2022.003.GeneralizedTRL - Reliability - Phase 1

**Survey Flow**

**EmbeddedData**

**RecipientFirstNameValue will be set from Panel or URL.**

**RecipientLastNameValue will be set from Panel or URL.**

**RecipientEmailValue will be set from Panel or URL.**

**PanelIDValue will be set from Panel or URL.**

**Block: Informed Consent (2 Questions)**

**Branch: New Branch**

**If**

**If Consent Question To provide informed and voluntary consent and participate in the research study,... No Is Selected**

**EndSurvey: Advanced**

**Standard: Generalized TRL Scale (5 Questions)**

**Standard: Reliability Questions (20 Questions)**

**Standard: Demographics (3 Questions)**

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Start of Block: Informed Consent

Consent Information

**Why are you being asked to participate in the research study?**   
You are being asked to take part in a research study conducted by Dr. Malcolm S. Townes because you are either (i) a current or former technology transfer professional, (ii) have experience in technology-based entrepreneurship, or (iii) believed to have an aptitude for technology and technology commercialization.

**Why is this research study being done?**   
The main purpose of the research study is to validate the reliability of a scale for characterizing and measuring the maturity level of technologies.  The scale is called the Generalized Technology Readiness Level (GTRL) Scale.  
   
**What are you being asked to do?**   
The research study consists of two phases.  In the first phase, you will be asked to first familiarize yourself with the GTRL scale.  Once you have done that, you will be presented with descriptions of 10 technologies.  For each technology, you will rate its maturity level using the GTRL scale.  Finally, you will be asked a few questions about your professional background.  After at least 7 calendar days following the date that you complete the first phase, you will be asked to rate the same technologies again using the same scale without referencing your previous ratings.  Your data collected in this research study might have identifiers removed and be used for future research studies or distributed to other researchers for future research studies without your additional permission.

**How long will you be in the research study?**It is anticipated that it will take you no more than 1 hour to complete each phase of the research study.  However, the amount of time required to complete each phase may vary among participants.  Some participants may take slightly longer to complete each phase, while others may take slightly less time.  You do not have to complete each phase in one session.  You may save your responses and return to complete the phase at a later time.

**What are the risks?**   
The risks of participating in the study are believed to be no more than you would encounter in everyday life. However, there may be risks that are unforeseen or unknown at this time.  As this study involves the use of your personal information, there is a chance that a loss of confidentiality may occur.  To protect confidentiality, the survey you are given is coded so that the researchers will know when you complete the survey without you having to put your name on the survey.  When the research study is completed, all documentation linking the participant names with their survey responses will be destroyed.  The researcher is willing to discuss any questions you might have about these risks.

**Are there benefits to participating in this research study**?   
You will not personally benefit from this research study.  Even though you may not receive any personal benefit, other people and society may benefit in the future because of what the researcher learns from this research study.

**What other options are there?**   
You may choose not to participate in this research study.

**Will your information be kept private?**   
The results of the research study may be published, but your name or identity will not be revealed, and your information will remain private.  State or federal laws or court orders may require that information from your research study records be released.

**What are the costs and payments?**   
You will not be paid for your participation in this research study.

**Who can you call if you have questions?**   
If you have any questions or concerns about this research study, or if you have any problems that occur from taking part in this research study, you may contact the researcher, Dr. Malcolm S. Townes, at malcolm.townes@att.net.

**What are your rights and what else you should know as a research study volunteer?**   
Your participation in this research study is voluntary.  You may choose not to be a part of this research study.  There will be no penalty to you if you choose not to take part in the research study.  You may leave the research study at any time.  The researcher will let you know of any new information that may affect whether you want to continue to take part in the research study.   
    
The use of your data may result in commercial profit, such as a product, material, or process.  You will not be compensated for the use of your data other than what is described in this consent information.   
    
The researcher may take your data out of the research study if something happens to make this necessary.

Consent Question

**Consent Question**   
To provide informed and voluntary consent and participate in the research study, you must confirm that you have read the consent information and have been given ample opportunity to ask questions and state any concerns.  If you have asked any questions or stated any concerns, you must feel that the researcher has responded to them.  You must also believe that you understand the research study and the potential benefits and risks that are involved.   
    
Do you give your informed and voluntary consent to participate in this research study?

