Non-Invasive Continuous Optical Lactic Acid Sensor (N.I.C.O.L.A.S.)

Vanderbilt University

Jude Franklin, B. Eng. in Biomedical Engineering, Class of 2020
Anthony Frederick, B. Eng. in Biomedical Engineering, Class of 2020
Chet Friday, B. Eng. in Biomedical Engineering, Class of 2020
Justin Mollison, B. Eng. in Biomedical Engineering, Class of 2020
Gregory Ridgel, B. Eng. in Biomedical Engineering and Spanish, Class of 2020

Advisors:
Susan Eagle, MD,
Professor of Cardiothoracic Anesthesiology at Vanderbilt University Medical School

Franz Baudenbacher, PhD,
Associate Professor of Biomedical Engineering at Vanderbilt University School of Engineering

Table of Contents:

Executive Summary:

PROBLEM: Lactic acid is a clinical biomarker that, at high levels, can be measured to predict various types of tissue hypoperfusion, including sepsis, organ failure, and hemorrhage. Lactate levels are currently monitored through intermittent blood draws, but undersampling with this technique often results in missing lactate spikes, leading to morbidity and mortality.

SOLUTION: We sought to design a continuous, non-invasive lactate monitor in order to follow patient's critical status. These can be used as denoter of severe organ systems failures in the ill patient. This would be done using a novel, continuous, non-invasive lactate sensor.

COMPETITION AND DIFFERENTIATION: There have been a variety of devices proposed that measure blood lactate levels. The most common method is the use of periodic blood draws which are then sent for chemical analysis. Some groups have proposed devices that use microneedles or do real-time intravenous measurements of lactate levels using electrochemical sensors. These methods have been shown to be extremely accurate; however, they are highly invasive and have a limited scope in terms of the situations in which they can be used. Additionally, electrochemical sensors that measure blood lactate indirectly by analyzing the lactate levels in sweat or saliva have been designed, mostly for use by professional and recreational athletes. These methods have shown to have significantly decreased accuracy and not be very robust. Our solution will be an improvement from others due to its non-invasive, ratiometric approach. Being non-invasive, our device has a much larger scope and potential market than the competitors. Also, due to the ratiometric approach using two wavelengths of light, the effect of tissue scattering on the lactate detection will be accounted for.

TECHNICAL FEASIBILITY: Our device is still in the developmental phase and a proof of concept to test feasibility is currently being built. Based on previous literature and the wide use of pulse oximetry and plethysmography for measuring heart rate and oxygen saturation which uses similar technology, the feasibility of this project is promising.

REGULATORY AND REIMBURSEMENT: The device would be classified as a class II medical device by the FDA due to the fact that it measures a physiological parameter and attempts to make a diagnosis. Because of this, we will be able to utilize the 510K pathway since the technology that the N.I.C.O.L.A.S. uses has been used in a similar manner in previously approved devices. For this device we will also pursue a category III, level I Healthcare Common Procedure Coding System (HCPCS) code. This will be the most logical step as our device will need ample time to accrue the necessary documentation to achieve the ultimate goal of fully adopted category I level I HCPCS code.

SALES AND MARKETING: The market for the N.I.C.O.L.A.S. device would include physicians, hospital staff, and any long-term or home care facilities, monitoring of lactate levels is a widespread need for clinical and surgical settings. Enabling faster responses to spikes in lactate concentrations would be beneficial for most areas of the healthcare field, and would allow for better reactions to high lactate levels in facilities without the best testing conditions.

Problem Description:

Lactate levels begin to rise when a patient is undergoing large-scale, life-threatening conditions, such as sepsis, hemorrhage, and organ failure. This demonstrates that lactate is one of the first signs that a provider has of the onset of the aforementioned conditions..Therefore, monitoring changes in lactate levels accurately and continuously is paramount in a clinical setting.

