UC DAVIS Grand Challenges in Research Initiative

Research Investments in Science & Engineering (RISE) Program

Final Summary Report

June 2016

UC DAVIS
OFFICE OF RESEARCH

CONTENTS

Section 1: Program Overview

As one of the world's most comprehensive research universities, UC Davis is uniquely positioned to make transformative discoveries and drive innovations at the intersections of multiple disciplines. In recognition of this opportunity, Chancellor Katehi made a bold decision in 2011 to invest $18 million to stimulate a new wave of interdisciplinary research at UC Davis. These funds were provided to the Vice Chancellor for Research (VCR) to design a program that would drive innovation at the frontiers of knowledge, embrace global issues, nurture a sustainable future and propel economic vitality.

Under leadership of the VCR and the Office of Research, an open, competitive proposal process with external peer-review was established to attract the most innovative proposals from across campus. The program, referred to as the UC Davis Grand Challenges in Research Initiative is composed of two constituent elements: the Research Investments in Science and Engineering (RISE) and the Interdisciplinary Frontiers in the Arts and Humanities (IFHA) programs. This report summarizes the outcomes and impacts of the RISE program over the past three and a half years. A separate report on the IFHA program will be published in 2017.

From among 117 applications, 13 RISE themes were awarded funding totaling $10.8 million over a three-year period, with an average grant of over $800,000 each. These themes involved more than 90 faculty from eight different schools and colleges. In its final year, the program provided interdisciplinary research opportunities for 58 graduate students, 53 undergraduate students and 37 postdoctoral fellows. As described below, the program yielded nearly a 10:1 return on investment, with predominantly multi-investigator interdisciplinary awards totaling more than $105 million as of April 2016.

In addition to the large-scale funding, the Office of Research supported each theme in the following ways to enable them to succeed:

- Identified funding opportunities and assisted with proposal development
- Promoted inter-theme collaboration and exchanges
- Established and fostered relations with industry and foundation partners
- Advised on protection and licensing of intellectual property
- Enabled the development of start-up companies
- Created marketing and communications platforms, including webpages, videos, press releases and social media posts
- Supported financial oversight and budget reviews

"The RISE program has provided the university a much needed platform to strategically leverage our strength in interdisciplinary research. Over the last three and a half years, we have witnessed significant impact in terms of scientific achievements, extramural funding, and collaboration."

-Harris Lewin
Vice Chancellor for Research

THEME	FOCUS	THEME LEAD
Breeding Healthy Crops	Breeding healthy crops via structural biochemistry of plant-pathogen interactions to promote crop protection	George Bruening, Plant Pathology
Detecting Plant Pathogens	Developing a rapid, efficient and low-cost method to detect and identify specific microbial pathogens	Bryce Falk, Plant Pathology
Enabling Mobile Health	Enabling mobile health to provide scalable and affordable healthcare as the demand increases	Jay Han, Physical Medicine & Rehabilitation
Evaluating Drug Development	Evaluating drug development to identify promising candidates early in the process	Kathy Ferrara, Biomedical Engineering
Imaging Eyes	Functional imaging of single cells in the eyes of living animals under normal, pathogenic and regenerative conditions to improve therapeutic strategies	Edward Pugh, Physiology & Membrane Biology
Molecular Level Imaging	Advance diagnosis and guide treatment options	Simon R. Cherry, Biomedical Engineering
Natural Scaffolding	Harness the unique abilities of amyloid proteins to self-assemble, and modify them to carry out useful functions	Daniel Cox, Physics
Sensing Plant Stress	Study the responses of plants to environmental stresses	Nelson Max, Computer Science
Seeing Big Data	Data visualization of raw data into high resolution, interactive, data driven visualizations to provide new insight	Kwan-Liu Ma, Computer Science
Seeing Energy	Transforming consumer energy use in vehicles, buildings and appliances	Thomas Turrentine, Institute of Transportation Studies
Promoting Intestinal Health	Protecting the fragile intestine: integrating microbiota and mucosal health	Satya Dandekar, Medical Microbiology & Immunology
Protecting the Cyber Frontier	Cyber-security for critical infrastructures: smart grid, financial and human-centered mobile networks	Karl Levitt, Computer Science
Understanding Schizophrenia	Understanding schizophrenia by testing the hypothesis of immune dysregulation	Kimberley McAllister, Neurobiology, Physiology & Behavior

Section 2: Outcomes and Key Achievements

SELECT SCIENTIFIC AND PROGRAM ACHIEVEMENTS

Each RISE theme has achieved significant scientific advancements within its area of focus. These accomplishments are described in more detail within Section 4: Theme Summaries located at the end of this report.