* Yes (1)
* No (2)

End of Block: Informed Consent

Start of Block: Generalized TRL Scale

GTRL Tour Page 1   
Before you begin rating the technologies, we would like to familiarize you with the Generalized Technology Readiness Level (GTRL) Scale reference document.  The reference document consists of four (4) pages as shown in the figure below.  Each page has the same basic layout.

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GTRL Tour Page 2

On the left side of each page, various technology readiness levels are specified as indicated by the red arrows in the figure below.  Each technology readiness level (TRL) is highlighted.

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GTRL Tour Page 3

Next to each TRL is a definition of the readiness level as indicated by the red arrows in the figure below.  Each definition is also highlighted.

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GTRL Tour Page 4

Underneath each TRL and definition are groups of examples of the technology readiness level for several categories of technologies as indicated by the red arrows in the figure below. The first group of examples are for medical drugs (as defined by the U.S. Food and Drug Administration). The second group of examples are for medical devices (as defined by the U.S. Food and Drug Administration). The third group of examples are for non-medical technologies. These examples are meant to provide you with additional information to help you interpret the general TRL definitions and apply them to various types of technologies as appropriate.

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GTRL Download   
Before responding to the following survey questions, please download the Generalized Technology Readiness Level (GTRL) Scale reference document and take some time to review it.  You will use the scale to rate each of the following technologies.  Please refer to this document when you are rating the technologies.   
    
To download the GTRL Scale reference document, please copy the URL below, paste it in the address bar of another browser tab, and click the GO button or arrow.  You may then print or download the reference document.  Once you have done that, come back to this browser tab to continue the survey.   
    
https://drive.google.com/file/d/1k8SwZhLOzFHkIEl9S-lYklb1ySZ2-r\_V/view

End of Block: Generalized TRL Scale

Start of Block: Reliability Questions

Tech01

**Technology 01: Novel Hit Compounds as Putative Antifungals**

**Technology Description**   
Researchers have discovered novel scaffolds which could serve as starting structures to develop new drugs with antifungal activity. They have identified eight (8) compounds that exhibit antifungal activity against two strains of *Aspergillus fumigatus* targeting the fungal cytochrome P450 dependent lanosterol 14-α demethylase (CYP51A) enzyme. These compounds can serve as new starting scaffolds for further hit-to-lead optimization.  

In recent decades, fungal infections have been one of the most common and serious health problems worldwide causing over one million human deaths each year. One of the most common airborne fungal pathogens, causing serious and usually fatal invasive infections, is *Aspergillus fumigatus*. The disease caused by fungi of the Aspergillus genus is known in the literature as aspergillosis. This disease is generally separated into three categories, based mainly on the range of symptoms it causes, namely allergic bronchopulmonary aspergillosis (ABPA), chronic necrotizing aspergillosis, and invasive aspergillosis (IA).

[image Tech01\_Fig01]

Figure 1. Compounds identified and selected from the pharmacophore-based virtual screening and docking studies.   
  
Zinc IDs: (1) ZINC02414861, (2) ZINC08765786, (3) ZINCE09152123, (4) ZINC09517045, (5) ZINC12729365, (6) ZINC12996228, (7) ZINCE13779062, and (8) ZINC4613236

**Stage of Research**   
The researchers evaluated the compounds docking scores and the presence of crucial binding interactions to a homology model of the CYP51A enzyme.  They have performed *in vitro* assays to determine the antifungal activity of the compounds against Aspergillus fumigatus (ATCC 204305) and Aspergillus fumigatus (human clinical isolate). Additionally, the researchers have identified the minimal inhibitory concentrations (MIC) and minimal fungicidal concentrations (MFC) for the compounds compared to reference azole drugs, econazole, and ketoconazole.

**Applications**

Treating invasive infections caused by *Aspergillus fumigatus*:   
Allergic bronchopulmonary aspergillosis   
Chronic necrotizing aspergillosis   
Invasive aspergillosis

**Key Advantages**

Scaffolds differentiate from classical azoles which exhibit high toxicity, unfavorable side effects, and a plethora of interactions with other drugs   
Drugs based on the new scaffolds will be less prone to resistance

Tech01 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 01 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech02