Historically, lactate levels have been monitored via intermittent blood draws every four to six hours. This gives a rough idea of the patient's health, but is not often enough to detect the rapid changes in lactate levels that can occur between intervals. Missing a jump in lactic acid concentration due to non-continuous could lead to a death, which would be detectable, perhaps preventable in some clinical situations. In addition, constant intermittent lactate level checks can result in internal wounds leading to deep vein thrombosis, resulting in over 100,000 deaths a year, with severe health problems (1). Often times, a patient's decompensation toward sepsis is not detected until it affects the entire system (i.e., a decrease in systemic blood pressure), showing a complete failure in homeostatic regulation. This lag time leads to lower health outcomes that could be avoided if there were a way to measure change in lactate levels more continuously.

Thus, our device must be minimally invasive, and integratable with different physiological signals. The device should be specific and sensitive to biologically relevant markers while being at low risk to exacerbate hypoperfusion. In addition, the device should be continuously monitoring the patient, while being easily analyzable for the practitioner. The device should have an algorithm to detect hemorrhage and infection given lactate level and other physiological signals. Finally, the device should be portable, cost-effective, and implementable into the current hospital infrastructure. The system's diode should emit light in the near IR range in order to excite lactate, therefore being able to work on different regions of the body.

Objective Statement:

As described above, the severe volatility of lactate levels produces a variety of challenges for health care staff within hospitals, as the most sudden and rapid changes can induce sepsis between traditional intervals of lactate measurement and testing. Plus, repetitive manual drawing of blood can put strains on a patient's body by causing deep vein thrombosis (DVT) (1) and allows for practitioner error while conducting this sampling. As well, the system for determining lactate levels can span a large area within the hospital, as samples need to be taken from the patient to the testing area.

To address these problems, our team intends to design the N.I.C.O.L.A.S. System, a lactate sensor that allows for continuous, non-invasive, and compact monitoring within clinical settings. Incorporating diffuse reflectance in order to monitor lactate concentration by relative irradiance values, our team plans to develop an infrared LED integrated finger-clip that utilizes two near-IR wavelengths that match absorbance peaks for blood-soluble lactic acid. By comparing the inputted light intensity against the output of a photosensor, values for circulating lactate can be determined more regularly, less invasively, and while taking up less space.

Currently, the planned N.I.C.O.L.A.S. design mimics the structure of pulse oximeters, with the finger clip containing LED's that produce uniform light when excited.

After shining the light down through the top of the fingernail bed, the laser light passes through the finger, interacts with the desired components in the blood, and then is scattered up through the fingernail into a photoconductor. The main difference between the designs is the wavelength of the light shined through the finger, mentioned above to be within the near-IR range, where values correspond to peak blood-bound lactate absorbance. Specifically, our team's selected wavelengths are 2100 nm and 1730nm, two wavelengths found to be highly absorbed by lactate and that, for the most part, avoid the peak absorbances for other regularly-absorbing components of the (water, skin, hemoglobin, melanin, etc.). An additional challenge is ensuring that measurements do not take place too frequently, as to prevent overexposure to electromagnetic radiation.

Ideally, by using the device over time, increases in lactate concentration will yield a lower level of transmitted light -- as with more lactate in the blood, the more light would be absorbed -- and the device could signal to health care staff that an unsafe increase in concentration has occurred. This premise could be successful within clinical and surgical settings, allowing for an easier-to-manage, closer view of this compound that can be dangerous when left unsupervised.

Competition and Differentiation

A variety of solutions have been proposed or are currently employed to address the issue of measuring lactate, each with their own drawbacks in regard to one of the tenets of our proposed N.I.C.O.L.A.S. system: noninvasive, continuous, mobile, highly reliable lactate measurements.

The current gold standard for lactate measurements in clinical settings is the use of periodic blood draws which are sent to a lab to be analysed by conventional analytical chemistry.The biggest issues with this technique are that it measures lactate in discrete levels at a sampling frequency of, at most, once per hour and as such it lacks the necessary responsiveness to maximize the potential of lactate as an early indicator of sepsis and hemorrhage. This method is also resource intensive and requires repeated blood draws which causes discomfort to the patient and can lead to serious pathophysiologies such as deep vein thrombosis (1).

