CALL FOR STUDENTS NOMINATIONS.

Research Abroad Program at Cincinnati University, Ohio, USA

With the aim of offering high-performing students at Tec de Monterrey a multicultural environment that contributes to their global perspective, academic and personal development in institutions of recognized international prestige, the Vice-Rector's Office for Internationalization in collaboration with the EIC and ECSG of Tec de Monterrey as well as the research laboratories of **Cincinnati University** invite pre-graduate students to carry out research stays for Summer 2023. The International Office at the University of Cincinnati will support undergraduate students to participate in research projects at UC during the summer of 2023 by providing housing and a meal allowance.

- This call is addressed to Students Tec 20 and Tec 21 from Semester 5th and up
- Project 5 is offered to ECSG and the remaining projects are offered to EIC students.
- Period of the Research Stay: Summer 2023 from June 26th to Aug 4th (6 weeks, 40 hours per week: full time)
- The deadline for the submission of the documentation will be March 18, 2023

GUIDELINES.

All students with a minimum general average of 90 at the time of the call and who present a copy of the card that endorses it and who satisfy the following points may participate as per the following guidelines:

1) It is the candidate's responsibility to carefully read the information on possible research projects as well as additional information on the center or laboratory and scientist associated with the research project of interest.
2) Present a letter explaining the reasons with a maximum of 1 page, addressed to the leading research professor at CINCINNATI, as well as a copy of your CV (free format). Both documents must be submitted in English.
3) Proof of English language proficiency as follows: TOEFL: 80 or higher on the iBT TOEFL Exam or IELTS: 6.5 or higher
4) Letters of recommendation in English from 2 teachers.
5) Evidence of teamwork skills, leadership and proactivity (participation in student groups, social activities, representative teams, outstanding work done as a team leading the respective team, etc.)
6) Have a VALID national passport at the time of submitting your application to this call and with sufficient validity to remain in the United States if selected.
7) Students must have sufficient funds (other that staying and meals provided by UC) and appropriate Medical Insurance as per hosting university guidelines to support themselves in CINCINNATI for the duration of the respective research stay.

PROJECTS.

Project # 1: IMA, Fisico Industrial
Project Title: Synthesis and Characterization of Hybrid Carbon Nanotube Composites for Wearable Human Body-Heat Energy Harvesting
PI: Je-Hyeong Bahk, Mechanical and Materials Engineering, College of Engineering and Applied Science
Project Description: Despite the explosive growth of wearable electronics and sensors on the market in recent years, most of the wearable devices are still powered by batteries that are subject to frequent recharging and replacement. Often these devices require energy autonomy for an extended service time without the need for the user's intervention. Examples include preventive healthcare for elderly people with wearable medical sensors that monitor the wearer's physiological parameters. These medical sensors need to be preferentially wireless, and operational during the patient's daily activities for a long time up to many years without maintenance or the doctor's direct assistance. However, the power densities generated by the TEGs made of state-of-the-art inorganic materials have been limited mainly due to the low efficiency of the materials used and the technical difficulties in device manufacturing. Furthermore, the non-flexibility of the inorganic materials and the expensive and non-scalable manufacturing techniques have been major limiting factors for the thermoelectric energy harvesting devices to scale up in size, and increase the power generated. Hence, there have recently been great interests in synthesizing flexible thermoelectric materials with scalable approaches for wearable energy harvesting applications.
Research Plan: In this project, we aim to tackle the outstanding challenges in the current wearable TEG technology with novel hybrid carbon nanotube (CNT)-based composites. We have the following specific aims for the proposed research activities: 1) Investigate the impact of CNT content on the thermoelectric performance of the composite (2 ~ 3 weeks); 2) Study the effect of various polymer matrices on the TE performance of CNT composites (2 ~ 3 weeks); Fabricate wearable TEGs using the developed CNT composites and characterize the TEG power generation performance (2 weeks). The skills and techniques learned from the trainings include 1) material synthesis and processing, 2) material characterization techniques, both thermal (thermal conductivity) and electrical (electrical conductivity, Seebeck coefficient), 3) device fabrication techniques (mold casting method and metallization), and 4) power generation measurement technique with the fabricated devices.
Student Requirements: We expect the participating student to be motivated and enthusiastic about the proposed research activities and keenly follow our supervision to complete the project in time. We would prefer a student having academic background in materials science, electrical engineering, mechanical engineering, or applied physics. Despite the nature of research geared towards materials science, our research is highly multidisciplinary encompassing all these academic backgrounds, so a student from any of these disciplines can be suited for this project.

