Innovation Merced

UC Merced, known for creativity, celebration of diversity and cutting-edge research, encourages talent from all corners of the campus to develop the best new ideas for the benefit of society.

Innovation Merced is a broadly scoped, multi-faceted endeavor recently initiated to ensure the continued growth of campus innovation from our Schools of Engineering, Natural Sciences and Social Science, Humanities and Arts. The program is also designed to facilitate the transfer of our innovations to commercial partners for the development of products and services beneficial to society.

In achieving these goals, we ensure compliance with all relevant laws and University of California policy, direct patent filings and patent prosecution, perform marketing assessments, determine the commercial relevance of campus inventions, seek out potential corporate research partners and negotiate all contracts relating to the commercialization of campus inventions.

Innovation Merced is dedicated to the education of our faculty, staff and students on all matters relating to entrepreneurship, intellectual property and business development, and continually seeks opportunities to further develop our campus’s flourishing culture of science, research and engineering combined with entrepreneurial spirit.

For more Information and Licensing
Office of Research and Economic Development
5200 N. Lake Road | Merced, CA 95343
TEL: 209-228-4678
FAX: 209-228-4424
EMAIL: ott@ucmerced.edu
In a short time, we have grown into a community of more than 6,200 students and more than 170 faculty members with credentials from some of the world’s top-ranked universities. As with all other University of California campuses, UC Merced is fiercely dedicated to research and scholarship. We are proud to report that just in the nine short years we’ve been open, UC Merced’s talented researchers have produced scores of inventions that have the potential to change people’s lives, industries and communities.

A byproduct of these research activities is intellectual property that can be copyrighted or patented. A vital element of our public service obligation to the people of California is to ensure these research discoveries make the responsible transition from idea to application as products or services that benefit the community and society.

Innovation Begins Here

This booklet represents a major milestone in the continuing progress of UC Merced. It is with great pride that we share with you the fruits of our research.

This document catalogues the inventions generated from 2007 to July 2014, and acknowledges the faculty members who worked so hard to produce these results. More than 100 inventions have been processed during this time, matching the progress of larger, more established campuses, especially when considering that a disproportionate percentage of our faculty members are early in their careers.

Our deepest admiration and appreciation go to the dedicated faculty and staff members and students identified in this document. Many thanks to Sonal Gadre, Jennifer Biancucci, Lorena Anderson and David Cepoi for the production of this booklet.

In a short time, we have grown into a community of more than 6,200 students and more than 170 faculty members with credentials from some of the world’s top-ranked universities.

As with all other University of California campuses, UC Merced is fiercely dedicated to research and scholarship. We are proud to report that just in the nine short years we’ve been open, UC Merced’s talented researchers have produced scores of inventions that have the potential to change people’s lives, industries and communities.

A byproduct of these research activities is intellectual property that can be copyrighted or patented.

A vital element of our public service obligation to the people of California is to ensure these research discoveries make the responsible transition from idea to application as products or services that benefit the community and society.

Innovation Begins Here

This booklet represents a major milestone in the continuing progress of UC Merced. It is with great pride that we share with you the fruits of our research.

This document catalogues the inventions generated from 2007 to July 2014, and acknowledges the faculty members who worked so hard to produce these results. More than 100 inventions have been processed during this time, matching the progress of larger, more established campuses, especially when considering that a disproportionate percentage of our faculty members are early in their careers.

Our deepest admiration and appreciation go to the dedicated faculty and staff members and students identified in this document. Many thanks to Sonal Gadre, Jennifer Biancucci, Lorena Anderson and David Cepoi for the production of this booklet.
From the microbes in the guts of living things to the idea of life elsewhere in the universe, PROFESSOR MARILYN FOGEL is pondering some of life's deepest questions.

When and how did life originate on Earth? What does the future hold for our planet? Are we alone in the universe?

"When you go back through time, there are bits and scraps of life everywhere," Fogel said. "It's ubiquitous."

As a geobiologist, Fogel, who joined UC Merced in January, explores these questions and more using the stable isotopes found in carbon, oxygen, hydrogen, sulfur and nitrogen, the elements that form the building blocks of all living organisms. She is in the midst of setting up the campus's first natural abundance stable isotope laboratory, and will run the Environmental Analytics Laboratory, too.

She came to UC Merced after 35 years at the Carnegie Institution of Washington's Geophysical Laboratory, where she was a senior scientist, and joins Professor Jessica Blois in paleoecology and paleoclimate studies, and Professors Asmeret Berhe, Peggy O'Day and others as part of the Earth sciences research roster.

Fogel and Blois, who joined UC Merced last fall, are two more examples of the stellar research team for which the university is rapidly becoming known.

Fogel's wide variety of research interests, including biogeochemistry, geology, marine sciences, astrobiology, paleoecology and paleoclimate and geology encompass the whole natural world and will add to the diverse array of scholarly work being produced at UC Merced.

Her work has earned her a prestigious award this year, too: the 2013 Treibs Award from the Geochemical Society, in recognition of her scientific contributions to organic geochemistry. She is the first woman to receive the award since its inception in 1979. Fogel was elected a geochemical fellow in 2003.

Her research has taken her to some of the Earth's remotest and most interesting places, including far northern Canada, Belize, Western Australia, India, Norway and the Sargasso Sea. Her research is used here on Earth and in space, including on Mars missions. Working in rocky, desolate Svalbard, Norway, she helped design instruments and methods for finding life on Mars, according to the USA Science Festival website.

Samples in her emerging lab at the Castle Research Facility show just how varied Fogel's interests are. A fossilized dinosaur bone, egg shells from an emu, a 1.2-billion-year-old rock made of layers and layers of bacteria, plant specimens, wombat bones and a beautiful burgundy rock shot through with silver strands that dates back 4.2 billion years – nearly to the beginning of Earth.

"I'm excited about joining some of the big research projects on campus, like the Critical Zone Observatory in the southern Sierra, along with building smaller collaborations with students and new faculty," Fogel said.

