to expand our fundamental understanding of biological systems and expand databases of biological data to ensure that we have access to high-quality data for training models to inform biotechnology. My colleagues and I have been using machine learning models to identify microbial taxa in complex environmental communities that can be used to monitor the presence and fate of contaminants. These microbial biomarkers are often more sensitive and persistent than the standard methods used for monitoring pollution. These models are only as good as the data used to train them and in order to apply these biomarkers more broadly, it is essential to have high-quality data that is well annotated to be used to train generalizable models. These models could be used to predict biological behavior and allow us to engineer organisms and proteins that have novel functionalities to produce desired products. This transformative potential requires there to be coordination in data generation, archiving, and management.

The amount of biological data has grown dramatically allowing us to identify microorganisms and biochemical pathways that have industrial relevance. However there are challenges to how these processes are transitioned to manufacturing. Some approaches can take processes found in the natural world and transfer those to well-characterized host strains using genetic engineering. Which has the advantage of being able to engineer well known organisms to do novel processes and may ease the process of scaling up. Alternatively, we can domesticate organisms that perform these important processes from nature and leverage those natural organisms for production. In both cases, we must have a strong foundation in fundamental science to allow for engineering and prediction of their behavior. For us to tap into the future of biotechnology, we must have a strong foundation in basic biological principles so that we can predict and engineer biology. This requires further investment in basic research with an eye toward application.

Despite the promises of emerging biotechnology, there are still challenges that must be overcome for biotechnology to supplement manufacturing. One of the challenges of using biology for manufacturing is scaling from the lab to practical applications. Many processes that work well on the benchtop, may run into challenges when scaled to industrial volumes. We need to bridge the gap between university labs and scaled-up industry processes. This will enable biology to be used in diverse settings for useful biotech compound production.

While scaling biology up to industrial scale is challenging, using biology often requires less energy and specialized equipment compared to other manufacturing processes. This has the potential to enable point-of-need biomanufacturing. While to-date most biotechnology has been used in large-scale production plants, biological systems often require less energy and fewer chemical inputs than non-biological ones. Therefore manufacturing processes that have biology at their core have the potential to greatly decrease the logistical burden for production and allow for production of material and chemicals at the point of need. We have been working on projects funded by DARPA to enable distributed biomanufacturing at the point of need. The goal of these projects is to develop systems that could be used in austere and low-resource environments to produce material and chemicals that are needed where they are needed. This removes the need to ship large quantities of materials to remote settings and allows for on-site production. This same biotechnology could be used to assist in disaster relief and humanitarian aid scenarios. For example, in disaster relief scenarios, there is a need for food and building materials. My colleagues and I have been working on developing low power, portable systems that use biology to convert waste streams to food and construction materials.

3. More than just biomedical and agriculture

As has been highlighted by other testimonies, the scope of biotechnology is rapidly expanding well beyond the expected biomedical and agricultural domains to the production of chemicals, fuels, and materials. Historically biofuels have sought to use plant biomass as a feedstock to microbial processes to produce fuels. This approach is now rapidly expanding beyond production of fuels to productions of foods, chemicals, and precursors for a wide range of materials from bioplastics to polymers.

Biotechnology also has potential outside of the manufacturing plant. Environmental biotechnology leverages natural processes in both natural and man-made settings to help in improving environmental quality, cleaning up contamination, and environmental monitoring. Microbes in the environment are able to metabolize many compounds that are contaminants or pollutants. These processes have been leveraged for remediation of contamination in large-scale contaminant releases. Further work is needed to better control and optimize environmental biological processes to achieve a desired end. This will involve investment in further research into microbial ecology and microbial physiology to not only understand the mechanisms for contaminant biodegradation but also inform how to optimize microbial communities that exist under changing and varying conditions.