**Technology 02: Ultrabright Fluorescent Nanoconstructs as Universal Enhancers**

**Technology Description**

Researchers have developed technology related to the composition and use of a novel combination of a plasmonic nanostructure, spacer layer, and fluorophores which results in a nanoconstruct which is spectrally similar to the fluorophores, but which is at least 500-fold brighter than the individual fluorophores alone. These ultrabright fluorescent nanoconstructs can be conjugated to at least one biorecognition element and used to enhance the performance of and improve the limits of detection of various biological assays and processes without changing or modifying existing bioassay protocols. Examples of assays that are suitable for use of these novel fluorescent nanoconstructs include, but are not limited to, antibody/protein microarrays, bead/suspension assays, biochip assays, capillary/sensor assays, cell assays, tissue assays, DNA/RNA microarrays, polymerase chain reaction (PCR)-based assays, glycan/lectin arrays, immunoassays, enzyme-linked immunosorbent assay (ELISA), microfluidic chips, and membrane-based assays.

[image Tech02\_Fig01]

Figure 1: Comparison of fluorescence intensity with and without enhancement

**Stage of Research**   
Researchers have tested the application of plasmonic-fluors as a fluorescence enhancer in fluorophore-linked immunosorbent assays (FLISAs) and a protein microarray and to enhance the SNR in flow cytometry-based cell analysis. They have used the fluorescent nanoconstructs to detect biomarkers related to kidney function and the results illustrate that the fluorescent nanoconstruct significantly enhances the ability to elucidate low-level kidney function parameters (biomarkers) to provide holistic kidney disease information.

**Applications**

The ultrabright fluorescent nanoconstructs, plasmonic-fluors (PF), can be used to enhance biological assays.

**Key Advantages**

Plasmonic-fluors are solution phase which are much more useful than substrates decorated with plasmonic species  
   
Straightforward, wet chemistry synthesis compared to things like alloyed Cu-Ag NPs, lithography created structures, or vapor deposition, or layer-by-layer synthesis  
   
Particle uniformity/stability/synthesis control is high which is crucial for immunoassays  
   
The spacer between the fluorophore and the plasmonic nanostructure core using MTPMS/APTMS/TMPS can be tightly controlled to achieve precise thicknesses on the nanometer scale and can be applied in solution  
   
The silane-based spacer layer is easily functionalized Improvement of assay performance is higher than previous methodologies  
   
Enhancement of fluorescence per dye molecule (on average) is higher than previously reported for arrangements which are suitable for immunoassay applications  
   
The larger particles used in the present disclosure can be loaded with more dye molecules than other designs -- more dyes plus enhancement of all conjugated dyes equals super-bright construct

Tech02 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 02 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech03

**Technology 03: Wireless Power Transmission**

Technology Description Researchers have developed technology that converts any wall outlet, vehicle charger, or power source into a smart electrical power router and antenna.  The technology sends directed power on demand to operate or recharge electronic devices.  It has a wireless recharging capability range greater than 10 ft.

[image Tech02\_Fig01]

Figure 1. How wireless power transmission works.  

[image Tech02\_Fig02]

Figure 2. Duty cycle comparison from the power management unit for single transmitter versus beam-steered multiple transmitter scenarios.

**Stage of Research**   
Researchers have demonstrated the technology with prototypes using modified commercial-off-the-shelf components. They have successfully demonstrated three (3) transmitters transmitting 1 Watt at 2.4 Ghz.  The receiver was able to harvest greater than 125 mA at greater than 5 V while in motion.  They have also demonstrated the technology wirelessly recharging a common cell phone and in a U.S. Department of Defense fighter jet pilot helmet application.

**Applications**

Various electrical power and recharging applications including:   
Mobile phones and other electronic devices  
Home appliances  
Electric vehicles

**Key Advantages**   
Greater autonomy  
Shorter charge-times and lower power costs  
Fewer negative environmental impacts

Tech03 Response

**Technology Maturity Level**

Rate the maturity level of Technology 03 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech04

**Technology 04: Vascular Graft to Promote Stem Cell Therapy for Diabetes and Other Diseases**

**Technology Description**

An interdisciplinary team of researchers has developed a multi-layered arteriovenous graft device that enhances the survival and function of stem cell transplants to treat Type 1 diabetes or other diseases. Artificial organs derived from stem cells could provide long-term, physiologically-regulated enzyme replacement treatment for a variety of conditions. To survive, these stem cells must have a sustainable and constant blood supply and they must be protected from attack by a host’s immune system. This new vascular graft achieves those goals: the cells are directly connected to the blood supply to provide oxygen and nutrients for survival; and they are embedded in a hydrogel to protect them from the immune system. Furthermore, because the graft has direct proximity to arterial and venous blood, the transplanted cells can sense metabolites in the blood and secrete enzymes or growth factors in response to physiological conditions. Finally, the graft can be easily inserted, replaced, or removed as needed to enhance the treatment or for patient safety. This device could be used to deliver stem cell-derived insulin-secreting pancreatic beta-cells, which are able to treat Type 1 or Type 2 diabetes via real-time sensing of blood glucose and rapidly delivering intravenous insulin. The same method can also be adapted for thyroid or adrenal gland cells to deliver other cell types, enzymes, or growth factors.