Machine parts in what will be her second lab, at Castle for now and likely opening in the fall, hint at what that space's big draw will be – two brand new stable isotope mass spectrometers, one of which can be run by students and used by the larger campus community.

The second one, she said, will be for intensive research she hopes will cross many disciplinary boundaries, from helping colleagues learn more about how cancer cells behave and examining microbes in new ways, to adding to the growing body of information on climate change.

Using the tracers, researchers can look at the smallest parts of anything that is or once was living and can tell just about anything, including where it lived, what it ate and where its ancestors came from.

"We can measure anything and see how it developed and when it entered the geological record," Fogel said. "We can take information about the modern environment and apply it to the historic record and infer what happened over a long period of time. It's all part of trying to figure out what happened up to this point, and develop accurate modeling for what's to come."

"I'm excited about joining some of the big research projects on campus, like the Critical Zone Observatory in the southern Sierra, along with building smaller collaborations with students and new faculty."
Virtual Reality for Customized Remote and Monitored Physical Therapy

Background
After injury or surgery, many recovering patients are given initial instructions outlining the various exercises they will need to perform as part of their recovery regimen. These instructions are often difficult to understand and provide no mechanism for ensuring proper execution or assessment of overall progress, especially when such exercises are performed at home. Further, even when therapeutic exercises are performed correctly, there is no way to allow a therapist to evaluate patient improvement either qualitatively or quantitatively.

Description
PROFESSOR MARCELLO KALLMANN at UC Merced and colleague Professor Jay Han of UC Davis, understanding the unmet need in physical therapy, developed a novel algorithmic application for the health care field that employs virtual characters, or avatars, and a motion-capture interface to improve physical therapy for upper-body limbs.

Applications
There are no known physical therapy software systems that offer 3-D interfaces designed to model motions provide remote interactions between patients and therapists. This system allows patients to better learn their required exercises while under remote supervision. Participation and progress can be monitored and logged. The remote consultation and customizable exercises are novel features never described in any relevant literature.

This technology was recently licensed to a California start-up company founded by physicians who are colleagues of the inventors. The company intends to further the algorithm and ultimately to introduce new and useful human diagnostics and therapeutics. Kallmann will continue to develop new algorithms for virtual-reality therapy for patient rehabilitation.

Mobile Indoor Localization and Navigation System Using Wi-Fi Signal Signatures and Machine Learning Techniques

Background
GPS receivers, although universally adopted by the general public, do not work indoors and suffer from inaccuracies of up to 25 meters in outdoor urban environments. This issue, combined with recent advances in mobile device technology, has created a strong interest in indoor localization research. Inventors from UC Merced have developed a novel algorithmic process, easily adapted into mobile software applications for use with consumer wireless devices that will allow real-time localization in both indoor and outdoor environments.

Description
This novel localization technology developed by the laboratory of PROFESSOR STEFANO CARPIN exploits the wi-fi signal signatures broadcasted from hotspots that are becoming more and more accurate and robust. This technology embedded into a mobile application will provide services including, but not limited to: localization, turn-by-turn directions and location-based information to users carrying smart mobile devices inside large, complex buildings (e.g., airports, shopping malls, hospitals and museums), as well as cities endeavoring toward total wi-fi accessibility. Moreover, businesses will be able to analyze their customers’ movements and provide them with targeted information or advertising when and where they need it.

Applications
Further development and proof-of-concept work will be conducted by ICP Labs, a start-up venture recently launched by two of the inventors, both former graduate students in Carpin’s lab. ICP Labs will further improve the accuracy and speed of the algorithm and currently performing additional analysis covering new indoor and outdoor experimental data acquired in real-world conditions.

We expect the indoor localization to become as pervasive as GPS is today. A provisional patent application is in preparation. UC Merced and ICP Labs are seeking business development partner(s) for licensing opportunities and for further development of the technology.
The Innovation and Design Clinic Challenge

The School of Engineering’s Innovation and Design Clinic (IDC) provides graduating seniors opportunities to join research teams with other students, but also includes card-carrying engineers and other professionals from partner and sponsoring organizations.

Participating organizations, agencies and nonprofits provide the industry aspect of the academe-industry partnerships the School of Engineering is rapidly developing.

The teams focus on real-world engineering design projects selected for their potential to have significant positive impacts on communities, organizations and/or industries in our region.

The program also brings in students from The Ernest & Julio Gallo Management Program’s entrepreneurship course to infuse an entrepreneurial mindset into the projects. The commitment of the teams and partners, combined with the challenging projects, culminates with the Innovate to Grow competition.

Innovate to Grow puts a new spin on traditional capstone projects. Innovation and entrepreneurial thinking are the signatures of this event, and the richness and intensity of the competition enhances the overall student experience for our undergraduates.

Innovate to Grow is an annual celebration of our students’ creativity, and is our launching pad for enterprises based on some of the most promising inventions and solutions they have developed.

During the inaugural Innovate to Grow event in 2012, student teams presented the results of their projects and demonstrated their innovations to a jury of industry and community representatives using posters, elevator pitches, videos and presentations to make their cases.

Innovate to Grow 2013 was even larger, with 27 teams covering a wider range of interdisciplinary challenges and design solutions, including food processing, healthcare, sustainability in energy and the environment, unmanned aerial vehicles for environmental remote sensing, and biomaterials and processing.

The Innovation and Design Clinic (IDC) provides graduating seniors opportunities to join research teams with other students, but also includes card-carrying engineers and other professionals from partner and sponsoring organizations.

During the inaugural Innovate to Grow event in 2012, student teams presented the results of their projects and demonstrated their innovations to a jury of industry and community representatives using posters, elevator pitches, videos and presentations to make their cases.

Innovate to Grow 2013 was even larger, with 27 teams covering a wider range of interdisciplinary challenges and design solutions, including food processing, healthcare, sustainability in energy and the environment, unmanned aerial vehicles for environmental remote sensing, and biomaterials and processing.