4. Developing the biotechnology workforce

The promise of biotechnology will only be realized by having a workforce that is prepared to use the advanced tools of emerging biotechnology. This requires hands-on experience with biotechnology across the curriculum from high school through undergraduate and graduate curricula. At Michigan Tech we have sought to integrate hands-on experiences throughout the curricula that give students real-world experiences to prepare them to join the workforce. This also applies to training in biotechnology. Michigan Tech has had an undergraduate degree in bioinformatics and computational biology that started in the early 2000s. This degree program seeks to train students to use tools of computer science and mathematics to address challenges in biology and biotechnology. We have developed a set of courses that give students hand-on experience with genomic data in their first year of undergraduate studies. It's through these experiences that they are being equipped with not only the foundational knowledge of biology and computer science, but experience handling real-world genomic data to address a question related to biotechnology. The biotechnology workforce will be one that has familiarity not only with molecular biology, microbiology, and chemical engineering, but also skills in data science and computation. We have been developing training for undergraduate students to give them experience across these disciplines.

The biotechnology workforce will also be highly interdisciplinary since biotechnology leverages so many disciplines. As such, we at Michigan Tech have been designing experiences to provide students with opportunities to work in interdisciplinary groups to address challenges. The Enterprise program at Michigan Tech engages students from across disciplines to work on teams to address challenging problems that require expertise from more than one discipline. One example is the Open-Source Hardware Enterprise that is composed of students from multiple disciplines including electrical engineering and computer engineering. As part of this enterprise, a group of students were working on developing an open-source bioreactor that could be used for point-of-need biomanufacturing. This group developed a number of sensors and control systems to allow for efficient, reliable, and automated control of low power and low cost bioreactors. Through this Enterprise experience these students coming from disciplines not typically associated with biotechnology had the opportunity to work on problems that are of interest to emerging biotechnology.

These are just a few examples of activities that can be integrated into training students to become the future biotechnology workforce. However, it's also important that students in K-12 schools have some hands-on experience with molecular biology. Molecular biology is fundamental to emerging biotechnology. As students are taught the concepts and approaches of biotechnology in high school, it will open the doors for more students to get training in and see the potential of biotechnology.

5. From basic science to application and transition

The university has always had a role to play in advancing biotechnology and the bioeconomy. That role includes both training of the future biotechnology workforce as well as research that provides fundamental knowledge that is applied to solving real world problems. This mindset is core to the DNA of Michigan Tech. Michigan Tech is charged with advancing knowledge that is applicable. This mission reaches back to our enabling legislation in 1885, which charged us to explore the "...application of science to industry…" and to "...promote the welfare of the industries of the state…". Fundamental knowledge and research is essential to developing emerging biotechnology. In order to engineer biology, we need to know how biology works at a very basic level. However, it's also important for us to view fundamental research as an investment in applied research as we seek to use that knowledge to benefit society. It is therefore essential that there is further investment in basic science that enables biotechnological advances. Many of the projects that my lab and colleagues have been working on are considered fundamental research where we are gaining deep insights into how microorganisms and microbial communities function. This information is essential in setting the foundation for how we can then engineer these systems to improve their operation as well and work to scale those processes to the point that they can be transitioned to those that might use that technology. In order for technology to advance beyond the university lab bench we need to both invest in basic science at universities but also cultivate pathways for researchers and technology to interface with the companies to better transition that technology. This can also create ecosystems where basic research is used to address societal needs and there are pathways for transitioning that technology rapidly to market. Michigan Tech has a history of successfully transitioning technologies developed through fundamental research to companies that are then moving that technology to market. This close relationship between basic science and application not only advances science but enables de-risking of technologies that may not be of current interest to industries.

6. Conclusion

America has been a leader in biotechnology. As the potential applications of biotechnology expands, it's essential that America maintains its leadership role. We are rapidly gaining insights into how to engineer and use biology for an incredible number of applications. More robust basic science is needed to transition technology to applications and enable America to be a leader in emerging biotechnology.

7. Additional Information:

To further support the ideas introduced above, we have assembled some examples of fundamental science related to emerging biotechnology, as well as examples of companies and products that have been the outcome of fundamental science that is pushing forward emerging biotechnology and the bioeconomy.