Notable highlights include:

- Identified the early source of gut inflammation in HIV infection and the impact of probiotics in preventing gut damage in non-human primates. (Promoting Intestinal Health theme)

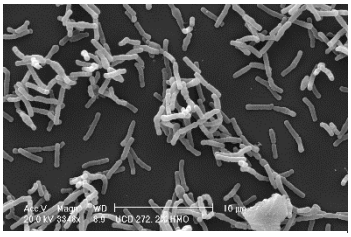


FIGURE 1: GUT BACTERIA

- Conducted the first observation in a non-human primate model of dopamine uptake in the striatum (a hallmark of schizophrenia and psychosis) in offspring of mothers with compromised maternal immune activation. (Understanding Schizophrenia theme)

- Completed feasibility studies for developing a total-body positron emission tomography (PET) scanner that has 40-fold higher sensitivity and finer resolution than existing instruments and allows simultaneous viewing of tissues and organs throughout the body. This theme has also been successful in establishing industry and academic partnerships. (Molecular Level Imaging theme)

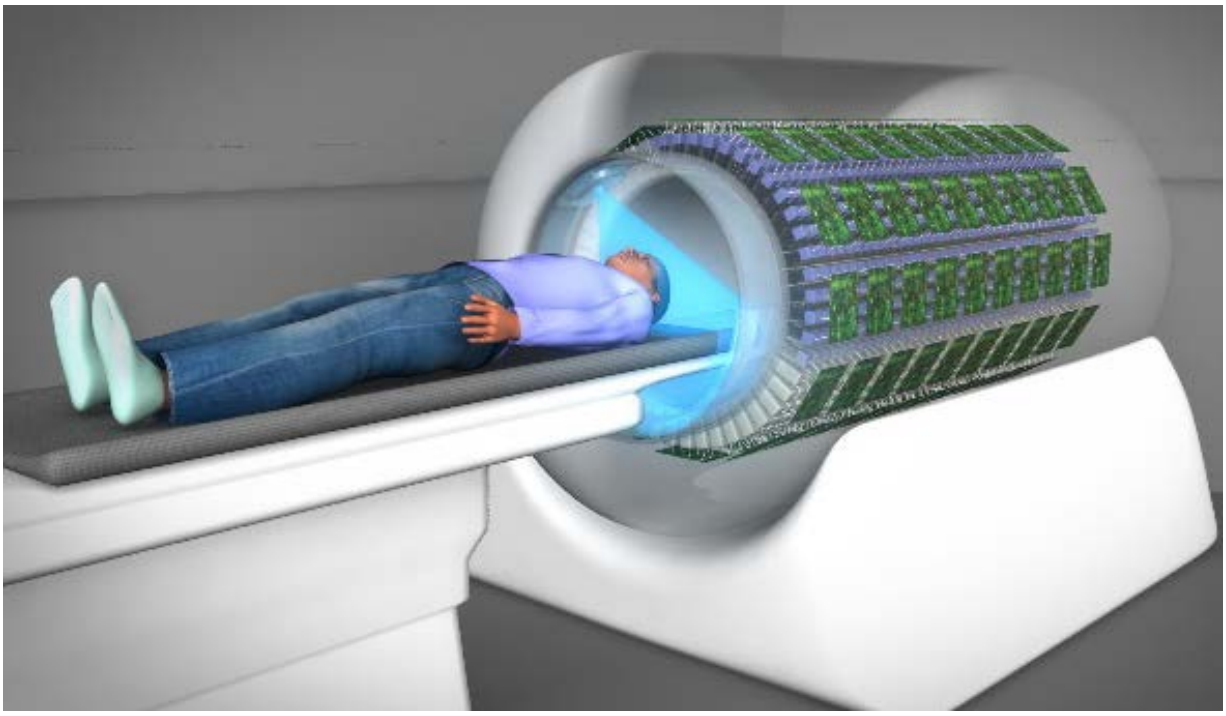


FIGURE 2: RENDERING OF TOTAL BODY PET SCANNER

- Launched a clinical trial to test the effectiveness of a mobile platform, activity sensors, and nurse health coaching within an employee wellness program. Enrolled a total of 104 subjects into a randomized, controlled clinical trial for a six-month employee health project. (Enabling Mobile Health theme)

- Successfully designed and fabricated a fluorescent microscope for digital imaging of whole plants containing fluorescent proteins. (Sensing Plant Stress theme)