Proposed solutions from academia are all based on the development of electrochemical sensors that are able to read lactate levels from other bodily fluids such as saliva (2) and sweat (3). These sensors are more sensitive than the N.I.C.O.L.A.S. system and are able to provide a more reliable absolute reading of lactate levels in the blood all while being less invasive than blood draws however some designs are still moderately invasive as some designs require placement in the mouth (4). Sweat based systems also struggle to collect sufficient quantities of sweat to make continuous and responsive. Another drawback of electrochemical systems is that many of them are enzyme-based and thus degrade over time due to prolonged use or storage (5). One team has developed a polymer based system to extend the shelf life of their sensor however their sensor lacks the capability of continuous measurement and they struggle to collect enough sweat for analysis.

Our N.I.C.O.L.A.S. system will be a vast improvement on the current technologies due to its ability to measure blood lactate levels continuously and noninvasively in a small package that will be less resource-intensive on hospitals. Our sensor will not be specific or sensitive enough to measure absolute lactate concentrations, however it will be sensitive enough to detect fluctuations in lactate levels and alert healthcare professionals of increases in blood lactate. This will help healthcare providers better utilize lactate as an early indicator of sepsis and hemorrhage, allowing for earlier preventative intervention in these cases leading to improved patient outcomes. Our platform also benefits the patient by eliminating the discomfort of periodic blood draws and eliminates the risk for DVT resulting from periodic blood draws for lactate monitoring.

Final Design Documentation, Prototype, and Proof of Function:

As of now, our project is in the developmental stage. We are currently working towards a functional proof of concept device that will be used to conduct feasibility studies and determine if the proposed solution is viable. We have built a circuit that can reliably pulse our LEDs, and filter and read a consistent signal from the photoconductor. The photoconductor can read the attenuation of our pulsed light source, and we are now testing the interaction between our system and lactate concentrations. When we do build our final design prototype, we plan on including a technical document that will include a component list, technical drawing, relevant safety information, device dimensions, relevant wavelengths and other technical details. To prove that our device works, we will be taking our final prototype to the Vanderbilt Medical Center to collect clinical data and compare our results to the gold standard blood lactate tests that are currently in place. We will perform statistical tests to determine how close our device efficacy comes to that of the gold standard.

Patent Search:

In doing a patent search, there are other ideas within the realm of lactate monitoring, but none quite cover our specific niche space in the way that we are. For example, there are a large number of patents for devices for bioanalysis - devices that can be used nonspecifically to measure the plasma concentrations of a host of various analytes, but are not specific to lactate . One uses Raman spectroscopy, emits a spectrum of light, and then detects the transmitted spectrum (6). However, the majority of these wide-spectrum bioanalysis patents measure the lactate plasma levels electrochemically by either invasively taking blood measurements or measuring the concentration in saliva or in sweat (10).

In terms of detection, many different optical methods have been proposed. As stated above, Raman spectroscopy has been one solution. Another patent (7) also uses Raman spectroscopy; an excitation laser beam at a wavelength of 700-900 nm is focused into the eye a Raman spectrum is detected, a fluorescence spectrum is subtracted from the Raman spectrum, and the blood glucose level is determined. Although this uses glucose as an analyte, the patent suggests lactate could be used as an analog (8). There are patents that conjugate a moiety to the molecule of interest and optically detect that molecule ratiometrically (9, 10).

Anticipated Regulatory Pathway:

As described above, other similar optical sensors have been submitted through the FDA in the past, and based on their history of granting these products 510k clearances (over 280 510k's currently on file in search of 'pulse oximeter') (12), it is not an unreasonable assumption to say that this device would also be cleared through the same pathway. Additionally, the fact that the device itself is not ‘life-sustaining’ restricts it from being classified as Class 3, and although it is technically non-invasive, Class 1 regulation does not apply because of the device’s ability to screen and measure important biological quantities. With all of this considered, Class 2 / 510k clearance seems to be the most logical regulatory pathway for the lactate sensor.