[image Tech04\_Fig01]

Figure 1. Conceptual diagram of graft location and function

Stage of Research The inventors have built a viable prototype graft that can be implanted with stem cell-derived beta-cell clusters. The inventors have also developed methods for reliable implantation and immune shielding of stem cell-derived beta-cell clusters. *In vivo* these cells are able sense blood glucose levels and rapidly secrete insulin in real-time. The inventors continue to currently develop and refine the next generation prototypes and implantation methods.

**Applications**

Delivery of biologically active, organ-specific differentiated stem cells, such as:   
Beta-cells to secrete insulin and treat Type 1 and Type 2 diabetes by normalizing blood glucose  
Thyroid or adrenal gland cells for enzyme and growth factor-replacement therap

**Key Advantages**

Enhanced cell/artificial organ survival:   
Cells embedded in graft, surrounded by hydrogel to protect them from host immune system

Cells have direct access to arterial blood supply to provide oxygen and nutrients Enhanced function/physiological regulation:   
For b-cells – cells in graft detect blood glucose fluctuations in real-time and can rapidly deliver insulin for glycemic control

For other cells (e.g., thyroid or adrenal) – could detect needed levels of metabolites to secrete other enzymes or growth factors Easy access for removing or replacing – Graft can be implanted under a patient’s skin in an outpatient procedure and accessed percutaneously, allowing access to:   
Periodically load the graft with new cells  
Replace the device with a fresh graft

Remove the device to ensure patient safety Convenient for patients:   
Cell therapy could provide a long-term glycemic control solution for patients with Type 1 and Type 2 diabetes without conventional blood monitoring and insulin injections

Tech04 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 04 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech05

**Technology 05: High-Throughput Blood Biomarker Test for Peripheral Atherosclerosis**

**Technology Description**

Researchers have developed a blood biomarker test for atherosclerosis that is more accurate than low-density lipoprotein (LDL). Circulating levels of Fatty Acid Synthase (cFAS) in the serum correlate to a high degree to severity of peripheral atherosclerosis. The team discovered that cFAS originates from the liver and is covalently linked to Apolipoprotein B, the major lipoprotein in LDL. In the serum, cFAS fractionates in the LDL fraction, and patients that have elevated serum cFAS also have high levels of FAS in their arterial plaque. Tissue FAS is responsible for making saturated fatty acids, which lead to atheroprogression and vulnerable arterial plaques.

[image Tech05\_Fig01]

Figure 1. Patients with high-grade carotid artery stenosis (CAS) showed circulating Fatty Acid Synthase (cFAS): (A) is predominately in the serum LDL fractions, (B) is elevated relative to healthy patients, and (C) correlates to content of FAS in arterial tissue.

**Stage of Research**

The researchers have developed this biomarker test into a high-throughput multi-well assay and have validated it in over 100 patients. The results have confirmed that cFAS serum content can independently detect peripheral arterial disease with 83% accuracy. Given the catalytic nature of cFAS, ongoing work involves inhibition of cFAS as a way to decrease the risk of peripheral atherosclerosis.

**Applications**   
Diagnostic indicator of peripheral atherosclerosis  
Stratification of atherosclerosis severity in higher risk patients (e.g., patients with diabetes)   Key

**Advantages**    
Minimally invasive  
Potential for combination with other diabetic blood tests  
Clinically validated  
Provides opportunity for early therapeutic intervention

Tech05 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 05 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech06