The three summaries highlighted below are from the 2013 Innovate to Grow Competition.

These exemplify both the challenges the students faced and real-world solutions they developed through these projects.

GLASS – Gas Line Automated Surveillance Systems:
Swarm technology is a method for controlling robotic devices as a single, intelligent entity, not unlike the way insects communicate as a single unit. Using this approach, the GLASS team developed a scalable network of multiple unmanned aerial vehicles capable flying in a synchronized and autonomous fashion while exchanging data to one another to accomplish missions such as detecting natural gas leaks from pipelines, GPS location tagging and wireless transmission of sensor data. The GLASS team successfully tested its autonomous flight swarming algorithm, demonstrating that mission-specific swarm algorithms can be developed for differing applications.

Leaf-Be-Gone – Strawberry Calyx Removal:
The removal of the calyx portion from harvested strawberries is a laborious and time-consuming process that results in fruit loss from imprecise cuts and unsanitary conditions because it is usually done by hand in the fields. Working with a local grower, Team Leaf-Be-Gone developed a prototype that can slice off the calyx with high precision, minimizing fruit loss. This scalable system was designed for use in any standard strawberry processing facility, and can process up to 120 berries per second. Employing rational design methods, the team developed its prototype in a functional, modular way, from sorting, sizing, aligning and positioning to cutting and separating. The end result is a machine that is simple, fast and capable of aligning and cutting the fruit with extreme accuracy.

EIVS – Humidification of Ventilator Gases:
Neonatal respiratory care involves monitoring and treating newborns for breathing disorders. The standard respiratory therapy equipment currently used in neonatal ICUs suffers from subpar performance and is susceptible to bacterial contamination. Team Engineers for the Improvement of Ventilator Systems worked with a local children’s hospital on two challenges first, to identify pass-over humidification – the air tube heating wire for condensation control and the water reservoir – as the major design flaws in current methods; and second, to engineer and test improvements for a more efficient and safer device. In particular, the team demonstrated that replacing the heating wire with a heated blanket covering eliminates most of the condensation that forms inside the respiratory tube and, further, prevents the formation of a water plug in the tube that could impede or even completely block breathing. In addition, the humidifier portion of the device was redesigned to allow improved humidification. Finally, the team settled on a silver-coated aluminum cylinder to provide a bacterial-controlled water reservoir.

Innovate to Grow is open to both the campus community and the public, allowing the students to experience honest critiques of their projects.

To date, more than 15 companies have partnered with our student teams, including Grundfos Pumps, Frito Lays, Children’s Hospital Central Valley, Sun- rise Growers/Frozsun Foods, Schneider Electric, E&J Gallo, Hillmar Cheese and PG&E. Several students have gone on to work as interns or even be hired as full-time employees by these companies.

Multiple patent applications have already been filed on inventions coming out of these projects, further exemplifying the creativity of our students, as well as the commercial relevance of the work they are performing.

The Innovation and Design Clinic challenges UC Merced’s senior engineering students to become "entrepreneurs" of their knowledge, skills and industry applications. The partner organizations provide gifts or other financial support to facilitate the clinic concept and activities.

Our partner companies are carefully selected and work closely to develop capstone projects that provide exceptional value to the partners while providing an important and exciting educational value for our students.
Round, Multisection Recycle Bin

Background
In addition to growing concerns and awareness of the environment, American society is increasingly turning to recycling and composting common trash to alleviate rapidly diminishing landfill space as well as to reclaim and reuse valuable materials. Although special containers for recyclable and compostable trash are now commonplace, individual containers are intended for single-waste forms, and are not practical in many settings where different types of waste are generated. The few containers intended to collect different types of trash in a single unit are bulky, immobile, ugly and are rarely intuitive, leaving the average user unclear as how to properly segregate trash. Further, existing containers are mostly intended for placement against a wall, away from traffic flow, where they’re not as useful.

Description
In response to a high percentage of recyclable trash being disposed of in landfill destined waste containers, UC Merced staff members ERIC SCOTT and MATT HIROTA collaborated to design a three-sectioned portable container that could be used in crowded public areas that experience a lot of foot traffic. This container is a handsome, highly visible, all-in-one waste receptacle with three divisions for different types of the most commonly generated refuse: landfill trash, recyclable material and compostable waste. The divisions are identified by color-coding, pictures and naming, allowing the casual, and often hurried, user to easily select the correct hole in which to dispose of refuse. The container is also mobile, allowing it to be easily moved to different areas as foot traffic patterns shift.

Applications
- High volume, high foot-traffic areas, where food is typically served, such as fairs, convention halls, transportation centers/hubs, schools, theaters, malls, sporting events, etc;
- Areas where having several containers, each for a different form of waste, is either impractical or aesthetically unappealing;
- Smaller-sized versions can be made for preschools/kindergartens so children can learn recycling at an early age.

The prototype containers were manufactured locally by Great Spaces USA in Merced. Licensing discussions are underway to grant Great Spaces USA the exclusive right to make and sell these containers in the United States.

In addition, the inventors are working with Great Spaces USA to design an all-metal variant for use outdoors. We have received purchase inquiries from other institutions from across the country. A United States design patent was recently issued for the container.
Activated Charcoal Composite Biomaterial Promotes Human Embryonic Stem Cell Differentiation Toward Neuronal Lineages

Background

Injuries involving the central or peripheral nervous system often result in lifelong disabilities caused by loss of neural function. Recovery from such injuries is poor because injured nervous tissue creates a hostile environment for the damaged nerves to heal. Biomaterial scaffolds are possible vehicles for facilitating the repair or rescue of injured neural tissue. In order to generate a 3D bio-scaffold structure, biocompatible and bio-resorbable material, compatible with the implant tissue area, is required for promoting tissue regeneration.