Before moving on, however, other important details should be considered. Exposure to laser light and radiation can have harmful effects on the body, so determining the exact amount of energy deposited into the finger while using the device would be an important indicator or safety. One indication that this device *could* be safe, if designed properly, is that the lactate sensor would produce a wavelength of light much longer than standard pulse oximeters, which in turn means that its frequency and resulting energy produced are lower as well. If pulse oximeters are safe enough to shine on fingers for prolonged periods of time, it is likely that a well-designed, responsibly-used optical lactate monitor would not expose subjects to dangerous amounts of exposure.

Reimbursement:

We expect the N.I.C.O.L.A.S. system to be reimbursable by Medicare and Medicaid by getting it coded initially as a category III, level I Healthcare Common Procedure Coding System (HCPCS) device, while the appropriate documentation and adaptation of the device required for a category I, level I HCPCS (13). This coding is appropriate as our device is intended for use in clinical settings by medical professionals as a common procedure. The ability of our device to achieve this status will be dependent on the ability to provide evidence of medical necessity which will be dependent on how much better, if at all, our device is proven to be compared to the currently employed standard. Our reimbursement status will also hinge on the devices ability to be approved by the FDA and adopted by the medical profession.

Estimated Manufacturing Costs:

Due to the fact that we are still in the developmental stage of design our device it is impossible to give a definite estimate of manufacturing costs at this time. However, at the moment we know that the cost of components for our proof of concept is estimated to be about $500. Cost is a major consideration taken into our design thus we are actively minimizing the number of specialized components and techniques that will be required to manufacture our device. Because many of our electrical components are made of standard material and have standard properties in addition to the decision to use 3D printing to build the plastic housing for our components, our device will be easily scalable for mass production which will help to reduce manufacturing costs. Finally, because most of our circuit components are standard, the use of microscale packaging technologies can be employed to help miniaturize our device and further reduce costs.

Market and Impact:

The potential market for this device would be physicians, hospitals, long term care facilities and even home units. The beginning customers could be for doctors who have cases where the end user or patient needs to have their lactate carefully monitored. This would begin with special cases but the practices would potentially move to more ICU personnel. Soon the market would expand to a common adoption policy in hospitals so that more end users could benefit from more careful monitoring of lactate concentrations. The market would then expand to long term care. Patients in nursing homes or other similar facilities potentially could benefit from monitoring of lactate levels, as a forewarning of potential organ failure. This could be extended to home use. Patients with long term conditions would be able to monitor their lactate levels without going into the hospital to get blood drawn. This would allow for faster responses to lactate spikes and allow for better patient outcomes. The economic impact of this discovery would allow for better care in low income areas as well improve income of the hospital. By investing in this device, it would be possible for hospitals to improve care, save money on running lactate blood testing and focus on getting better patient outcomes. The device could be implemented in more satellite hospitals that probably cannot afford a lactate testing equipment or have enough of the equipment. This would potentially improve patient outcomes where they are far away from hospitals with the correct equipment and doctors.

JUDE FRANKLIN
RESIDENTIAL ADDRESS: 3548 HUTCH DRIVE PLANO, TEXAS 75074
UNIVERSITY ADDRESS: PMB 358863, 2301 VANDERBILT PLACE, NASHVILLE, TN 37235-8863
Phone: 469.534.6577 Email: jude.s.franklin@vanderbilt.edu

EDUCATION

Vanderbilt University, Nashville, TN **August 2016 - Present**

- *Bachelor of Engineering in Biomedical Engineering*
    - Courses Taken: General Chemistry, General Physics, General Biology, Biomechanics, Organic Chemistry I and II, Biomaterials, Biomaterial Manipulation (cell design), Calculus I and II, Intro to Basic Java, Matlab, Systems Physiology I and II, Biochemistry, Circuits I
        - All the associated labs were taken as well
        - System Physiology focused on Cardiac System and theoretical implementation of pacemakers