**Technology 06: Stent System for the Treatment of Aorto-Iliac Occlusive** Disease

**Technology Description**

Researchers have developed an improved stent system to treat aortoiliac occlusive disease. Aorto-iliac occlusive disease is caused by atherosclerotic plaque accumulation in the abdominal aorta where it connects to the common iliac arteries. Plaque accumulation can significantly reduce blood flow to lower extremities and pelvic organs, resulting in high morbidity, disability, and increased risk of amputation. The two methods currently available to treat this disease are open bypass surgery or stenting the aorto-iliac arterial segment. The stenting approach is commonly used as it is non-invasive. However, the inverted Y shape of this arterial segment complicates the stenting procedure. It is common ‘off-label’ practice to place two adjacent stents in a “kissing” configuration to provide flow from the aorta into each of the common iliac arteries. However, this is often sub-optimal and has limited long-term patency. To overcome the limitations associated with the ‘off-label’ use of “kissing” stents in the aortic bifurcation, the inventors have developed a new aorto-iliac fenestrated (AIFEN) stent system. This is comprised of a balloon-expandable, tapered, covered stent with a fenestration (an outlet opening) that can be placed across the distal aortic bifurcation from one iliac artery, and the fenestration aligned with the inflow of the opposite iliac artery. A secondary stent can be placed in the opposite iliac artery to facilitate unobstructed flow from the AIFEN if needed. The AIFEN technology has the potential to enable tailored, percutaneous, and effective endovascular treatment of aorto-iliac occlusive disease.

[image Tech06\_Fig01] [image Tech06\_Fig02] [image Tech06\_Fig03]

                                 (a)                       (b)                                             (c)   
  
Figure 1. Comparison of kissing stents and fenestrated stent: (a) schematic of the aortic bifurcation with placed kissing stents and observable cross-section, (b) schematic of the aortic bifurcation with the fenestrated stent design in the aortoiliac bifurcation in one embodiment, (c) photogragh of a prototype embodiment of the fenestrated stent.

**Stage of Research**

A prototype has been developed and validation is ongoing.

**Applications**

Treatment of aorto-iliac occlusive disease.

**Key Advantages**

System provides a percutaneous solution for the treatment of the entire aorto-iliac bifurcation

Stents and associated openings will have radiopaque markings to track placement

System is designed to reduce stress on the aorta and be deployed from either a femoral or arm endovascular approach

Design significantly improves flow properties compared to the current off-label use of “kissing” stents:

Reduces flow stagnation and thrombus formation

Outlet flow velocities and mass flow rates are superior Provides an alternative solution for the treatment of aorto-iliac occlusive disease that is far less morbid than open surgical bypass

Tech06 Response

**Technology Maturity Level**Rate the maturity level of Technology 06 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech07

**Technology 07: Exosome-based Therapy for Tendon Injuries and Other Soft Tissue Repair**

**Technology Description**

A team of researchers has developed a cell-free, nano-sized extracellular vesicle (EV or exosome) system to enhance repair of soft musculoskeletal tissue. This technology leverages the natural anti-inflammatory effects of adipose-derived stem cells (ASCs) through derived exosomes and includes a local delivery mechanism that promotes healing.  
   
The underlying cause of poor outcomes following many soft tissue injuries (Achilles tendon rupture, rotator cuff tear, flexor tendon injury) is inflammation triggered by macrophages. ASCs can be used to curb inflammation, but they have safety concerns and are hard to deliver to the repair site. Exosomes secreted by the ASCs provide an alternative approach by mimicking the anti-inflammatory function of ASCs but avoiding some safety concerns and offering improved features.  
   
These exosomes can be delivered locally via a collagen sheet and can penetrate the injured tissue because they are nanosized. In addition, they have the potential to be selectively enriched with active molecules (e.g., miRNA) to further enhance healing.

**Stage of Research**

The inventors have used a mouse model of Achilles tendon injury to demonstrate the effects of primed ASC exosomes in modulating tissue inflammatory response, promoting tendon matrix regeneration, and reducing post-operative rupture/gap formation. The priming effect is likely associated with selective enrichment of certain regulator miRNA cargos within the exosomes.

[image Tech07\_Fig01]

Figure 1. Schematic illustration of process and preparation of delivering adipose-derived stem cell (ASC) extracellular vesicles (EV’s, also known as exosomes) to a mouse model of Achilles tendon transection and repair.  

[image Tech07\_Fig02]

Figure 2. Mice receiving ASC exosomes recovered range of motion more quickly following Achilles tendon repair.