Carbon related micro- or nano-biomaterials have been used in the construction of bio-scaffolds for use in tissue engineering. Among these carbon-related micro/nano-biomaterials, carbon nanotubes (CNTs) and graphene have proved efficacious in supporting stem cell attachment and subsequent differentiation into neurons. However, the applicability of the existing biomaterials or platforms is significantly hampered by toxic effects and instability.

Description

Researchers at UC Merced, under the direction of PROFESSOR WEI-CHUN CHIN, have identified new carbon-based biomaterials that offer biocompatible and mechanically stable platforms for stem cell transplantation composed of natural bituminous coal-based composite bio-substrate. These novel bio-scaffolds with extracellular matrices added were shown to foster stem cell attachment, proliferation and final incorporation into host tissue. The use of these bio-scaffolds when used at sites of injury, trauma or other forms of physical insult were particularly effective. Such sites are typically hostile for stem cell therapy, yet differentiation toward neuronal lineages was observed as evidenced by expression of neuronal markers as well as by myelinated axonal projections following implantation of the cell/substrate matrix.

Applications

The bio scaffold described here serves as an implantable, carbon-based platform for repairing neural and, possibly, other tissues because of their bio-friendly, semi-conductive and stable nature. The bio-material used in the manufacture of the scaffolds is highly porous and adsorbent, qualities that aid in cell attachment, proliferation and differentiation, as well as for concentrating the growth factors and cell adhesion proteins needed for encouraging attachment and differentiation.

A Rapid Method for Detecting and Identifying Bacterial Contamination Using Differential Calorimetry

Background

Antibiotic-resistant bacteria present a major health threat and a tremendous economic burden. Approximately 20,000 people in the U.S. die annually from Methicillin-resistant Staphylococcus aureus, only one of many such resistant strains. Recent estimates place health-care related costs of antimicrobial resistance at $20 billion annually in the United States. Additional downstream societal costs have been estimated at $35 billion annually. Methods currently used to detect these resistant microbes date from the 1950s and are manual, slow (up to 72 hours) and labor intensive. The use of calorimetry shows promise in the identification of unknown bacterial strains, largely because highly sensitive calorimeters have been developed which are able to more rapidly detect smaller samples of bacteria than older methods based on visual or metabolic assays.

Description

The laboratory of PROFESSOR MIRIAM BARLOW at UC Merced has developed BioSentry, a method using differential scanning calorimetry capable of detecting, identifying and characterizing bacteria as well as the identification of multiple species. When bacteria are susceptible to an antibiotic, the metabolic heat they produce is decreased upon exposure to that antibiotic. In contrast, resistant bacteria continue to grow and produce heat following exposure. The use of calorimetry is readily assayable using an isothermal titrative calorimeter and differences in heat output from the cultures can be accurately monitored using an isothermal titrative calorimeter and differences in heat output are readily assayable using BioSentry.

Applications

Can be easily adapted for high-throughput operation using most commercially available, high-precision, multi-chamber calorimeters

Greater potential for complete automation than currently existing standards

Capable of assaying antibiotic resistance profiles of bacteria in many different environments

For any situation in which the rapid detection, quantification and analysis of viable contaminating bacteria is essential, including, but not limited to hospitals, food processing and schools.
Stem cell research is an extraordinarily promising field of modern biology, yielding already fundamental discoveries on the nature of complex organisms and human medicine.

The Stem Cell Instrumentation Foundry (SCIF) was created to provide stem cell scientists at UC Merced and throughout California access to the instruments, techniques and training necessary for carrying out advanced applications in stem cell research. The facility was created and is funded by a $4.35 million investment by the California Institute of Regenerative Medicine.

The Foundry is housed in 4,260 square feet of research laboratory space providing for human and mouse stem cell culture, flow cytometry, quantitative cell imaging, as well as Class 1000 and 100 clean rooms for micro/nano fabrication and workstations.

What sets SCIF apart from analogous laboratories at other institutions is that it houses a range of microfluidics, nano-technology and single-cell analysis-based systems. This enables researchers, many with no prior knowledge of micro/nano techniques, to custom design their unique devices online to address their specific scientific needs and rapidly integrate these cutting-edge technologies into their experimental designs.

SCIF is also equipped with advanced “collaboratory” technology composed of integrated, tool-oriented computing and communications systems allowing researchers to access both online support and workshops, as well as connect with collaborating scientists. SCIF is also set up to allow for the development of new tools and approaches applicable to basic and applied research that will further advance the understanding of regenerative medicine.

The mission of SCIF is to provide an open and versatile environment for the most promising stem cell projects.

Leadership and Vision for SCIF

As the director of SCIF ANAND GADRE, PH.D., MBA oversees training and manages the equipment and other resources of the Foundry. Gadre has extensive collaborations with other campus researchers, and, in particular, shares his research interests in the areas of lab-on-a-chip systems, microfluidics stem-cell-based tissue engineering and biosensing.

His vision for SCIF is that it will enhance the research experience for undergraduate and graduate students in their early academic careers – helping create future leaders in research – and serve as a hub for collaborations within the campus and with neighboring institutions.
Fluorescent Embryonic Stem Cell Lines for Studying Vascular Development

Background

Vascular progenitor cells are desirable for a variety of therapeutic strategies. However, the lineage commitment of endothelial and smooth muscle cells from a common progenitor is not well understood. PROFESSOR KARA MCCLOSKEY’S lab at UC Merced has developed the first reported dual reporter mouse embryonic stem cell lines engineered to facilitate the study of vascular endothelial and smooth muscle development in vitro. Employing both GFP and RFP under different vascular-specific promoters, these dual reporter mouse embryonic cell lines permit visualization and tracking of individual endothelial and vascular-specific promoters, these dual reporter mouse embryonic cell lines permit visualization and tracking of individual endothelial and smooth muscle cells over time and in multiple dimensions.

Description

Mouse embryonic stem cell lines were engineered to express dual fluorescent reporters under the control of cell type-specific promoters. These cell lines have been used to show how certain small molecule and other biochemical signals affect the differentiation of embryonic stem cells into vascular cells in real time. To date, there are no other reported embryonic stem cell lines that express two reporters for studying vascular development.