Collaborative Projects on Emerging Biotechnology

<u>BioPROTEIN - Biological upcycling of plastics:</u> Millions of tons of plastics are produced annually. The vast majority of this plastic waste ends up in landfills and eventually the environment. This plastic waste poses a problem for the environment. In this project we are developing novel solutions to upcycle plastic wastes into valuable products using an integrated system that is low power and portable. This system uses chemical treatment and biology for conversion of waste plastics from military operations into single cell protein powder (food source), lubricants, and Pyrolysis gas, which is a gas that can be used as a fuel similar to natural gas. This system could be deployed in austere environments for plastic upcycling to produce needed products where they are needed. The core of this system is a microbial community derived from compost from the Upper Peninsula of Michigan that can rapidly break down deconstructed plastics and produce high biomass. This biomass is recovered and dried. The microbial biomass has a nutritional content similar to many conventional foods. This system has applications for distributed biomanufacturing from low-cost waste input streams.

Ice Control Proteins for Extremely Cold Environments: Extreme cold temperatures pose a challenge for life and operations. As part of this project, we have investigated the biological processes that allow microorganisms to cope with living in extreme cold conditions and in ice. These biological mechanisms include ice binding proteins, antifreeze proteins, and ice nucleation proteins. These proteins have the potential to be used as tools for control of ice formation, either as inhibitors of ice formation or as inducers of ice formation. A better understanding of these biological processes is allowing us to make protein-based solutions that can serve as either a more sustainable deicing alternative or a means of increasing ice formation where needed for construction or transportation purposes.

Novel Solutions for Densified Wood Production from Waste Wood: Wood is one of the most common wastes produced in both military operations as well in domestic waste streams. This waste is often incinerated or ground into wood chips. Previous work has shown that densification of wood can produce materials that have higher strength and improved performance compared to natural wood. However previous densification processes use natural lumber. Here we seek to develop a process for densifying waste wood into materials that could be used for construction. We are leveraging white rot fungi as tools for pretreating the wood prior to extrusion to produce high-strength materials for construction from waste streams.

Underwater energy generation using microbial communities and dissolved organic matter: Underwater sensors have provided key insights into phenomena that are happening in the oceans and has enabled better understanding of oceanic processes. However, these underwater sensors rely on batteries that have defined operational life and must be replaced for long-term monitoring. In this project, we are developing a system for generation of electricity underwater using in situ resources to power underwater sensors. Microbial metabolisms will convert chemical energy in the form of electron donors into electrical energy to produce cellular energy. Dissolved organic matter is a ubiquitous organic matter source in the oceans. We are developing a system that harvests dissolved organic matter from the water in the oceans and uses this organic matter as an input for microbial metabolisms that produce electricity. This underwater microbial fuel cell will take advantage of resources that are present throughout the oceans to make electricity for powering underwater sensors.

Phytomining: Plants as tools for extraction of critical minerals: Plants have been used to remediate metal contaminated soils through natural processes by taking metals out of the soil and accumulating metals in the plant tissues (roots, shoots, and leaves). While this process has been primarily used for removal of contaminants, it’s possible to harness the same biological approach for recovery of important metals from soils. Microorganisms in the soil are also known to cooperate with plants to both increase the amount of metals that can be removed from the soils as well as increase plant growth. Here we are working to develop a community of microbes and plants that can be used for mining of nickel from natural soils. Nickel is a critical mineral that is used in electric vehicles, wind and solar power. This process would allow for increased recovery of critical minerals with limited chemical and energy inputs from soils that are not able to be mined for these minerals using conventional methods.

Tim Eisele, Associate Professor, Chemical Engineering and Chemical Engineering Endowed Faculty Fellow, is making use of communities of metal-reducing bacteria to extract manganese, iron, nickel, and cobalt from low-grade ores so that they can be recovered domestically at low cost and with minimal environmental impact. Manganese, nickel, and cobalt are all listed on the "Critical Minerals" list as there is no significant domestic production of any of them. The dozens of bacteria species that we are using work together as a community to create an ecosystem that specifically dissolves these metals listed. The nutrients for these bacteria are produced by the decomposition of biomass by a different community of fermenting organisms. Once dissolved and separated from the ore, the metals are recovered by a third community of microorganisms that reoxidize and precipitate purified metal oxides.