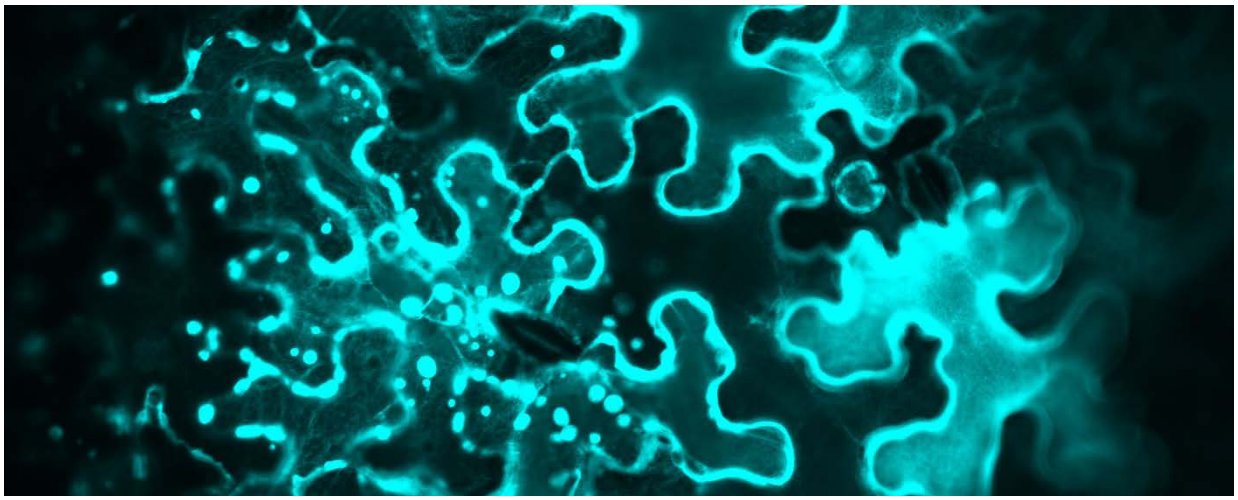


FIGURE 3: FLUORESCENT PROTEIN CONSTRUCT

- Determined the structure for a new fungal elicitor; binding properties of three fungal elicitors were compared by numerous biological and chemical tests. (Breeding Healthy Crops theme)

- Developed key research infrastructure that is differentiating UC Davis as a state-of-the-art in vivo imaging center of individual cells — including transplanted cancer and stem cells. This team of researchers completed the first in vivo imaging and longitudinal studies of Adeno-associated virus transfection of retinal cells with fluorescent protein receptors. (Imaging Eyes theme)

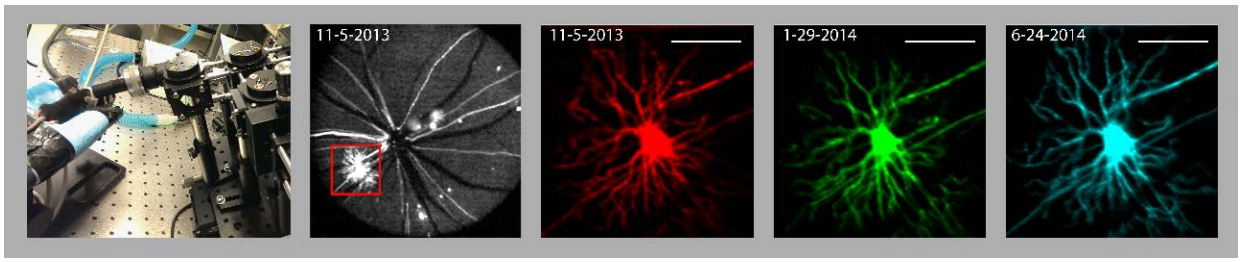


FIGURE 4: SINGLE RETINAL GANGLION IMAGE AT WEEKS 1, 9 AND 30

- Played an important role in establishing the UC Davis Chile Life Sciences Innovation Center in Santiago. The Detecting Plant Pathogens theme also developed an important partnership with IBM Research, Almaden, which has subsequently led to broader and deeper interactions between UC Davis faculty and IBM researchers in a number of research areas. (Detecting Plant Pathogens)

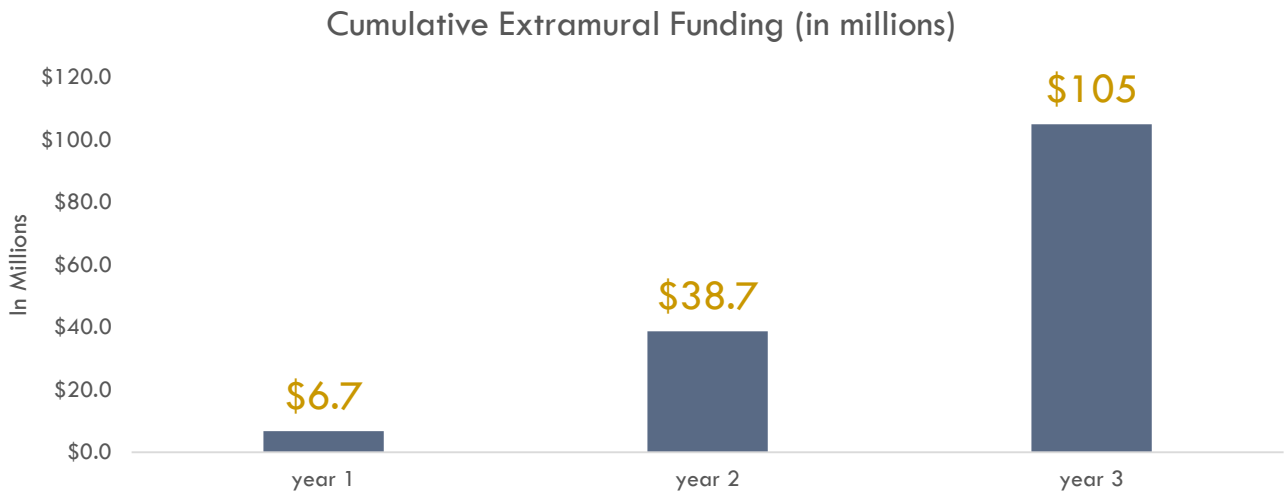
INCREASED COMPETITIVENESS WITH STRONG RETURN ON INVESTMENT

A primary goal of the RISE program was to create internationally competitive interdisciplinary teams of researchers capable of producing proof-of-principle discoveries to address areas of strategic importance for California, the nation, and the world. From an initial campus investment of $10.8 million, the RISE program themes have generated $105 million in extramural funding to date since the program's inception in October 2012 — a return of almost 10 times the initial investment.