Project # 2: IQ, Mecatronica

Project Title: Nanoelectrochemical Sensors for Single Cell Imaging

PI: Ryan White, Department of Chemistry, College of Arts & Sciences

Project Description: Gliotransmission is the bidirectional information transfer between astrocytes, neurons, the neurovascular system, and other cell types through the release of small chemical messengers termed gliotransmitters. This communication is implicated in normal and abnormal brain function in a variety of functional roles. Astrocytes act as integrators across many circuits and environments in the brain and the mode with which gliotransmitters travel between cells can vary in time and space. Rigorous prior research suggests that astrocytes are heterogenous, varying by brain region and circuit. Some of this heterogeneity is affected by transcriptional control related to synapse function, plasticity, and molecular transmission. It is anticipated heterogeneity extends to gliotransmission in a brain circuit specific manner. A major barrier to studying gliotransmission is the lack of measurement tools that possess the requisite spatiotemporal and chemical specificity to study these dynamic messaging processes.

Research Plan: The overall strategy of the research experience will be to develop recessed electrodes with subcellular dimensions (≤10 m diameter) to probe gliotransmission at different sites within a single cell. Using these probes and our scanning electrochemical system, we will determine the spatial heterogeneity of gliotransmission at the subcellular level. The specific aims of the 8-week research experience are as follows: 1. Fabricate subcellular-scale sensors at 10 µm, and <1 µm diameters. The expected outcome of this aim is the fabrication of sensors to perform subcellular site-specific detection. 2. Improve temporal resolution of nanoscale sensors via the use of intermittent pulse amperometry for single vesicle release measurements. The expected outcome of this aim is a sensor protocol to perform the first direct and quantitative characterization ATP release from astrocytes. 3. Site-specific sensing of gliotransmitter release at different cell portions including soma, process, and end foot using both square wave voltammetry and intermittent-pulse amperometry. The expected outcome of this aim is quantitative measure of exocytosis events at subcellular regions with high activity at the end-foot.

Student Requirements: Students with experience in analytical chemistry, electrochemistry, or neuroscience would be preferred for this project.

Project # 3: IBT

Project Title: What triggers brain injury-induced neurodegeneration – intensity or quantity?

PI: Olga Liaudanskaya, Biomedical Engineering, College of Engineering and Applied Sciences

Project Description: Traumatic Brain injury (TBI) is the leading cause of long-lasting mental and physical disabilities affecting all ages, races, and socioeconomic classes worldwide. TBI is a primary injury event inflicted by mechanical impact to the head followed by secondary damage resulting from cellular and molecular responses to the primary stimulation. Recently long-lasting pathological changes in mild TBI survivors were discovered, with a clinical picture similar to an affliction called chronic traumatic encephalopathy (CTE), described first in boxers. Damages include, but are not limited to, acute neurodegeneration, demyelination, accumulation of phosphorylated Tau protein, and neuroinflammation 2. CTE is prevalent among patients with documented concussions (single or multiple; variable severity) or in contact-sport athletes. However, the brain trauma threshold and criteria that trigger CTE onset after TBI are still poorly understood. Thus, there is a critical need to establish the brain trauma criteria that lead to the switch from a healthy state to a diseased one.

Research Plan: Previously, Liaudanskaya Lab developed a human in vitro 3D triculture tissue model of brain injury composed of neurons, astrocytes, and microglia. Human tricultures (neuron, astrocyte, and microglia culture) were generated by seeding neurons, astrocytes, and microglia at a ratio of 2:0.5:0.1 million, respectively, in 3D silk scaffolds and then enveloping them in a collagen type I hydrogel for sustained long-term growth. This model allows us to inflict physiologically relevant mechanical injuries and monitor the primary and secondary injury progression over an extended time frame. Using this human in vitro 3D triculture model of brain injury, I anticipate creating a roadmap of injury criteria and corresponding damages on the cellular level. *Specific Aims of the Proposed Activities* **Aim 1** - Determine the injury intensity threshold. We will use our in vitro human 3D triculture model composed of neurons, astrocytes, and microglia to induce injury of different intensities with the controlled cortical impactor. We will use 6m/s injury speed as a positive control (shown in our previous studies to induce severe network degeneration, neuroinflammation, and metabolic alterations 24 hours after the injury 5) and scale down the speed to 0.5m/s with increments of 0.5 m/s. **Aim 2** – Correlate the number of impacts to the CTE onset and progression. We will monitor the samples with 1-5 mild impacts of various severity (will be selected from Aim1) over 4 weeks to evaluate the onset of CTE. We will measure the level of secreted pTau/Tau and the accumulation of Tau in the extracellular space. Moreover, we will link the results to neuronal network integrity as the main indicator of chronic neurodegeneration.