Applications

Current theory holds that smooth muscle cells and endothelial cells derive from a common progenitor cell type. The dual reporter lines described here enable the study of micro-environmental cues that promote differentiation of smooth muscle cells and endothelial cells from this common progenitor into their distinct vascular cell types under in vitro conditions. In addition, these dual reporter lines will facilitate the isolation of smooth muscle and endothelial cell populations, providing critical tools for the study of certain disease states, such as cancer, atherosclerosis, etc.

The McCloskey laboratory continues to use these lines to explore vascular development. UC Merced is seeking licensing partners as well as development partners interested in using these lines to develop disease models and expand their use as research tools. A manuscript entitled “Mouse Embryonic Stem Cells for Studying Vascular Development,” which describes these cell lines, is in press.

A New Cell Fixative that Greatly Extends Freezer Life of Harvested Tissue/Cells for Immunohistologic, Molecular and Flow Cytometric Analysis

Background

Experiments using flow cytometry typically use live cells harvested from animals to be stained and analyzed on the same day. If further in-depth studies are needed on additional samples, such analysis must occur within two days, or another cohort of animals is required, because of degradation of the original tissue. In addition to the extra cost of obtaining and housing new animals, day-to-day variability in standard staining reagents and instrumentation can make data analysis between sample sets problematic.

The laboratory of UC Merced PROFESSOR JENNIFER MANILAY is using a fixative that allows unstained cells to be kept in cold storage and re-analyzed at later dates, resolving the issue of variability between experiments and significantly reducing the costs associated with such studies. Large numbers of samples and different time points can be analyzed at one time, limiting day-to-day variability in analysis. The fixative can easily replace more standard reagents in histology, and its enhanced preservation of proteins, DNA and RNA are advantageous to modern genomic and proteomic techniques. The fixative was tested with various murine tissues, organs, cell types and cell lines with little to no loss in macromolecule quality.

Description

Experiments using flow cytometry typically use live cells harvested from animals to be stained and analyzed on the same day. If further in-depth studies are needed on additional samples, such analysis must occur within two days, or another cohort of animals is required, because of degradation of the original tissue. In addition to the extra cost of obtaining and housing new animals, day-to-day variability in standard staining reagents and instrumentation can make data analysis between sample sets problematic.

The laboratory of UC Merced PROFESSOR JENNIFER MANILAY is using a fixative that allows unstained cells to be kept in cold storage and re-analyzed at later dates, resolving the issue of variability between experiments and significantly reducing the costs associated with such studies. Large numbers of samples and different time points can be analyzed at one time, limiting day-to-day variability in analysis. The fixative can easily replace more standard reagents in histology, and its enhanced preservation of proteins, DNA and RNA are advantageous to modern genomic and proteomic techniques. The fixative was tested with various murine tissues, organs, cell types and cell lines with little to no loss in macromolecule quality.

Applications

This fixative shows promise as a convenient and cost-effective alternative to commercial fixatives and more traditional fixatives that rely on formalin and alcohols. It allows for high-quality histology, and preserves DNA, RNA and protein extremely well. Potential users of this fixative range from immunologists and pathologists to ecologists and biochemists, and any lab, institution or company that uses fixation.
The UC Merced Mobile App Challenge

Mobile App Challenge Reproduces the Entrepreneurial Experience

UC Merced is a student-centered research university. Graduates are expected not simply to find jobs, but to become the thinkers and professionals who will create career opportunities for others and advance the region’s status.

In light of this vision, it is essential to do all we can to promote student success. In April 2011, a group of university officials met with a Silicon Valley executive to discuss how we prepare tomorrow’s workforce to be entrepreneurial and creative. What are the technical skill gaps that need to be filled? How do we inspire university students to become entrepreneurs who are able to tackle real-world problems?

We realized we had the chance to create an innovative entrepreneurial competition and the UC Merced Mobile App Challenge was born. While other universities sponsor similar contests, UC Merced’s competition is unique because it only involves undergraduate students. Other universities also define a problem for students to solve. At UC Merced, we’ve allowed them to come up with their own problems and their own solutions. UC Merced students have the opportunity to develop apps that could launch new business ideas or emerging technologies to help people now and in the future.

The main goal of the challenge — now in its third year — is to help students sharpen technical skills, showcase their creativity and cultivate their entrepreneurial spirit. During the course of the competition, the students are challenged to implement management, leadership, marketing and public speaking, among other skills. The competition also teaches students what it takes to carry an idea to fruition.

Thirty-five students representing each of the university’s three schools took the challenge last year and developed innovative and custom applications for wireless devices. Some teams tackled students’ real-life problems, such as manually assigning chores, dividing bills and keeping track of personal finances, downloading homework, exams and other study tools and exploring career options. Another team created a breathalyzer with a social component and mobile games.

Last year’s winning team, known as HiFive, tackled event posters. Junior Alyson Cabral said she and fellow students Nectali Castellanos, Robert Hewitt, Raymond Lee and Kevin Rodriguez wanted to make it easier for students to know what events are taking place at UC Merced without having to memorize everything that’s posted around campus.

Their app, called Posters, allows clubs and organizations to post events so they are easily accessible to students’ mobile devices and can be sorted by categories including free food, academics, athletics, professional development and more.

"The Mobile App Challenge is a great opportunity for all students because it gives us the hands-on experience needed to develop relevant skills for the work place, regardless of discipline," said Cabral, a mechanical engineering major from Merced. "I have no doubt that this experience will benefit my future greatly."

Cabral said she was drawn to the competition after watching the final presentations during the first year’s event.

"Seeing the teams’ final products first hand inspired us to want a piece of the experience as well," Cabral said. "It is important to take part in opportunities like the Mobile App Challenge because experiences like these develop our confidence, professionalism and collaborative skills."