Total Funding Awarded	Total Proposals Submitted	Pending Proposals	Success Rate
$105 million	$444 million	$78 million	31% awarded

Top Extramural Awards

- $15.5 million National Cancer Institute Transformative Research Award for whole-body PET scanner (Molecular Level Imaging theme)
- $10 million National Institute of Mental Health grant for neuro-immune mechanisms of psychiatric disorders (Understanding Schizophrenia theme)
- $4.2 million National Institute of Health (NIH) grant for activation of probiotic *Bifidobacteria* by milk glycans (Promoting Intestinal Health theme)
- $3.9 million National Eye Institute grant for the vision research core (Imaging Eyes theme)
- $3.1 million NIH grant for image-based analysis of miRNA delivery (Evaluating Drug Development theme)

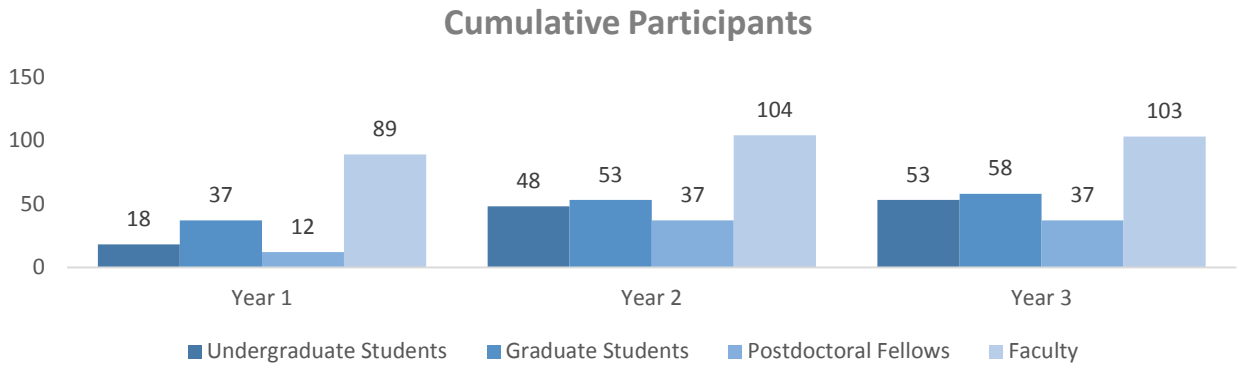


Given that the median time for a funding decision at most federal agencies is 9-12 months, this data suggests support over a 2-3 year period has produced significantly greater returns compared to what might have resulted from a one-year stimulus program.

PROGRAM RETURN ON INVESTMENT (TO APRIL 2016) = 871%

ENHANCED COLLABORATION AND LEARNING

Another objective of the RISE program was to enable a unique team-based research learning environment, where researchers from different disciplines and career stages could come together to tackle challenging scientific problems. This environment provided postgraduate students with exposure to a wider range of faculty expertise than they would have received through individual faculty-led research projects. It also provided a strong framework for mentoring junior faculty, particularly assistant professors. The figure below highlights the cumulative numbers of students, fellows and faculty that have participated in the thirteen RISE themes.



Cross-Discipline Faculty Participation

College of Agricultural & Environmental Sciences	11	School of Medicine	40
College of Biological Sciences	6	School of Nursing	1
College of Engineering	18	School of Veterinary Medicine	2
College of Letters & Science	12	Graduate School of Management	2

INNOVATION AND ECONOMIC IMPACT

In just three years, the RISE themes have generated an impressive portfolio of intellectual property — submitting fifteen records of invention and contributing to the technology platforms of five start-up companies.

Start-up Companies

- Evolve Biosystems: Founded in 2004 by Bruce German, David Mills, Carlito Lebrilla, Daniela Barile and Samara Freeman (Promoting Intestinal Health theme)
    - Building on more than a decade of research into the infant biome and its intimate interaction with breast milk
- EicOsis: Founded in 2011 by Bruce Hammock (Evaluating Drug Development theme)
    - Developing a novel treatment for diabetic neuropathic pain using a soluble epoxide hydrolase inhibitor
- Sersense Technologies: Founded in 2013 on technology developed by Alexander Revzin (Evaluating Drug Development theme)
    - Providing an easy-to-use kit for detecting latent tuberculosis from a blood sample

- Protein Architects, Inc.: Founded in 2015 by Daniel Cox, Michael Toney, Gang-yu Liu and Krishnakumar Mayuram Ravikumar (Natural Scaffolding theme)
    - Developing robust protein architectures to self-assemble devices and materials
- Astrona Biotechnologies: Founded in 2015 by Bryce Falk, Paul Feldstein, Andre Knoeson, Maria Marco, Erkin Seker, Josh Hihath and Jeremy Warren (Detecting Plant Pathogens theme)
    - Combining RNA-based molecular biology and nanotechnology/electrical engineering to rapidly and efficiently identify microbes, including pathogens of humans, animals and plants

PUBLICATIONS

To date, the 13 RISE themes have held 15 workshops, produced 456 presentations and published over 400 journal articles, with a number of articles appearing in top-ranked journals including *Nature* and *Proceedings of the National Academy of Sciences*.