Plano East Senior High, Plano, TX **August 2012 – May 2016**

- International Baccalaureate Scholar, Diploma received
  ACT: Composite: 34/36 Math 36, Writing 36, Science 28, Reading 36
  SAT: Super score: 2280/2400 Math 770, Reading 750, Writing 760
  SAT Subject Tests: Biology Molecular: 700, Mathematics Level 2: 730
- GPA: 4.46/5.00 (5.0 scale)
- Rank: 22/1286
    - Top 1.71% of the class

ACADEMIC AWARDS/ACHIEVEMENTS

President's Volunteer Service Award **Dallas, TX/Washington D.C.**
Bronze Level Award Recipient May 2015

- The President's Volunteer Service Award recognizes United States citizens and lawfully admitted, permanent residents of the United States who have achieved the required number of hours of service over a 12-month time period or cumulative hours over the course of a lifetime.
- For the bronze award, 170 hours of volunteering were verified and accepted as valid service work.

EMPLOYMENT, INTERNSHIPS, AND SHADOWING EXPERIENCE

Residential Advisor| Vanderbilt Residential Education **Nashville, TN**
Vanderbilt Commons/Alumni Lawn Residential Advisor January 2018-present

- Resident advisors enforce the rules of an institution and offer personal and professional guidance to its residents. Advisors are usually expected to lead by example in terms of their character, integrity, and level of maturity.
- It is the responsibility of the RA to make sure every resident feels that they are part of the community, and this includes dealing with any mental health issues that may arise.

Crisis Center| Baylor Scott &White **Dallas, TX**
Intern Summer 2015

- Worked as an intern to carefully package and analyze equipment that were deemed out of date of hospital use but could be sent out to foreign countries for usage.
- Contacted and talked to many officials and companies for donation and proceedings for equipment transfer.

Shadowing Experience| Baylor Scott & White Medical Center at Dallas **Dallas, TX**
Shadowing cardiologist, radiologist, oncologist, Summer 2015

- Followed doctors around to understand their typical day, particularly in diagnosing and processing patient information
- Was able to see the set up for a few surgeries

Research Experience| Vanderbilt Neonatology Lab **Nashville, TN**
Research Intern in the Guttentag Lab Summer 2018-Present

- Abstract: Cargo delivery to lysosome-related organelles universally relies on the recognition of sorting signal by adaptor proteins
- Prepared various plates for sequencing and would run various mini/maxi-preps
- Transfection of DNA into various mutant cells, tagging various locations with antibodies
- Proposal sent in for publication - will attend conference in Orlando in May 2019

Research Internship| Neural Interfaces Lab at UT Dallas **Dallas, TX**
Research Intern in the Cogan Lab Summer 2019

- Corrosion studies of various implantable devices
- Prepared various electrodes and ran galvanic corrosion tests
- Learned how to analyze potentiodynamic polarization tests to understand how best to re-passivate an electrode in model ISF
- Methods can be used for modelling implants in cases such as Deep brain stimulation

SKILLS

- Lab experience isolating mRNA for sequencing, autoclaving, gel electrophoresis, transfections, DNA isolation, immunohistochemistry, meta/gene set analysis. Pipetting and preparing samples; ELIZA tests, statistical tests
- General chemistry, biology, physics, and Organic Chemistry I and II lab experiences
    - Microsoft Excel/Word proficiency
    - Reading and interpreting IRs and NMRs after preparing and performing the reactions

Anthony Frederick

Student-Vanderbilt University

anthony.m.frederick@vanderbilt.edu

8032377271

COLUMBIA, South Carolina, United States

I would like to use my background in Biomedical Engineering and Computer Science to help create and develop new devices, techniques, and materials.