The organism communities used in this work were collected from local wetland environments in Michigan. They have been undergoing directed adaptation in our laboratory for many years, resulting in organisms that are much more efficient at dissolving metals than the wild forms. Each of the three communities consists of numerous bacterial species. The research group has been working with Dr. Techtmann to characterize and identify these microorganisms, most of which have not previously been successfully cultivated in a laboratory or industrial environment, and many of which had not previously been known to science. This work has led to the development of an industrial process (patent pending) for extraction of manganese dioxide, a key component in both battery manufacture and steelmaking. The research group created a company in the summer of 2024 with the specific goal of commercializing this process, which is already achieving success.

Caryn Heldt, Director of the Health Research Institute, the James and Lorna Mack Chair in Continuous Processing, and Professor in the Department of Chemical Engineering, works in the area of viral vector manufacturing. Globally competitive biomanufacturing is a key aspect to keeping the U.S. in the forefront of manufacturing excellence. The U.S. has 46% of the $540B biopharmaceutical market, with an expected 14% growth each year through 2034. But to stay competitive and benefit all Americans, we must continue to innovate to reduce costs. Dr. Heldt's research group works to reduce the cost of biomanufacturing by creating new and innovative purification processes for gene therapies for difficult-to-treat diseases like hemophilia and muscular dystrophy. This will increase U.S. competitiveness in manufacturing and innovation, while improving public health.

While creating new processes, we are training students (from the BS to PhD level) and developing a workforce for the biopharmaceutical industry. There are less than ten U.S. professors that focus on the purification of biopharmaceuticals and working to train the generation of scientists and engineers with this vital knowledge. Yet, the U.S. biopharmaceuticals industry has a constant and growing need for workers with this skill set. Continued support from the U.S. government is needed to continue this workforce development and innovation to keep the U.S. leading in biopharmaceutical manufacturing.

Rupali Datta, Professor of Biological Sciences, researches plant-microbe interactions and develops phytotechnologies and their applications. This work is summarized below:

Phytomining for Critical Metals: Sustainable methods to extract valuable metals (e.g., Ni, Co) from marginal or contaminated soils using hyperaccumulator plants — supporting resource recovery and reducing dependence on imports for the development of clean energy technologies within the US. It also has applications for in-situ resource utilization (ISRU) goals for lunar/Martian missions.

Sustainable, field-tested phytoremediation techniques: Using tolerant grasses to reduce lead levels in contaminated residential soils, offering a cost-effective, scalable solution with wide applicability across diverse urban areas in the U.S. to mitigate childhood lead exposure risks.

Low-Cost Water Remediation: Designing floating treatment wetlands as affordable, passive systems that use floating plants to remove heavy metals, nutrients, and organic pollutants from contaminated water bodies — ideal for under-resourced rural settings. This technology is also effective in treating acid mine drainage and heavy metal-laden wastewater, helping to rehabilitate landscapes affected by legacy mining operations.

Support for National Security and Infrastructure: The ability to remediate explosives like TNT using plants such as vetiver grass contributes to safer military training grounds and surrounding environments. Also developing technologies to clean up the wastewater from munition plants that manufacture more advanced insensitive high explosives aids in maintaining operational readiness and infrastructure safety.

Plant–Microbe Synergies: Investigating beneficial microbial inoculants (e.g., Plant growth-promoting microorganisms) that enhance nutrient uptake, stress tolerance, and biomass production — essential for establishing plants in marginal and degraded lands. This technology is now being developed for closed-loop space farming systems.

Phytoremediation of Contaminated Sites: Demonstrating effective use of plants and microbes to clean up heavy metals and explosives, with implications for restoring polluted terrestrial and extraterrestrial habitats.