Publications	Workshops	Presentations	Media Coverage
404	17	456	149

"It has been a great pleasure for our team in the Office of Research to work so closely with this cohort of gifted researchers over the past three and a half years. We are very proud of all themes' achievements and look forward to the possibility of supporting a second RISE program in due course."

-Paul Dodd
Associate Vice Chancellor for Interdisciplinary Research and Strategic Initiatives

Section 3: Conclusions

While the ultimate impact will continue to develop over time, it is clear that the RISE program has been successful in stimulating new competitive interdisciplinary research at UC Davis. The RISE themes have produced significant scientific insights in a relatively short period of time and dramatically leveraged the campus' investment by generating over $100 million in competitive funding to date. They have created nurturing, team-research environments that have enabled not only interdisciplinary, but inter-generational collaborations, providing an intellectually stimulating training ground for scientific discovery.

Key factors of success for the program included:

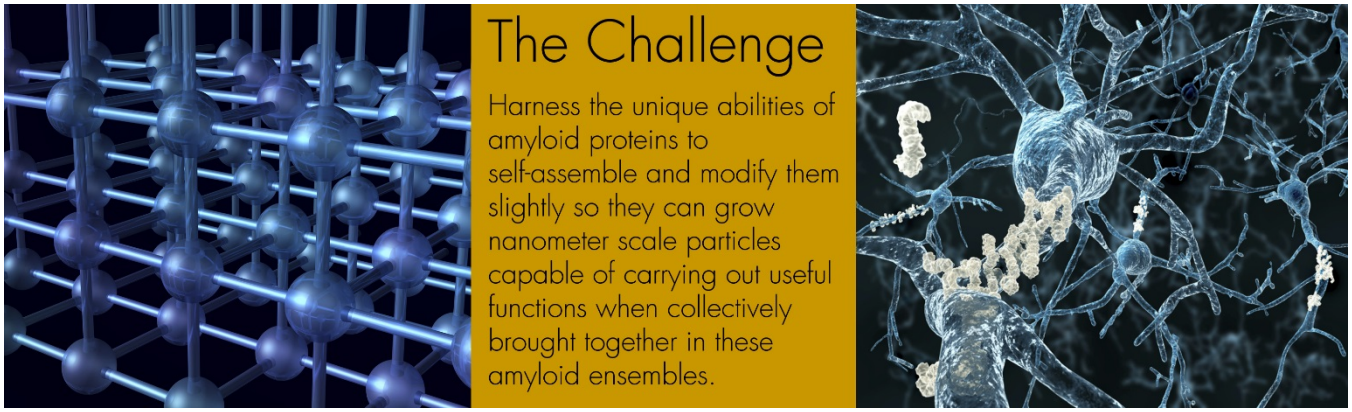
- Creating an open, bottom-up, competition for funding
- Using external peer reviewers for all proposals, including a visiting panel
- Providing scale of funding required to get interdisciplinary interactions and sufficient preliminary data for major funding opportunities
- Emphasizing problem solving and linkages to the private sector
- Continuously monitoring and supporting themes
- Defining verifiable milestones and metrics of success for each theme
- Providing early support for development of intellectual property

Significant issues to consider moving forward:

- Flexible co-location space is a major factor and current limitation for long-term success of interdisciplinary teams
- Continued funding beyond three years for some themes may be warranted
- Faculty leaders are critical to team success
- Early-stage partnering with the private sector may complicate pre-competitive research strategies, but represents a major opportunity for future programs

Section 4: Theme Summaries

AMYLOIDS FOR NANOPARTICLE SYNTHESIS, WIRING, ENERGY, & REMEDIATION



Theme Leader: Daniel Cox, Physics

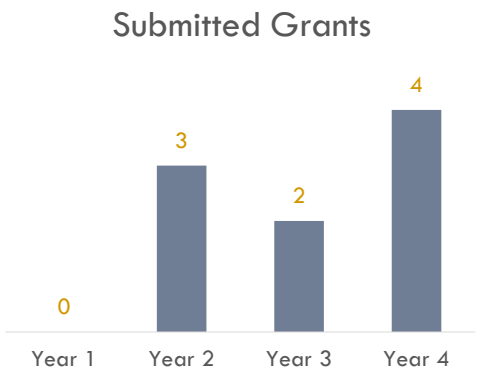
Theme Co-Leads: Rajiv Singh, Physics; Xi Chen, Chemistry; Josh Hihath, Electrical & Computer Engineering; Gang-Yu Liu, Chemistry; Michael Toney, Chemistry; Ted Powers, Molecular & Cellular Biology; Gergely Zimanyi, Physics

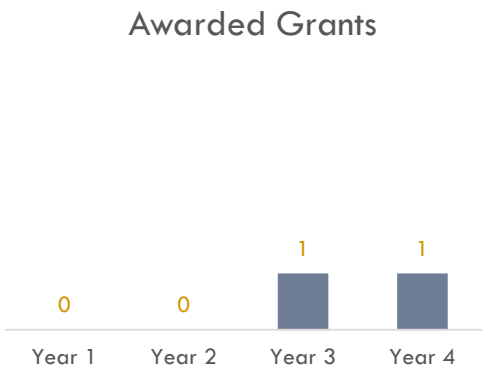
Approach

This theme is examining whether the intrinsic amyloid structures bacteria and yeast employed in biocolony formation can be modified to template growth of photocatalytic materials that can break down environmental contaminants, act as alternative energy storage devices, or produce other alternative minimal viable products.