**Applications**

Exosome therapy for soft tissue injury to enhance healing after tendon, ligament, or cartilage injuries

**Key Advantages**

Nano-sized and cell-free – ASC-derived exosomes mimic the function of ASC’s to modulate inflammatory response with improved features:

Readily deliverable in large quantities to full thickness tissue through biological barriers

Eases safety concerns of stem cell therapy

Potential to enhance effects by loading with therapeutic cargo such as miRNA or other agents

Stable membrane lipid composition that could protect, carry, and deliver a variety of functional agents targeted and local delivery:

Exosomes have cell surface markers that could enable cell-specific interactions and delivery of therapeutic cargo

Collagen sheet can be used for local and retained delivery of exosomes to site of surgical repair

Tech07 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 07 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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Tech08

**Technology 08: Ultrasound-Guided Diffuse Optical Tomography for Fast, Low-Cost Functional Imaging of Breast Lesions**

**Technology Description**

Researchers have pioneered a compact, low-cost ultrasound-guided optical tomography system designed to differentiate between benign and malignant breast lesions and reduce the need for costly and invasive biopsies. This technology enables fast, robust image reconstruction for diffuse optical tomography (DOT) in near infrared spectrum, providing objective, quantitative functional images for characterizing suspicious lesions identified through ultrasound and mammography.  
   
Currently, it is difficult to distinguish the appearance of malignant vs. benign lesions with conventional breast imaging modalities and up to 80% of breast biopsies are performed on benign lesions. DOT could improve diagnostic accuracy and reduce the number of benign biopsies by providing complementary functional information. However, in the past, DOT has suffered from slow and difficult image reconstruction complicated by low accuracy and artifacts due to intense light scattering, presenting a bottleneck for wide clinical use. This technology addresses that problem with a combination of software and hardware to produce fast, high-fidelity images.  
   
The compact hardware can be easily combined with any commercial ultrasound transducer for DOT imaging. The user-friendly software includes computational techniques for automated ultrasound image segmentation for DOT reconstruction guidance; automated DOT data pre-preprocessing; and conditioning for improved signal-to-noise ratio; and fast image reconstruction. Collectively, the system generates optimized functional images for quantifying hemoglobin concentration and blood oxygen saturation in the lesion. Because higher levels of hemoglobin are associated with angiogenesis and malignancy, a conservative hemoglobin threshold could reliably identify many benign lesions, greatly reducing benign breast biopsies without compromising cancer detection sensitivity. In addition, functional imaging with DOT could predict response to neoadjuvant chemotherapy for breast cancer.

[image Tech08\_Fig01]

                                                     (a)                                             (b)  
                     
Figure 1. Reconstructed hemoglobin map of a benign but proliferative lesion. Image (a) is a co-registered  
 ultrasound image. Image (b) is a center slice of the reconstructed hemoglobin distribution.

**Stage of Research**

Prototype and prospective testing:   
The inventors have developed a fourth-generation prototype ultrasound-guided optical tomography system that is currently being used at a university hospital for a prospective clinical trial.

Image reconstruction software:   
Software currently provides imaging results in 20-30 minutes. The inventors plan to improve the software and develop it for near real-time imaging read out.

Retrospective studies:   
The inventors conducted a retrospective study of 288 patients and estimated that using the ultrasound-guided optical tomography system would reduce the number of patients referred for biopsy by 45 percent. In a different study, the inventors used the system to predict treatment response to neoadjuvant chemotherapy.

**Applications**

Breast cancer imaging:   
Adjunct to mammography and ultrasound to characterize suspicious lesions, particularly in dense breast tissue  
Treatment monitoring/assessing response to neoadjuvant chemotherapy  
Ultrasound-guided optical tomography reconstruction algorithms could be adapted for use with MRI or X-ray guided imaging

**Key Advantages**

Reduce benign biopsies:   
Objective, quantitative criteria to predict likelihood of malignancy  
Potentially reduce 40-50% of benign breast biopsies by combining functional image with traditional ultrasound to identify false positive screens  
Lowers total healthcare costs and subjects fewer patients to the risks of costly and an invasive procedure or an aggressive management plan

Compact, portable, low-cost, compatible device:   
DOT technique is non-invasive and does not require any contrast agents  
DOT probe can be easily combined with any commercial ultrasound transducer

User-friendly operation and interface Fast, robust image reconstruction:   
Preprocessing and imaging reconstruction algorithms currently generate images in 20-30 minutes with ongoing improvements aimed at achieving near real-time imaging read-outs  
Automated data processing to improve consistency and facilitate clinical translation  
Improved lesion quantification accuracy from ultrasound-guided image reconstruction techniques

Tech08 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 08 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

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| Page Break |  |

Tech09

**Technology 09: Sustainable Rare Earth Element Extraction from Coal Ash**

Technology Description Researchers have developed a more sustainable and efficient process for extracting rare earth elements from coal fly ash using supercritical fluids. Compared to the conventional roasting and acid leaching method, supercritical fluid extraction uses considerably less energy and produces no liquid or organic waste, while also yielding rare earth elements at 10x purity.  
   