SKILLS

Proficient in C++ | Proficient in Java | Proficient in Matlab | CAD Designing/SolidWorks | Circuit Creation | Data Analysis and Storage

EDUCATION

Biomedical Engineering
Vanderbilt University
08/2016 – Present *Nashville, Tennessee*
Courses
- Computer Science Introduction to Programming Java
- Computer Science Program Design and Data Structures
- Analysis of Biomedical Data
- Biomedical Transport Phenomena
- Biomedical Materials
- Circuits I and Circuits II Circuits II Lab
- Bio-mechanics
- Organic Chemistry I/ Organic Chemistry Lab
- Biomedical Imaging Techniques
- Biomedical Instrumentation

ORGANIZATIONS

InterAxon (02/2018 – Present)
Teach neuroscience to local middle school students in the Metro Nashville area

Vanderbilt Students Volunteer for Science (01/2018 – Present)
Taught science theories and performed in class experiments to interest middle and high school students in science fields

Hospital Volunteer- Radiology Department (08/2016 – Present)
Directed and escorted patients to and from X ray and MRI rooms and other areas of the hospital

Relay for Life (08/2016 – Present)
Help organize and run several events at Relay for Life

WORK EXPERIENCE

Undergraduate Researcher
MEDLAB/Vanderbilt Initiative in Surgery and Engineering
01/2018 – 12/2018 *Nashville, TN*
Created and design prototypes for steerable/curved Kidney stone basket
Achievements/Tasks
- Work with micro heat shrink tubing
- Learn and understand the mechanism of Kidney stones and baskets
- Work with super-elastic metals and laser cutting

Contact: Katy Rjojas – ktriojas@gmail.com

Undergraduate Researcher
Biomedical Photonics Center at Vanderbilt University
12/2018 – Present *Nashville, TN*
Vanderbilt Biophotonics Center
Achievements/Tasks
- Performed surgery on slugs to remove nerves for experimentation
- Setup and run experiments on the nerve and measured heat transfer and Compound Action Potential of the nerves
- Wrote and used a Matlab code to simultaneously analyze heat transfer and compound action potential to determine nerve response
- Created Optical scanning design and calibrate optical systems

Contact: Jeremy Ford – 8474049330

Biomedical Engineering Intern/Product Specialist
Greenlight Medical
05/2019 – 08/2019 *Nashville, TN*
Cloud Software Based Company to help with medical device procurement to hospitals.
Achievements/Tasks
- Created a database of medical devices for easier comparison of devices
- Cataloged and reported clinical research concerning medical devices and development

Contact: Greenlight Medical HR – (629) 888-2920

LANGUAGES

English	●●●●●
Spanish	●●○○○
Latin	●●●●○

Chet S. Friday

104 San Francisco Drive
Quakertown, PA 18951
(US) 267-347-9467
chet.s.friday@vanderbilt.edu

Education:

- **Vanderbilt University, Class of 2020**
  - Major in Biomedical Engineering
  - Spring 2019: Semester Abroad at University of New South Wales (UNSW) in Sydney, Australia

Work Experience and Relevant Coursework:

- **Product Specialist and Research Intern – GreenLight Medical, Nashville, TN, Summer – Fall 2019**
  - Clinical research, 'Product Library' development, and specs writing for GreenLight software
  - Software works to speed up and increase safety of hospital medical device procurement
- **VISE Summer Research Fellow – Biomedical Modeling Laboratory, Vanderbilt University, 2018**
  - Vessel and liver phantom fabrication using agar-albumin, waxes, silicones
  - Microwave Ablation observing variation in treatment zone with image segmentation and analysis
  - Continued work through Fall 2018 in Research for Credit program
- **Summer Intern – Foundations Community Partnership, Doylestown, PA, Summer 2017**
  - Service-learning organization focused on providing resources to other local non-profits
  - Service component: on-site non-profit work, related journal reviews, final paper and presentation
  - Academic component: three-credit psychology course, focusing on interpersonal communication
- **Other Coding / Programming Experience**
  - Extensive academic experience with MATLAB (various VU BME courses)
  - Some academic experience with Java (VU CS 1101)

Volunteer Experience and Extracurricular Involvements:

- **Site Leader – Vanderbilt Alternative Spring Break, Present – Spring 2020**
  - Week-long service trip in Portland, OR focusing on sustainable and eco-friendly building practices
  - Service planning and group education throughout year; supervision of trip in March 2020
- **Program Manager, Junior Facilitator – HOBY Leadership PA East Seminar, 2015 - Present**
  - Event planning and management for weekend seminar for high school sophomores
  - Minute-by-minute rundown of seminar, leading small group activities, general fundraising
- **Treasurer – Vanderbilt Club Spikeball, Fall 2017 - Present**
  - Involved with running practice, organizing tournaments, and managing roster dues and budgeting
- **'Dore for a Day' Student Host – Vanderbilt University Admission, Fall 2017 - Present**
  - One-on-one college visit program, more personalized tour of university for prospective students