Student Requirements: Basic biomaterials processing and cell culture experience are highly recommended, while protein analysis and histology experience will be nice but not a requirement. Student responsibilities will include: Material processing and fabrication; Cell culture work - Conduct biochemical and molecular analysis of experimental samples; weekly reports (or presentations) on research progress.

Project # 5: Any major in ECSG

Project Title: Vying for Seats at the Head Table of the World Economy: The Commercial, Technological, and Geopolitical Significance of Multinational Corporations from the Global South Rising to Challenge the Long Dominance of Multinational Corporations from the Global North

PI: Thomas G. Moore, School of Public & International Affairs, College of Arts & Sciences

Project Description: Two decades into the 21st Century, scholars in the interdisciplinary field of international relations – economists, political scientists, and public policy experts – are reassessing the extent to which "developing" countries from the "Global South," such as China, India, and Brazil, have begun to challenge – individually or collectively – the long-standing dominance of "developed" countries from the "Global North," such as the U.S., Germany, and Japan. To complement the existing literature, which has studied these issues mainly by examining trends in transnational flows of goods, services, capital, and technology, my project examines the extent to which multinational corporations (MNCs) from developing countries have been able to break into the top echelon of MNCs – not only in the world economy as a whole but also in specific key industries dominated since the end of World War II by MNCs from developed countries in North America, Europe, and the Asia-Pacific. With the quantitative data largely collected and the background profiles largely complete, the focus of the project in Summer 2023 will be presenting and analyzing the data and preparing preliminary written assessments that evaluate the quantitative and qualitative evidence in light of the project's core questions.

Research Plan: Students will work in parallel on different countries, industries, or regions of the world, completing a sequence of tasks leading to a written assessment. Here, a realistic goal for a Global Research Experience Program student would be to prepare a written assessment for two major countries and two major industries. The specific assignments given to a student from the Global Research Experience Program could be tailored to their background, interests, and goals.

Student Requirements: Although social science majors – including but not only economics, business, political science, international affairs, and public policy majors – might find the project's subject matter particularly relevant to their studies, I'll gladly consider any motivated student who finds the topic interesting, as the project's work does not presume any specific academic background. The main qualifications are a willingness to follow instructions carefully, having a strong attention to detail, and being comfortable asking questions and raising concerns. While it would be a plus if a student had a familiarity with programs such as Excel or Tableau, this is certainly not a requirement.

Project # 6: Biomedical Engineering, Mechanical Engineering, Electrical Engineering, Computer Engineering, Computer Science

Project Title: MyA: Multi-Biometric Vest for People Living with Angelman Syndrome

PI: Orlando Hoilett, Biomedical Engineering, College of Engineering and Applied Science

Project Description: Angelman syndrome (AS) is a neurogenetic syndrome associated with severe developmental and intellectual disability. Symptoms of AS include very limited speech, difficulty sleeping, and poor motor function. AS is caused by a mutation or deletion of the UBE3A gene on the maternal chromosome 15 and is typically diagnosed in the early childhood period using genetic testing. At present, there is no cure for AS. A major barrier to clinical trials is the lack of available outcome measures suitable for AS. Wearable devices that monitor physiological and behavioral output are promising solutions because they provide objective metrics of physiological function without requiring verbal or motoric input from the patient. We have designed MyA, a biometric vest that will measure several key signals relevant to AS (heart rate, respiration, vocalizations, temperature, and sleep), while meeting the unique sensory and tactile needs of the AS population.

Research Plan: For the proposed project, the student intern will work closely with myself to evaluate two microcomputers, the SAMD51 and the MIMXRT1062DVJ6B, to ensure they can interface and record each signal of interest, so that the vest can operate as a completely contained unit, independent of a computer and without any user input. **Aim 1:** Ensure that each microcomputer (SAMD51 and MIMXRT1062) can successfully interface and record data from each sensor and peripheral. Each microcomputer has its own set of capabilities and limitations, so it is necessary to ensure that we can successfully interface with each sensor and are able to extract the necessary signal of interest from each sensor. **Aim 2:** Ensure each microcontroller can successfully interface with auxiliary peripherals such as Secure Digital (SD) cards, real-time clocks (RTC), buttons, and light-emitting diodes (LEDs). Peripherals such as SD cards for data storage, RTCs for time-keeping, buttons for quick user control, and LEDs for device status updates are necessary to realize a fully-functional, user-friendly device.