Most rare earth elements are currently mined internationally, creating a supply chain vulnerable to geopolitical factors. This technology enables a more robust and sustainable extraction process from coal products like fly ash, reducing our reliance on mined rare earth elements.

[image Tech09\_Fig01]

Figure 1. Overview of the supercritical fluid extraction process from coal fly ash

**Stage of Research**

The inventors have achieved 10x increased purity and high extraction efficiency using this process in a laboratory demonstration, when compared to conventional extraction methods. Further, those results are consistent regardless of the supercritical fluid used, such as scCO2, scN2, or scAir.

**Applications**

Rare earth element extraction from coal-based products:   
Coal fly ash  
Coal bottom ash  
Pulverized coal

**Key Advantages**   
Yields 10x increased purity  
Produces no liquid or organic waste  
Requires less energy than typical roasting process

Tech09 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 09 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

|  |  |
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| Page Break |  |

Tech10

**Technology 10: NRF2 Inhibitors as Cancer Therapeutics**

**Technology Description**

NRF2, a transcription factor involved in the cellular response to oxidative stress, appears to play a role in the metabolic reprogramming of cancer cells. Cells with constitutive NRF2 activation show increased resistance to both chemotherapy and radiotherapy. The anti-parasitic drug pyrimethamine has been shown to inhibit NRF2, but no version of an NRF2 inhibitor has been approved for use in cancer.  These small molecules are analogs of the known NRF2 inhibitor pyrimethamine. Constitutive activation of NRF2 promotes metabolic reprogramming, leading to cancer cell proliferation, chemoresistance, and radio-resistance.

[image Tech10\_Fig01]

Figure 1. RT-qPCR analysis of KYSE70 cells treated with PYR (10 μM) for 24 or 48 hours. NQO1 and OSGIN1 are NRF2 downstream targets. Error bars are +/−SD and \* represents p-value <0.05.

**Stage of Research**

The researchers have synthesized a series of pyrimethamine analogs and tested their ability to inhibit NRF2. The lead compound, WCDD104, provides 10x more inhibition of NRF2 than pyrimethamine, and WCDD115 is 30x more potent. Research is ongoing to better optimize the lead compound and to test the analogs *in vivo*.

**Applications**

Treating diseases related to oxidative stress, including:   
Cancer  
Autoimmune disease  
Toxoplasma infection

**Key Advantages**

Though pyrimethamine is FDA-approved, there are currently no NRF2 inhibitors approved for use in cancer.  
The lead analog is 10x more effective at inhibiting NRF2 than pyrimethamine.

Tech10 Response

**Technology Maturity Level**   
Rate the maturity level of Technology 10 by selecting the appropriate level below.  Please refer to the Generalized Technology Readiness Level scale for additional details about each technology readiness level, if you need to do so.

* TRL-0 (1)
* TRL-1 (2)
* TRL-2 (3)
* TRL-3 (4)
* TRL-4 (5)
* TRL-5 (6)
* TRL-6 (7)
* TRL-7 (8)
* TRL-8 (9)
* TRL-9 (10)

End of Block: Reliability Questions

Start of Block: Demographics

Demographics Intro

You're almost finished.  Please answer a few demographic questions.

Education

Do you have an undergraduate or graduate degree in the following disciplines?

|  |  |  |
| --- | --- | --- |
|  | Yes (23) | No (24) |
| Biology, medical, or life science (17) |  |  |
| Social science (18) |  |  |
| Engineering or physical science (19) |  |  |
| Computer science or information technology (20) |  |  |
| Mathematics or statistics (21) |  |  |
| Technology or engineering management (22) |  |  |

Tech Experience

Which of the following choices describes your technology-related experience? (Select all that apply)

* Technology transfer professional (6)
* Technology-based entrepreneur (7)
* Product manager for technology products or services (8)
* Developer of technology products or services (9)
* Technology analyst (10)
* Technology enthusiast (11)
* None of the above apply to me (12)

End of Block: Demographics