Justin Mollison

Phone: (347)-703-6286
Email: Justin.e.mollison@vanderbilt.edu
LinkedIn: linkedin.com/in/justin-mollison/

EDUCATION

Vanderbilt University, Nashville, Tennessee — May 2020
Bachelor of Engineering, Biomedical Engineering — Minor: Nanoscience and Nanotechnology

- Jackie Robinson Foundation Scholar, Class of 2020

Relevant Coursework: Materials Characterization Techniques for Nanoscale Engineering, Experimental Nanoscale Fabrication and Characterization, Fabrication of Microfluidic Devices, Applications of Nanostructures, Biomedical Instrumentation

EXPERIENCE

Building Diversity in Biomedical Sciences Program at Tufts University – Summer Researcher — May 2019 – August 2019

- Performed bioinformatic analysis and characterization of a Neisseria gonorrhoeae hypothetical gene involved in host adaptation during natural mucosal human infection in the lab of Dr. Caroline Genco
- Utilized genetic database searches to determine the possible role of gene NGO0319 which was identified previously in a context likelihood of relatedness network analysis as having edges with transport, energy, and metabolism genes
- Showed that NGO0319 is likely involved in N. gonorrhoeae heme biosynthesis as evidenced by its characterized homologous sequences in other species
- Successfully created an NGO0319 knockout strain confirmed by DNA sequencing and observed preliminary growth defects
- Presented a poster on this work at the Building Diversity in Biomedical Sciences Symposium (August 2019)

Vanderbilt Institute of Nanoscale Science and Engineering Cleanroom – Tech Crew — May 2018 – Present

- Research, design, fabricate and assemble needle mounted, alumina neural probes for simultaneous, *in vivo* recording of local field potentials and amperometric measurements of both choline and acetylcholine concentration in mouse brains and presented a poster on this work at the VINSE REU Symposium (August 2018)
- Instruct high school students from the Vanderbilt Summer Academy in the fabrication of a microfluidic device and educated them on standard microfabrication practices: spin coating, photolithography, and plasma etching
- Develop standard recipes and procedures for the spin coating and photolithography of silicon wafers with various photoresists such as mr-DWL-40 and NR9
- Design photomasks for the testing and optimization of photolithography processes as well as for cleanroom users
- Write Standard Operating Procedure for Trion Phantom RIE ICP

Biomedical Instrumentation Lab Course at Vanderbilt – Student — January 2019 – May 2019

- Proposed, designed, and fabricated a proof of concept low cost (~$150 per pair) gait analysis insole for the early detection of peripheral neuropathy in diabetic patients

The Duvall Advanced Therapeutics Lab, Vanderbilt University – Undergraduate Researcher — October 2016 – April 2018

- Developed an injectable, ROS protective hydrogel as a vehicle for the transplantation and proliferation of chondrocytes as a treatment for cartilage degeneration induced by chronic inflammation from osteoarthritis or trauma
- Presented poster on preliminary findings in determining the appropriate substrate and extracellular matrix that will constitute the protective hydrogel at the National Society for Black Engineers Fall Regional Conference, Nov. 4, 2017.
- Designed and verified a procedure for the antioxidant loading and quantification of polymer micelles

The Jackie Robinson Foundation- Development Department Intern — June 2017 – August 2017

- Managed maintenance of Scholar, Alumni, Individual Sponsor, and Corporate Sponsor information in the Foundation's Blackbaud Raiser's Edge database
- Proposed, developed, and implemented a Snapchat Campaign for The Jackie Robinson Foundation's New Scholar Orientation to provide a medium for inter-scholar communication and explore Snapchat's viability for future use by the Foundation. The campaign yielded ~9000 views and 32 impressions per person per day at the 4 day, 70 person conference.
- Presented analysis of Snapchat usage metrics and proposed areas of future usage by the Foundation
- Filmed and edited interviews for a promotional video to be posted on the Foundation's social media platforms and blog