A panel of judges awarded the grand prize — $2,500 in scholarships — based on the quality of the app, innovation and professional pitches to a panel of judges. The campus community voted to award four other prizes that include the most original app and the app with the best functional design.

In just two years, the Mobile App Challenge has become one of the highlights of the academic calendar.

This year, UC Merced students will again meet the challenges of current and future society. In addition to being popular on campus, the challenge was recently recognized by the International Data Group as a 2013 Laureate for the Computerworld Honors Program, an annual award program that honors visionary applications of information technology promoting positive social, economic and educational change.
Combined Heat and Power Solar System

- All-in-one design results in cost and space savings over having to use separate photovoltaic and solar thermal units.
- Generates hot water to temperatures up to 100 degrees Celsius.
- Ideal in remote places where hot water must be pumped to where it is needed.
- Hot tubs and Jacuzzi-style units.

Background

Solar collectors are used to achieve specific tasks: solar thermal systems collect heat by simply absorbing solar radiation and transferring that heat to a working fluid, whereas solar photovoltaic systems generate electricity from sunlight through the use of special materials. Combining the properties of both systems, while not novel, has been problematic for a long time, in part, because the standard electricity-generating photovoltaic cells dramatically lose efficiency as they become hotter, a problem exacerbated during hot summer months.

In other words, it’s coupling a system that strives to make heat with one that performs poorly when heated. When such co-generation systems were actually made and tested, the effective lifespan of the photovoltaic part was effectively reduced to between five and 10 years, resulting in a poor return-on-investment.

Winston took a non-imaging vacuum tube solar collector that was designed for heating liquids and placed a thin-film solar cell absorber onto the mirror portion of it – basically, Winston included a photovoltaic layer in an existing solar thermal device, and this feature allows that device to convert a portion of the sunlight it receives into a modest amount of electrical energy. The remaining light not converted into electricity is used to heat the working fluid.

Applications

The co-generation system described here generates both electrical energy and low-temperature heat (i.e., temperatures no greater than 100 degrees Celsius) at reduced cost, making it applicable and beneficial for both residential and certain commercial uses, or in other applications in which both electricity and hot water are needed or where space is at a premium. While this system doesn’t produce a large amount of electricity, it is enough to run the pumps, thermostats and other equipment used in typical hot water systems.

Vehicle Carrier for Cardiac Tissue Engineered Grafts

Background

In biomedical research, cell/tissue delivery relies primarily on single-cell and single-material systems. The delivery scaffold usually consists of an acellular matrix derived from a variety of biologic or synthetic polymers, and in fewer cases, a composite of materials. These designs, however, do not allow for the delivery of organized cells and tissue, resulting in poor engraftment, and in particular for cardiac tissue regeneration, poor cell-cell communication, leading to deranged functioning of the transplanted tissue. No current methods make use of precise combinatorial-layered designs, which would eliminate these problems.

Description

Packaging and delivery of cells in a specific, tissue-engineered modality is an alternative to direct cell injection. PROFESSOR KARA MCCLOSKEY’S lab has developed a delivery scaffold engineered to provide vital nutrients to transplanted cells, as well as a cell-surface attachment sites that together ensure protection from pro-inflammatory agents and inflammation. The McCloskey lab found that using such a 3-D matrix delivery vehicle led to increased cell retention compared to direct cell-injection methods. Tissue patches like this allow enhanced cell-cell communication via patterned surfaces, specific alignment and enhanced vasculature.

Applications

McCloskey’s laboratory continues to develop the tissue patch system to explore various aspects of tissue transplantation biology. A U.S. provisional patent application has been filed.
Lee describes his research and teaching mission, giving some insight into the way our young faculty members carry forward the university’s mission of research beneficial to society, and how they help shape the culture of our campus.

What is your core research about?
One project involves the development of a totally new kind of electrode for making solid oxide fuel cells, one of the most widely employed fuel cell types. These cells have many advantages over other fuel cells. They accept hydrocarbons including natural gas and butane (not restricted to pure hydrogen), and are virtually free of other complications such as sensitivity to humidity and toxic contaminants, significantly reducing the overall system complexity.

However, SOFC are not practical for mobile and/or vehicular applications because of their reduced functionality at very high temperatures. The biggest challenge in reducing SOFC operating temperatures has been finding decent electrodes that operate at much lower temperatures.

Right now, we’re testing carbon-based nano-structured materials as SOFC electrodes. Carbons weren’t considered as catalysts for SOFCs before, because of their chemical instability in air at elevated temperatures. However, our recent studies using crystalline forms of carbon are very promising, and this has the potential to be a major breakthrough in the field.

What are your future projects?
We plan to pave a new way of making in-situ nanoscale observations of electrochemical reactions and charge-transport phenomena for energy devices such as solid oxide fuel cell and ionic batteries. SOFC and ionic batteries necessitate very high temperature and air-sensitive liquid environments, respectively. We will use atomic force microscopy, rigorous experimental design and custom-made probes to determine true nanoscale information on the electrochemical kinetics and charge transport in these systems. This project should significantly advance the current state of knowledge on these devices.

What is your teaching and mentoring philosophy?
I vividly remember how much I enjoyed and actively participated in classes that were well organized and structured. I believe the objectives of a class have to be clear to all students and the scope of the lecture needs to be well defined and prepared to facilitate learning. I also think classes should not limit the minds of those who are interested in further study. I tend to try expanding the academic interests of students by providing timely information on related materials and supporting their forays into relevant fields of science and engineering.

As a young faculty member, what is your take on research at UC Merced?
UC Merced is a new research university in which many talented young faculty members are striving to do good research. We have many opportunities to work with other UC campuses, nearby national laboratories and industries. I love the vibrant atmosphere in a very quiet and calm location. Many groups render fruitful and high impact outputs. The environment is great to do research and motivates you all the time.
Undergraduate Database Research Recommendation System

Background
Research projects conducted by undergraduate students are frequently driven by the need to fulfill the requirements of specific assignments within the framework of formal course curricula. Unlike knowledge-based systems, typical library information retrieval systems are not designed to recommend broad publication databases in response to student queries. Moreover, undergraduate students are often unfamiliar with the expert vocabulary of the subjects they are researching or the organization of scholarly literature. It is a challenge for them to effectively retrieve the most relevant scholarly information.