Scientific Accomplishments

- Designed and synthesized several modified (from wild type) beta solenoid protein sequences which assemble into amyloid fibrils that appear to have the right characteristics
- Demonstrated in principle, control of length and twist and made significant progress on design of lateral assembly
- Made progress on templating and nanoparticle binding
- Initiated design of photovoltaics and thermoelectrics





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	8	8	8	Number of Colleges	3	3	3
Number of Undergraduate Students	3	7	5	Records of Invention	0	1	1
Number of Graduate Students	2	3	7	Publications	1	3	8
Number of Post Doc Scholars	1	5	4	Workshops	0	0	1
Number of Departments	4	4	4	Presentations	2	6	4

Looking Forward

- Develop industry collaborations
- Achieve binding of nanoparticles and templating of nanoparticles with conduction
- Attempt to construct a successful binary AB alphabet for our monomers
- Try new strategies for controlling fibril twist by insertions
- Assess whether the graphene/amyloid hybrid supercapacitors are feasible on a prototype basis
- Execute on grant from the National Science Foundation I-Corps program with the newly incorporated start-up, Protein Architects Inc.

CONSUMER ENERGY INTERFACES (C-ENERGI)

Theme Leader: Thomas S. Turrentine, Institute for Transportation Studies

Theme Co-Leads: Nina Amenta, Computer Science; Kwan-Liu Ma, Computer Science; Glenda Drew, Design; Dan Sperling, Environmental Science & Policy/Civil & Environmental Engineering; Alan Meier, Institute of Transportation Studies

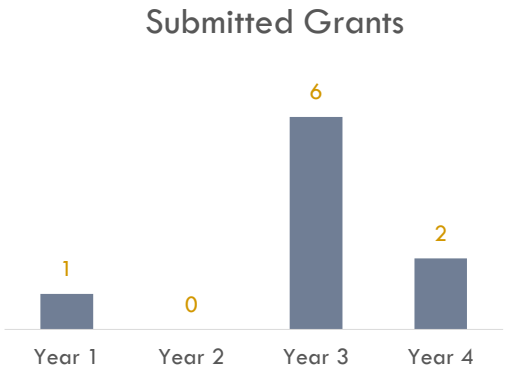
Approach

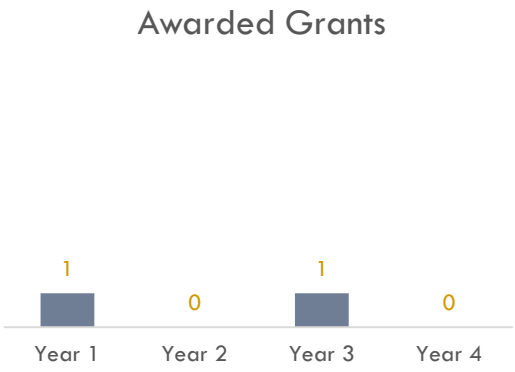
The Consumer Energy Interface (cENERGI) interdisciplinary theme is investigating how one would fundamentally transform the way energy is experienced and perceived by consumers. The target is to alter individual and social behaviors and lifestyles in ways that significantly educate consumers to understand and reduce their energy use and emissions. This involves creating innovative user feedback tools in combination with ubiquitous computing and social models based in grounded behavioral science and linked to new energy-saving technologies that will initiate behavioral and cultural change.

With a group of internationally recognized experts in consumer behavior and energy use from the behavioral sciences, design, computer science, and engineering, the theme is harnessing the potentially transformative effect of user-generated energy content distributed to and among energy users—through ubiquitous computing and feedback systems, tangible user interfaces, and innovative social connections.

Top Impacts

- Participated in the Plug-in Hybrid & Electrical Vehicle (PH&EV) Research Center symposium in November 2014; hosted a reception for partners and potential funders in the evening
- Received funding from the National Center for Sustainable Transportation (NCST) and Multi-campus Research Programs and Initiatives for a project to study eco-driving, including eco-driving feedback that has resulted in a white paper, policy brief, webinar, conference presentation, and submission of two manuscripts to academic journals (under review)
- Partnered with campus Facilities Energy Conservation Office (ECO) to develop TherMOOstat, a mobile app for campus occupants to provide feedback on their thermal comfort and vote for changes in thermostat settings
- Particpated in Glenda Drew's *Design 157* undergraduate interactive design course focused on the design of interfaces targeting water consumption
- Participated in a webinar hosted by NCST: https://www.youtube.com/watch?v=Ow4OyE6wfGY