Student Requirements: For this position, a background in Biomedical Engineering, Mechanical Engineering, Electrical Engineering, Computer Engineering, Computer Science, or another related field is required. Introductory experience analyzing electronic circuits, reading circuit diagrams, building circuits on a breadboard, and simulating circuits using a simulation software such as LTspice is also required. The student intern should also have previous coding experience in MATLAB, R, Python, C, C++, Java, or similar language. Previous experience with microcontrollers or single-board computers like the Arduino, STM32, Teensy, Raspberry Pi, BeagleBoard/BeagleBone, MSP430, or similar devices is also required. Experience designing circuit boards using Autodesk EAGLE, Altium Designer, or similar software is preferred, but not required. Experience using git, or other version-control platforms is preferred, but not required.

Project # 7: Biomedical Engineering, Mechanical Engineering, Electrical Engineering, Computer Engineering, Computer Science
Project Title: Smart Helmets for Detecting and Preventing Concussions
PI: Orlando Hoilett, Biomedical Engineering, College of Engineering and Applied Science
Project Description: Concussion, as defined by the Guideline Development Subcommittee of the American Academy of Neurology, is a syndrome of biomechanically induced alteration of brain function potentially affecting memory, orientation, and state of consciousness and is the most common type of mild traumatic brain injury. Despite early work suggesting that concussion symptoms were directly correlated with the magnitudes of singular impacts, a more complete analysis of the data has made it clear that an impact threshold does not exist. In fact, the deleterious consequences of repetitive head impacts or sub-concussive blows can accumulate over time, causing tissue level damage that both increases susceptibility to later head impacts, and increases the volume of damaged brain tissue. While numerous attempts have been made to design sensor systems to measure head impacts, including in-helmet systems, wearable accelerometers, and even mouthguards, these sensors only quantify risk of injury and even so with varying reliability. The goal of this project is to develop a system that mitigates head injury by tracking the force of each hit and provides a video-based tool that will allow coaches to teach better technique.
Research Plan: Aim 1: Design Smart Helmet sensor chip in Autodesk EAGLE. The Smart Helmet sensor chip will be composed of two high-impact accelerometers, a Global Positioning System (GPS) module, and a Bluetooth Low Energy (BLE) microcomputer. The sensor chip needs to be constructed in a computer-aided design software so that it can be manufactured on a professional-grade printed circuit board. **Aim 2**: Develop firmware to extract data from the Smart Helmet sensor chip. The BLE microcomputer will need to be programmed to extract data from the high-impact accelerometer and GPS unit. The student intern will work with myself, Dr. Orlando S. Hoilett, in the Hoilett Lab as well as Dr. Eric Nauman in the Human Injury Research and Regenerative Technologies (HIRRT) Lab to develop a miniaturized device that combines high-impact accelerometers, GPS, and Bluetooth capabilities into a single, discreet wearable. The student intern will design the sensor chip in a computer-aided design software, namely Autodesk EAGLE. The circuit outline will be provided to the student by me, and the student will complete the design by arranging how the components are organized and oriented on the physical circuit board. While the sensor chip is being fabricated, the student will develop the firmware for the sensor chip. The firmware will require coordinating sampling both the high-impact accelerometers and the GPS unit.
Student Requirements: For this position, a background in Biomedical Engineering, Mechanical Engineering, Electrical Engineering, Computer Engineering, Computer Science, or another related field is required. Introductory experience analyzing electronic circuits, reading circuit diagrams, building circuits on a breadboard, and simulating circuits using a simulation software such as LTspice is also required. The student intern should also have previous coding experience in MATLAB, R, Python, C, C++, Java, or similar language. Previous experience with microcontrollers or single-board computers like the Arduino, STM32, Teensy, Raspberry Pi, BeagleBoard/BeagleBone, MSP430, or similar devices is required, but not required. Experience designing circuit boards using Autodesk EAGLE, Altium Designer, KiCad, or similar software is preferred, but not required. Experience using git, or other version-control platforms is preferred, but not required.