Remote Sensing Integration: Linking plant physiological changes to spectral traits, enabling non-invasive monitoring of plant-microbe responses and site remediation via remote sensing platforms.

Alignment with NASA Space Biology: Supporting crop productivity in regolith-like substrates, bioprocessing for life support, and biosignature development for health diagnostics in controlled extraterrestrial environments.

Ishi Keenum, Assistant Professor, Civil, Environmental, and Geospatial Engineering, leads a research program that has spent the past decade developing and characterizing the earth's microbiomes and has begun to design microbial communities for specific functions. Dr. Keenum's research group is ushering in an era of synthetic biology where microbes can create enzymes to help in human medicine, cleaning products, and general production. However, critical barriers remain for understanding microbial processes so that we can both use them and understand how they function as a community. Currently, microbial measurements are hard to compare across labs due to differences in methodologies and sample variation. Therefore, we need to explore better methods to identify what causes variability. Further, additional research is needed to develop widely adopted microbial measurement standards that are quantitative, specific, and comparable. This progress will dramatically hasten our ability to implement and measure the effects of biotechnology applications at large, but specifically in infrastructure systems.

For example, we still do not understand how complex microbial systems, such as soil microbiomes or ocean microbiomes, work. Methods are critically needed that can capture microbial function, as well as identity. Currently, we can either ask 'who is there' or ‘what are they all doing,’ but we cannot drill down to specific constituents. This is critical to understand how unbalancing the microbiome of systems can make it more susceptible to invaders such as pathogens or antibiotic-resistant bacteria. Our current surface-cleaning methods rely on broad disinfectant strategies (for example, leading antibacterial wipe brands tout killing 99.9% of bacteria). This widespread approach may be progressively helping resistant bacteria get better at resisting our methods (whether household cleaning or medical treatments). Understanding how these natural systems function is required for us to design probiotic buildings and surfaces that can help us further lower disease and create microbiomes for function. Dr. Keenum’s research group is developing biotechnology methods that prioritize speed and simplify the expertise needed to use these tools. Many specialized processes require very advanced, sterile labs to measure microbes, and microbiomes. However, we can envision a future where measuring a microbe is as easy as measuring pH with a probe.

Zhiying Shan, Professor of Kinesiology and Integrative Physiology, leads a research team that focuses on two major areas of biotechnology—gene regulation in hypertension (high blood pressure) and drug delivery through bioengineered extracellular vesicles (EVs). In the first major area—gene regulation in hypertension—Dr. Shan’s research group identifies genes involved in the development and maintenance of hypertension (high blood pressure). Once target genes are identified, recombinant adeno-associated viruses (AAVs) are used to deliver either the genetic coding sequence or small hairpin RNAs (shRNAs) that turn off the gene of interest. By injecting AAV vectors into cardiovascular-related brain regions, we can knock down specific genes to prevent or alleviate hypertension. In the second major area—using extracellular vesicles (EVs) for drug delivery—Dr. Shan’s research group uses EVs (nano-sized, membrane-bound vesicles secreted by cells that carry molecules reflecting the physiological or pathological state of their cells of origin. They mediate intercellular communication by transferring their molecular cargo, which can influence the behavior and function of recipient cells. Dr. Shan’s research group studies the role of EVs in blood pressure regulation and explores their potential as a drug delivery system. Due to their small size and ability to cross the blood-brain barrier, we chemically engineer EVs to carry therapeutic molecules. The research group uses this strategy to deliver drugs directly to the brain for treating hypertension and other neurological diseases.

Thomas Werner, Professor of Genetics and Developmental Biology, Biological Sciences, works in three distinct biotechnology areas. First, Dr. Werner and his research group test various fluorescent probes designed by Dr. Haiying Liu to evaluate their effectiveness in living fruit fly larvae, which validates their performance in vivo. These probes can detect numerous conditions within cells and even within subcellular organelles such as mitochondria, providing insights into disease, aging, and other metrics of living cells.

These brief examples highlight the diversity of biotechnology research and applications and the rapidly evolving nature of the field.