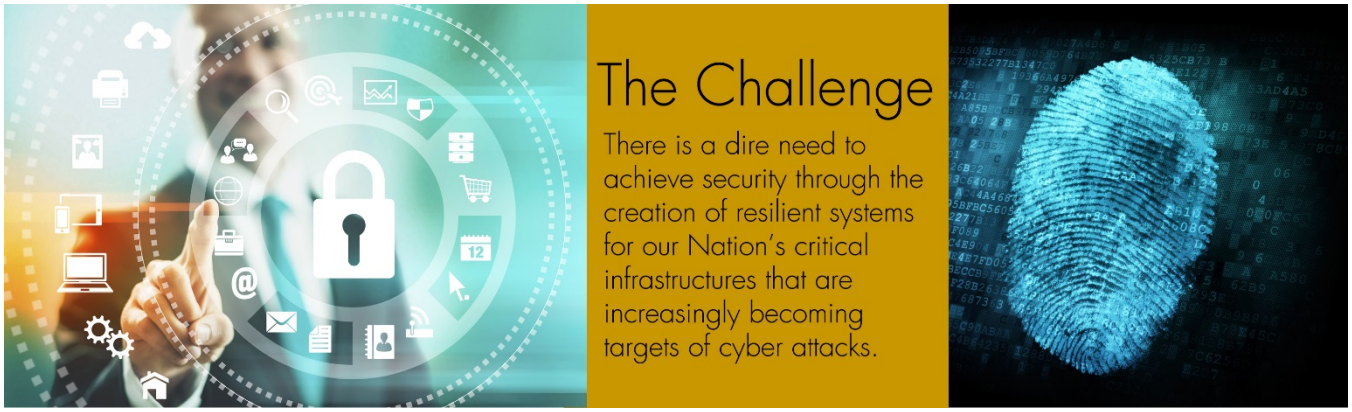
Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	4	6	6	Number of Colleges	1	2	2
Number of Undergraduate Students	4	5	13	Records of Invention	0	0	0
Number of Graduate Students	1	4	6	Publications	3	7	5
Number of Post Doc Scholars	1	1	1	Workshops	0	0	1
Number of Departments	2	4	4	Presentations	16	17	15

Looking Forward

- In partnership with the Water Energy Efficiency Center and funded by Bay Area water utilities, cENERGI will be studying the adoption of water efficient technologies and water conservation behaviors among Californians, with implications for developing high-impact eco-feedback interfaces that target water consumption and conservation practices.
- Working with SEE Change Institute on a project for Pacific Gas and Electric (PG&E), studying adoption of home energy management systems (HEMS). HEMS is the new frontier of residential eco-feedback and this project will be developing a roadmap for PG&E's role in the realm of smart home technologies
- Hosting a workshop for potential collaborators and funders from key stakeholder agencies, including the California Energy Commission and California Public Utilities Commission
- Obtain funding to support several graduate students and undergraduate students with expertise in computer programming, design, mechanical engineering, electrical engineering, social science and behavioral science for the 2016-2017 school year

CYBER-SECURITY OF CRTITICAL INFRASTRUCTURE



Theme Leader: Karl Levitt, Computer Science

Theme Co-Leads: George Barnett, Communication; James Bushnell, Economics; Hao Chen, Computer Science; Anna Scaglione, Electrical & Computer Engineering; Nicole Woolsey Biggart, Graduate School of Management

Approach

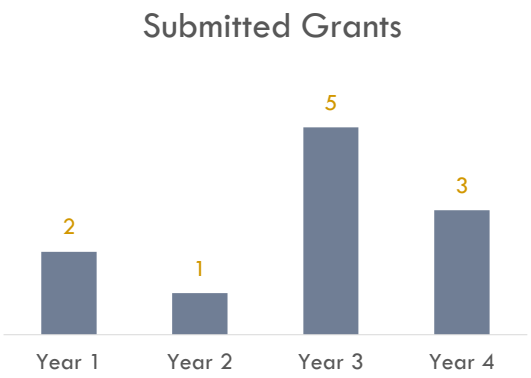
This theme is developing technology to protect against cyber-attacks on critical infrastructures such as power delivery systems, financial networks, mobile computing, transportation and medical systems. More specifically, they are targetting:

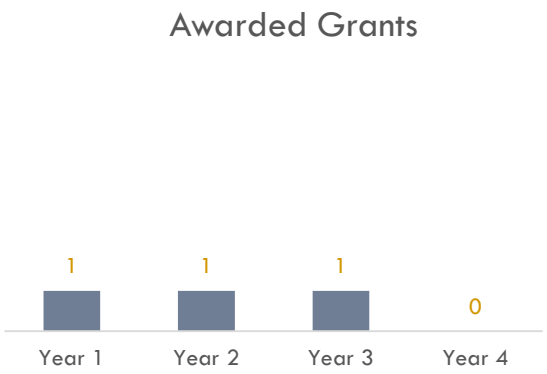
1. The security and reliability of next generation Smart Grids supplying electric power and the associated market-based control system
2. Techniques to design and protect financial markets with embedded cyber-enabled transactions
3. Emerging cyber-attacks and novel new security services from the pervasive use of powerful mobile computing devices

Their approach is to achieve resiliency properties through run-time monitoring to alert for, and recover from, malicious attacks. The group is also pursuing opportunities for collaboration with and outreach to public utilities, national labs, government agencies and industry contacts.