Description
UC Merced researchers David Noelle and Donald Barclay have developed an easy-to-use, Internet-based software tool, Undergraduate Research Database Recommendation System (URDRS), that uses a locally managed knowledge base, coupled with machine learning methods, to increase the success of students as they attempt to access the relevant information needed to complete scholarly research projects related to their coursework.

URDRS supports course-based research, prompting users to input information on class/course codes and even specific course assignments. Ranked results are provided in a manner that facilitates subsequent access to the recommended databases.

Applications
This invention is generally useful for undergraduate students to conduct course-based research. URDRS can be integrated into websites, catalog, course management systems and other web-accessible resources. Campus librarians would save significant time by dealing less with repetitive reference, instruction, development of online tutorials and website tinkering.

Exact Optics with Total Internal Reflection for Use as a Super Telephoto Lens or Telescope

Background
A compact, high thermodynamic efficiency optical system employing a special lens with “total internal reflection” was developed by PROFESSOR ROLAND WINSTON to be a high solar concentrator for solar power applications. In essence, this optical system was designed so that the unique lens, covering a relatively large illuminated area concentrated sunlight onto a very small, chip-sized photovoltaic cell. It was quickly noted, however, that the unique optical properties of the lens made it unparalleled for projecting a collimated beam of light – that is, a beam in which the individual rays of light stay parallel and do not scatter. A Southern California company, under an exclusive agreement with UC Merced, is developing novel and revolutionary lighting devices based on this lens. In yet another embodiment, the design of this lens allows it to be used as a highly compact, very fast, aplanatic (i.e., without spherical aberration) telephoto system for photographic and/or telescopic applications in which the image output is delivered in a digital format, such as a viewing screen.

Description
Like older technologies going back hundreds of years, this system is a two-mirror design. However, instead of using multiple glass elements, Winston incorporated dielectric materials into the base optics to serve as a one-way mirror transmitting in one direction while internally reflecting in the other direction. The advantage of such a design is a wide acceptance angle optical device (near the thermodynamic limit) that can be exceptionally compact and able to correct for spherical aberrations without using additional lens elements. Because this invention was engineered to fit on top of a charge-coupled device chip and is composed of, essentially, a solid piece of plastic, the lens is extremely small and very low cost. The wide acceptance angle allows the lens to capture far more usable light than lenses of similar diameter.

Applications
Uses for this design include, but are not limited to, situations where a tiny, very fast and very inexpensive imaging device capable of telephoto/telescopic focal lengths is desirable. Such uses include, but are not limited to: portable electronic devices with cameras (cell phones, computers/tablets, etc.), drone aircraft, surveillance, security and robots.
Computational chemistry is the branch of chemistry that uses the physical principles of quantum and statistical mechanics with computer programs to solve chemical problems and calculate the structures and properties of molecules and solids.

Computational chemists devise and use quantum and statistical mechanical computational methods that are valuable tools for predicting a wide range of chemical properties, including thermochemistry, reaction mechanisms, chemical kinetics, protein dynamics and spectroscopic quantities. Their work provides atomic or electronic-level insights into an array of molecules, in isolation, complexes or condensed phases.

Our campus now hosts a quartet of such investigators: PROFESSORS MICHAEL COLVIN, CHRISTINE ISBORN, HRANT HRATCHIAN and ERIN JOHNSON. They share the same overall research interests of methodology development, with applications to material chemistry, catalysis and biology.

Johnson and members of her laboratory have been developing new quantum chemistry methods in the field of density-functional theory, with applications in reaction mechanisms and the electronic structure of materials and surfaces.

Izborn, in the short year since her arrival, has been using and improving existing quantum mechanical and molecular mechanical methodologies to more accurately model electronic excitations in the condensed phase.

Hratchian recently joined the UC Merced family after a stint in industry. His research focuses on developing and applying new computational models for studying chemical reactivity, especially in the area of transition metal catalysis. This will allow the development of next generation catalysts for driving chemical reactions.

Finally, founding faculty member Colvin uses computational approaches to study complex biochemical problems at the molecular level. In particular, his group is modeling the activity of DNA-binding food mutagens and anticancer drugs. Insights will have a huge effect on the development of novel therapeutics.

When asked why they chose this branch of chemistry as a career path, each faculty member voiced a passion for mathematics, physics and chemistry.

While no new chemical compounds or syntheses are expected to come out of their labs, the methods and programs they develop can end up having profound utility, be it in their own research or in the chemistry field as a whole.

The four computational chemistry groups are working independently, but they anticipate strong internal research collaborations between themselves in the coming years. They are also developing a computational chemistry track for our undergraduates, ensuring that UC Merced remains on the cutting edge of scientific education.
Graduate Student Profile: Melissa Ricketts

Melissa Ricketts

MERED NATIVE MELISSA RICKETTS discovered her innate talent for scientific discovery thanks to an inspirational high school AP physics teacher.

In her undergraduate career, Ricketts continued to pursue her love for physics, first while attending Merced College, and then after transferring to UC Merced. Before transferring to UC Merced, she embarked on a three-month Research Experience for Undergraduates Program internship at the Thomas Jefferson National Accelerator Facility in Virginia.

There, she joined the “Injector Group,” helping engineer electron guns used to insert subatomic particles into the collider.

Cool topic for a “What did you do last summer” report.

It was during her senior year of undergraduate studies that she was introduced to the research of Professor Roland Winston, the pioneer of the use on non-imaging optics for harnessing solar energy.

Ricketts’s project was a joint effort between Winston’s group and that of Professor Linda Hirst, and it was during this time Winston noticed her quick intellect, curiosity, and above all, her enthusiasm for scientific research.