Transitioning Technology

Michigan Tech has a strong performance record of taking scientific, engineering, and outreach advances to create spin-off companies and productive business models.

Dr. Timothy Eisele - BioMang, LLC - Managese, Nickel, and Cobalt Extraction Using Spent LI-ION Batteries
BioMang, LLC, led by Dr. Tim Eisele in Michigan Tech Chemical Engineering, has been working on various metal-reduction and dissolution technologies for well over five years. The core technology uses reductive bioleaching to recover manganese and nickel from "black mass," a byproduct of lithium-ion battery recycling. Unlike conventional methods, this process operates under mild conditions (pH 4.5–5.0) without harsh chemicals or expensive equipment, making it both low-cost and environmentally friendly. The core technology relies on specialized microorganisms cultivated over five years in the PI's lab, with lab-scale results already demonstrating effective nickel leaching. Funding has been secured to scale up the process to demonstrate production-level feasibility. This approach addresses a key barrier in battery recycling: the high cost of traditional chemical leaching. By eliminating these costs, the technology significantly enhances the economic viability of nickel recovery, a critical component in the $20 billion global nickel market, while also supporting the circular economy in battery manufacturing.

Dr. Yoke Khin Yap - Stabilux Biosciences - Flow Cytometry Cell Identification
StabiLux Biosciences is a Michigan Technological University spinout led by Dr. Yoke Khin Yap of the Michigan Tech Physics Department. The company's core technology uses optically transparent and nonconductive boron nitride nanoparticles as the foundation for high-brightness dyes. This high-performance dye enables ultra-sensitive biomolecule detection, with initial applications in flow cytometry and broader potential across biomedical diagnostics. Stabilux has raised $3.2M in non-dilutive grants, $2.8M from investors, and closed $500K for a $2.0M priced round. The company has created at least 15 jobs, including 7 full-time employees and 5 interns, with 28 additional internships supported through STEMForward and National Science Foundation Research Experiences for Undergraduates awards. StabiLux has also contracted $1.5M in research to the university, supported 5 graduate researchers, filed 7 foundational patents under the Patent Cooperation Treaty (PCT), and holds 3 issued patents in South Korea, Japan, and Europe.

Dr. Megan Frost - Sterile State, LLC. - Sterilization Packaging for Biomedical Devices
Sterile State, LLC traces its roots to Michigan Technological University's biomedical engineering department, where co-founder Dr. Megan Frost spent over two decades researching nitric oxide (NO) for biomedical applications. Originally developed to enhance safety in implantable devices, the core technology, a polymer that stores and releases nitric oxide, was

refined through academic research with a focus on biocompatibility and controlled release. Recognizing the urgent need for safer sterilization alternatives to ethylene oxide (EtO), Sterile State pivoted from device applications to packaging-integrated sterilization. The innovation enables medical devices to be sterilized directly in their packaging, without the need for centralized EtO facilities. This addresses regulatory pressures, environmental safety, and supply chain delays in the $20B U.S. medical device sterilization market. The result is a novel, scalable NO-based sterilization platform that eliminates EtO-related risks, while leveraging Michigan Tech's research legacy in safe, nitric oxide delivery systems.

Dr. Jeremy Goldman and Dr. Jarek Drelich - Patent for Bioresorbable Metallic Stents
Researchers at Michigan Technological University, in collaboration with University Hospitals Cleveland, have developed a novel biodegradable stent technology utilizing a patented zinc-based alloy. This alloy is engineered to provide temporary vascular support, maintaining arterial patency for 6–12 months before safely degrading within the body. The zinc-based material offers an optimal balance of mechanical strength and corrosion rate, addressing limitations found in earlier magnesium and iron stents. A recently issued patent secures the composition and fabrication methods of this alloy, underscoring its potential to advance bioresorbable stent applications in cardiovascular medicine. Work continues with clinical collaborators at University Hospitals Cleveland Medical Center and Case Western Reserve University.