Project # 8: IQ
Project Title: Photodynamic Azido Crystals
PI: Anna Gudmundsdottir, Department of Chemistry, College of Arts & Sciences
Project Description: Smart materials, which have one or more properties that change in response to external stimuli, such as moisture, heat, light, and electric or magnetic fields, are used in numerous applications, including sensors and actuators, in industrial processes and devices. The many potential uses of smart materials has created a demand for new materials with specific properties, especially those that can convert light into mechanical motion. Traditionally, polymers and elastomers have been considered the most appropriate substances for fabricating smart materials and they have accordingly been developed and adopted for smart materials applications. However, more recently, it has been demonstrated that crystals can perform many of the same mechanical feats as polymeric materials. Crystals respond rapidly to external stimuli such as light, heat, and mechanical force, and the response can be quite spectacular, with crystals propelling themselves over distances much larger than their own size, twisting, coiling, crawling, bending, fracturing, or shattering. The mechanical motion of the crystals can be driven by switching between crystal packing arrangements or phase transitions. In addition, mechanical motion can be brought on through chemical reactions such as rearrangements and cis–trans isomerization or dimerization. In more detail, the underlying molecular reconfiguration generates strain in the crystal lattice, which is revealed as macroscopically visible crystal motion.
Research Plan: The student will spend their summer being trained to synthesize new azido derivatives, studing the mechanism of their photoreactivity using transient spectroscopy and product studies, and document the crystal movements. The proposed research will allow the student to become familiar with using various spectroscopic methods, including NMR and IR spectroscopy, and time resolved UV absorption, along with digital microscopy. In addition, the student will have the opportunity to participate in twice a week workshops during lunch to learn about things such CV writing, interviewing, career opportunities as chemists, scientific writing and other important aspects of being a professional chemist.
Student Requirements: Students on this project will preferably have backgrounds in organic and physical chemistry, with interests in photochemistry and spectroscopy.

DOCUMENTS SUBMISSION.

• Documents must be digitized in 1 single PDF file named with the prospective student ID # and last name of CINCINNATI Research Professor of the project to be applied for. Applications will not be received if the documents come in multiple files.

• Pre-grad Students

Enter info and requested documentation in the following link: (NEED TO CREATE A DOCUMENT REPOSITORY)

Without exception, applications will not be accepted after the date indicated, so it is suggested to complete the application as soon as possible. Candidates with incomplete documentation will be automatically disqualified. There is the possibility that they will not be selected for the laboratory to which they applied, but they could be selected for another, so if it is of interest to you, it is recommended to indicate a second, or even a third option.

SELECTION PROCESS.

The selection process is divided into two parts.

1) At Tec de Monterrey.

An analysis and evaluation of the candidacy will be carried out by Tec de Monterrey

a) Analysis and review of documentation

b) Selection of candidates according to the program

c) Sending the file directly to the research project leading professor at CINCINNATI

2) At CINCINNATI

a) Analysis of the candidates sent and, where appropriate, selection of them for an interview.

b) If selected for the interview, an appointment will be arranged with the CINCINNATI researchers via video link. It is important to consider that the language of the communication appointment with the researchers is in English.

c) Report from CINCINNATI's leading researchers to the professor in charge of the Tec de Monterrey program on students selected to participate in the respective research projects.

Once the process is completed, the selected student will receive the response to the application by email. The committee's decision is always final.

TO THE SELECTED STUDENTS.

• Be fully aware that, as selected student, you are the image of the institution, so that in addition to complying with the norms and standards of the respective research center or laboratory, you will be obliged, without exception, to always comply with the institutional values and the General Regulation of Students of the Tec de Monterrey, which applies when the students of our institution are abroad.

• The commitment of the selected student to participate in the research project in an active and committed way, with an attitude of learning and contribution always.

• Under no circumstances the selected student will be able to seek additional work to support themselves during the stay. It is important to take this point into account since it is a very serious matter for the immigration authorities of the United States.

• The work schedule will be defined by the mentors of the project in which they will participate and must be fully complied with.

• Due to the nature of the projects and the intellectual property involved, the student must sign a confidentiality agreement.

• The time will be determined by the CINCINNATI researcher together with the Tec student, as well as any change in dates.

• Students must have sufficient funds to support themselves in CINCINNATI Ohio for the duration of their stay. This call does not include funds for accommodation, food or any other type of expense derived from your research stay in the selected laboratory or center.

- Accepted students are expected to complete and pay for the corresponding visa process including any related fees that UC dictates.
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REGISTRATION AND ACCREDITATION OF COURSES.

The program has a duration of 6 weeks in person for which, depending on the length of the research stay, students will be enrolled at the Tec de Monterrey in the following academic periods:

- Summer 2023

The number of credits to be revalidated will be defined by your program director (career director) and informed to the International Programs Office of your Campus.

Once accepted, students must send the accreditation format for each period to the International Programs office at their correspondent Campus.

It is student’s responsibility to validate with the career director the availability of the topics and / or subjects to be revalidated by a project in which they participate.

The tuition to be paid will be directly at the corresponding Tec de Monterrey campus. Payment will be made according to the number of units registered in each period.

ADDITIONAL INFORMATION.

Any point not covered in this call will be resolved by the selection committee in conjunction with the competent authority of Tec de Monterrey as the case may be.

Coordinators of the Research Stay Program:
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International Programs Office
Queretaro Campus