After graduation, Ricketts presented the results of her project “Luminescent Solar Concentrators” at the prestigious SPIE conference in San Diego, where she gained the attention of industry representatives.

Not one to let a good thing go, Winston lobbied Ricketts to apply for grad school at UC Merced, and continue her work in his lab. She was considering becoming a high school physics teacher, but “It was an opportunity to apply myself in the solar energy field, to do relevant and practical research that would benefit society. In that respect, I’m definitely more of an engineer than a physicist; I prefer hands-on science,” Ricketts said.

But solar power was not in the cards. Impressed with her presentation the previous summer, representatives from a major European lighting company approached her and Winston about furthering that study and using it as a basis for developing a better alternative to common office/work lighting.

Fluorescent lighting has been the mainstay of building lighting for more than 50 years, but only in the past 10 years has the effect of such lighting on people been thoroughly investigated.

Fluorescent lighting is linked to disrupted circadian rhythm, fatigue, poor concentration and other health-related issues. Curiously, people working primarily in windowed offices do not suffer such problems as often.

Indeed, their performances on similar tasks was markedly better than co-workers without access to natural light, because of the dynamic quality of natural light (i.e., spectral distribution, intensity, etc., collectively referred to as “sparkle”).

There is now a huge incentive to develop indoor lighting that captures these qualities of outside, natural lighting.

“We’re attempting to represent numerically the sparkle of sunlight, and knowing how represent this sparkle will allow us to set up the tunable LEDs,” Ricketts said. “That is, to represent in real time what is occurring at the window throughout an entire room, leaving those workers deep in the bowels of cubicle hell still feeling sunny…so to speak.”

Such a lighting system would also be responsive to rain and other meteorological events, and may even brighten and dim in relation to the position of the Sun.

Recent advancements in the lighting field, in particular the development of fluctuating or tunable, LEDs, make such a project feasible.

But major hurdles exist.

The first problem to solve is how to translate the dynamic qualities of sunlight that occur in two dimensions at the window into a three-dimensional workspace that’s spread out over many floors of a building.

Fluorescent lighting has been the mainstay of building lighting for more than 50 years, but only in the past 10 years has the effect of such lighting on people been thoroughly investigated.

Fluorescent lighting is linked to disrupted circadian rhythm, fatigue, poor concentration and other health-related issues. Curiously, people working primarily in windowed offices do not suffer such problems as often.

Indeed, their performances on similar tasks was markedly better than co-workers without access to natural light, because of the dynamic quality of natural light (i.e., spectral distribution, intensity, etc., collectively referred to as “sparkle”).

There is now a huge incentive to develop indoor lighting that captures these qualities of outside, natural lighting.

“We’re attempting to represent numerically the sparkle of sunlight, and knowing how represent this sparkle will allow us to set up the tunable LEDs,” Ricketts said. “That is, to represent in real time what is occurring at the window throughout an entire room, leaving those workers deep in the bowels of cubicle hell still feeling sunny…so to speak.”

Such a lighting system would also be responsive to rain and other meteorological events, and may even brighten and dim in relation to the position of the Sun.

Recent advancements in the lighting field, in particular the development of fluctuating or tunable, LEDs, make such a project feasible.

But major hurdles exist.

The first problem to solve is how to translate the dynamic qualities of sunlight that occur in two dimensions at the window into a three-dimensional workspace that’s spread out over many floors of a building.

Once implemented into the lighting system, significant fine-tuning would then be done to determine the best settings. The final step will be to test the system on people in a controlled environment. Ricketts envisions this form of interior lighting will eventually be used in personalized lighting to improve mood and to enhance learning and productivity. It could be used to help patients deal with psychological trauma like PTSD, or in hospital/clinical settings. Children in schools would benefit from the improved learning environment provided by this form of lighting.

Before even beginning, more immediate challenges like securing research funding and facilities to carry out the tasks outlined above remain to be met.

“There’s so much to do before we even start the research. The scope is so large that I feel overwhelmed sometimes,” Ricketts said. “As to my dissertation, I’m going to select the parts of this project that are mainly physics based. There are a lot of human factors involved but for the purpose of my physics Ph.D., I will mainly highlight the physics aspects of the project.”
Internal Compound Parabolic Concentrator

Background

This technology is a non-tracking solar thermal collector system that’s used for generating mid-level temperature (100-300 degrees Celsius) working fluid. At its heart is a uniquely-shaped mirror known as a compound parabolic concentrator (CPC). The CPC functions by receiving sunlight and focusing that light onto a glass absorber tube with such high efficiency that it doesn’t need to follow the movement of the Sun. Before the development of CPC, the generation of working temperatures in excess of 200 degrees Celsius required solar tracking, resulting in additional installation and maintenance costs to the point of making these older technologies not economically viable. The internal compound parabolic concentrator (ICPC) is a new CPC design developed by PROFESSOR ROLAND WINSTON and based on an earlier Winston design. That earlier CPC technology was successfully licensed and is being put to use throughout the world.

Description

The ICPC system design relies on a flexible way to shape the CPC portion of the unit so that it matches any convex shape of the absorber cross section that may be selected. This feature guarantees a useable concentration of solar energy can be achieved without the need for tracking the Sun’s movement across the sky. The novel CPC shape is also built into the glass tube portion of the absorber and these matching geometries are responsible for the high efficiency of the ICPC system. ICPC also makes use of a transparent covering over the mirror that protects the absorber and the aluminum-based reflective material of the mirror. In addition to protecting, the cover also reduces maintenance and cleaning costs, as neither the CPC, with its sensitive reflective coating, nor the absorber are exposed to the outside environment, but maintained in vacuum.

Applications

ICPC is intended to either augment or entirely replace systems that rely on natural gas to generate industrial process heat while producing no greenhouse gases. Because ICPC can heat water to temperatures approaching 300 degrees Celsius, it has utility in a number of applications: solar heating, cooling, desalination, sterilization, dehydration, generation of electricity and food processing, among many others.