Dr. Shiyue Fang - Patent pending for Solid Support Synthesis, Oligo Purification, DNA Synthesis
Dr. Shiyue Fang at Michigan Technological University is developing transformative technologies in synthetic DNA purification and synthesis, aimed at improving scalability, efficiency, and functional versatility in the life sciences. One of his key innovations is a non-chromatographic method for purifying synthetic DNA and peptides, known as "catching by polymerization." This method offers a cost-effective and high-throughput alternative to traditional HPLC-based purification, which is expensive and impractical at large scales. It enables selective isolation of full-length oligodeoxynucleotides by attaching polymerizable tags to either the desired or undesired sequences, simplifying purification for applications such as genome assembly and antisense drug development. Dr. Fang has also pioneered a novel DNA synthesis method that allows the incorporation of chemically sensitive functionalities into DNA and RNA. Traditional synthesis techniques use harsh conditions that degrade sensitive groups, limiting their use in chemical biology and nanotechnology. Dr. Fang's approach replaces standard protecting groups and linkers with ones that can be removed under mild oxidative conditions, preserving delicate chemical features. This technology allows for the synthesis of DNA and RNA with delicate chemical modifications, enabling new insights into gene regulation mechanisms and supporting the development of advanced nucleic acid-based therapies.

Dr. Marina Tanasova - Fluorescent Probes, Glut 5 Delivery
Michigan Tech research is advancing our understanding of glucose transporters (GLUTs), uncovering their roles in diseases like cancer, diabetes, and cognitive decline. By studying how these proteins regulate sugar uptake in cells, researchers are identifying new targets for diagnostics and treatment. For example, overexpression of certain GLUTs has been linked to aggressive cancers, and Michigan Tech-led studies are contributing to the development of GLUT inhibitors that may improve patient outcomes by limiting cancer cell growth. In addition to

cancer research, Dr. Tanasova's lab is exploring how altered GLUT expression contributes to conditions like epilepsy, endometrial disorders, and metabolic diseases. This work supports new therapeutic strategies, including dietary interventions and precision drug development, that could benefit millions of Americans. These efforts exemplify how Michigan Tech is using basic science to drive real-world health solutions that improve lives. Dr. Tanasova and her research group are actively working with Michigan Tech's Office of Innovation and Commercialization to explore the next phases of intellectual property protection.

Dr. Jingfeng Jiang, Prediction of Aneurysms using AI with Image Analysis
Dr. Jingfeng Jiang, a professor of biomedical engineering at Michigan Technological University, collaborates with the Mayo Clinic Radiology Department in Rochester, Minnesota. His interdisciplinary research focuses on artificial intelligence-augmented in vivo biomechanical analysis and imaging (BAI) to enhance diagnostic and therapeutic strategies for conditions like vascular aneurysms and cancer. By leveraging AI technologies, Dr. Jiang aims to streamline labor-intensive components of BAI and improve how specific a diagnostic outcome can be, facilitating the integration of these methods into clinical workflows—helping doctors and patients identify disease with more confidence. Dr. Jiang and his research group are actively working with the Michigan Tech Office of Innovation and Commercialization to disclose and protect this advanced technology.

Michigan Technological University's SBIR and STTR activity

At Michigan Technological University, and across the United States, federal research funding across basic, applied, and technology transfer phases allows concepts to move from ideas into products and technologies, and provide jobs and better quality of life. In particular, initiatives like the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are vital catalysts for biotechnology product development. SBIR and STTR funding provides crucial early-stage capital to small businesses, startups, and university research partners, allowing them to pursue high-risk, high-reward research and development that might not otherwise attract private investment. This seed funding enables the proof-of-concept studies and initial technology development necessary to translate scientific discoveries into tangible biotechnological products. These programs are particularly important in non-medical and non-agricultural fields, where biotechnology solutions are still emerging and private investment can be viewed as high risk. By de-risking these ventures and validating their commercial potential, SBIR and STTR grants help bridge the gap between academic research and market-ready solutions, ultimately fostering innovation, economic growth, and the creation of products that address critical societal needs.