SKILLS

- Proficient in wet lab techniques: bacterial and eukaryotic cell culture, bacterial transformation, lyophilization, PCR and spectrophotometry
- Elementary knowledge of and experience performing micro and nanoscale characterization techniques: SEM, TEM, AFM, XRD, FIB, EBL, profilometry, spectroscopic ellipsometry
- Proficient in common nanofabrication techniques: plasma etching, photolithography, soft lithography and thermal deposition
- Proficient in Adobe Premiere, AutoCAD, Autodesk Inventor, Blackbaud Raiser's Edge, Google Drive, Matlab, MS Office, Tanner L-Edit

Gregory L. Ridgel, Jr.

Mobile: +1 (205) 515-2425 | Email: gregory.l.ridgel@vanderbilt.edu

Education: **Vanderbilt University** May 2020
Bachelor of Engineering in Biomedical Engineering and Spanish
Honors: Dean's List (Spring 2019), Out for Undergrad Engineering Attendee
Study Abroad: Universidad Carlos III de Madrid (UC3M), Madrid, Spain Spring 2019

Relevant Coursework

BME Senior Design (in progress)	Pathology & Pathophysiology	Biomechanics
Image Processing	Biomedical Instrumentation	Biochemistry
Phys. Transport Phenomena	Intro to Tissue Engineering	Circuits I & II

Projects & Research:

Pfizer Medicine Design - ADME Sciences **Intern** **Summer 2019**
- Investigated the food effect on endogenous biomarkers for transporter-related drug-drug interactions
- Completed data analysis on 52 samples for 15 analytes/mass transitions via LC-MS

Universidad Carlos III de Madrid **Student** **Spring 2019**
- Designed and built a fully-functional electrocardiography (ECG) device
- Digitally processed and filtered the raw ECG signal in order to analyze and interpret it
- Worked collaboratively to construct and test iterations of our design to optimize signal morphology

Work Experience:

Department of Athletics, Vanderbilt University **Student Lead** **Summer 2017 - Present**
- Coordinate and lead rehearsal & game day logistics for the 150-person Vanderbilt Marching Band
- Setup and breakdown podiums, ladders, coolers, etc. for the home and visiting bands

Survey Research Unit, UAB Hospital **Research Interviewer** **Summer 2018**
- Collected clinical health data for the Alabama Department of Public Health and the CDC
- Displayed proficient interpersonal skills with research participants

Resource Management Systems, UAB Hospital **Patient Care Technician** **Summer 2017**
- Obtained and recorded patient vitals, weights, intake/output, blood glucose levels, etc.
- Assisted nursing staff in holistic patient care, including domestic duties and bathing patients

Leadership:

Phi Beta Sigma Fraternity, Inc. - AΓA Chapter **VP/Treasurer** **Fall 2018 - Present**
- Coordinate 4 to 6 events every semester to promote campus involvement and provoke discussions
- Create an annual budget and expense report that displays the success of our events

Alternative Thanksgiving and Winter Break **Site Leader** **Fall 2017 - Winter 2018**
- Executed a weeklong service trip for 12 college students in San Francisco, CA
- Spearheaded the budgeting & logistics of the trip, along with the participant education on and off-site

Other Activities:

Vanderbilt Student Volunteers for Science	Team Leader	Fall 2017 - Present
Vanderbilt Juggling & Physical Arts Club	President	Spring 2017 - Present
Spirit of Gold Marching Band	Senior Representative	Fall 2016 - Present

Skills:

Computer: Proficiency in Matlab, Mathematica, Analyst & MultiQuant, and Microsoft (Word, Excel, etc.)
Language: Proficiency in Spanish (B2): Written (advanced), Oral (advanced), Spoken (advanced)
Interests: Trombone, euphonium, linguistics, language learning, juggling, music composition, spoken word

References:

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