Top Impacts

- Developed methods for coordinating power-generation schedules in the presence of colluding attackers
- Investigated security protocols for automated vehicles, vehicle cooperation and emerging highway traffic control methods
- Secured external funding for new Smart Grid security work
- Investigated security and privacy aspects of the emerging Internet of things and associated devices





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	6	6	6	Number of Colleges	3	3	3
Number of Undergraduate Students	0	1	0	Records of Invention	0	0	0
Number of Graduate Students	2	3	4	Publications	5	6	4
Number of Post Doc Scholars	0	3	0	Workshops	0	1	0
Number of Departments	5	5	5	Presentations	2	8	3

Looking Forward

- Develop deeper industry collaborations
- Three proposals are currently under development: Secure agriculture data collection; Internet of Things security and privacy; and secure smart and connected communities

CENTER FOR CONTENT RICH EVALUATION OF THERAPEUTIC EFFICACY (CCRETE)

The Challenge

Creating a high throughput and content rich assays to summarize the impact of therapeutics on cellular functionality that would help the pharmaceutical industry identify promising candidates early in the development process.

Theme Leader: Katherine Ferrara, Biomedical Engineering

Theme Co-Leads: Steven Currall, Graduate School of Management; Ralph de Vere White, Urology/ Comprehensive Cancer Center; Fredric Gorin, Neurology; Bruce Hammock, Entomology & Nematology/MIND Institute; Alexander Revzin, Biomedical Engineering; Anne Knowlton, Cardiovascular Medicine; Fitz-Roy Curry, Physiology & Membrane Biology; David Segal, Genome Center; Rachel Pollard, Vet Med: Surgical & Radiological Sciences; William Murphy, Dermatology; Kent Lloyd, Surgery/Comparative Medicine/Mouse Biology Program; Edward Kim, Hematology & Oncology; Alexander Borowsky, Pathology

Approach

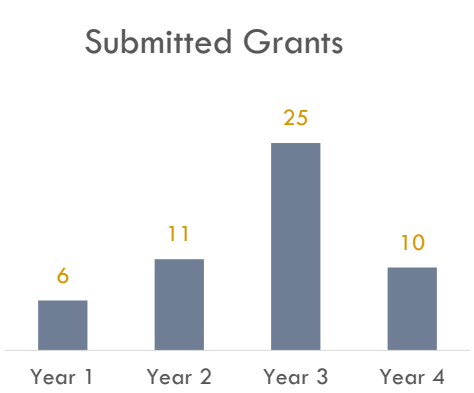
The focus of this theme is on assays of invasive potential and inflammatory markers by measuring cell secreted factors in vitro and *in vivo*, including peroxide, tumor necrosis factor alpha and matrix metalloproteinases (MMPs). They are developing cell micro-systems where micro-patterned co-cultures of cancer and non-cancer cells will be juxtaposed with arrays of sensing elements for monitoring downstream readouts of cell-drug interactions. The group has also applied *in vivo* imaging to assess therapeutic efficacy and will validate the new assays with *in vivo* assays of cell invasion and inflammation. To address this critical need, a team of cancer biologists, social scientists, bioinformatics experts and bio-engineers has been created to develop and validate high throughput bio-marker assays for the effect of new therapeutics on invasive cancers. In addition, members of the group have developed novel small molecule therapeutics that effectively inhibit key pathways in these cancers; the success of these new therapeutics will require the development of bio-markers. The important problem to be solved is the creation of high throughput and content-rich assays to summarize the impact of therapeutics on cellular functionality. The “rich” content required to fully characterize the response to therapy must go beyond the quantification of proliferation and apoptosis to evaluate invasive potential, inflammatory markers, markers of “stem-ness,” autophagy, metabolic pathways and senescence.

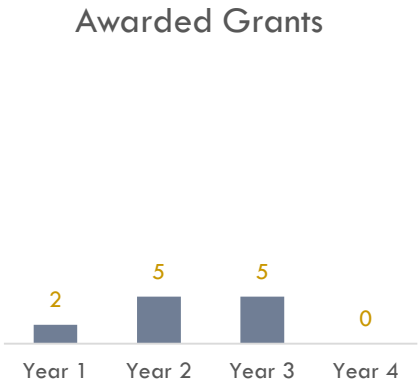
Scientific Accomplishments

- Completed RNA-sequencing and exome sequencing analysis with, and without, the application of a therapeutic
- Established new collaborations with Genentech and L'Oréal to study mechanisms of cancer drug resistance
- The Hammock Laboratory formed the start-up company EicOsis with options to license the soluble epoxide hydrolase inhibitor patents (excluding cancer) from UC Davis
- Alexander Revzin formed Sersense Technologies to provide an easy-to-use kit for detecting latent tuberculosis from a blood sample
- Developed treatments for cancer combining chemo and immunotherapy, which are curative in some cancers
- Demonstrated ability to detect interferon gamma (IFNγ) secreted from single tumor cells and that the result was predictive of tumor aggression

Awards

- Katherine Ferrara, National Academy of Engineering, 2015





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	7	9	14	Number of Colleges	4	4	5
Number of Undergraduate Students	0	0	0	Records of Invention	4	1	0
Number of Graduate Students	1	5	6	Publications	14	59	35
Number of Post Doc Scholars	4	4	5	Workshops	0	0	0
Number of Departments	6	6	13	Presentations	20	9	25

Looking Forward

- Expanding collaboration with faculty at the UC Davis School of Medicine and industry
- Seeking funding from several mechanisms

FUNCTIONAL IMAGING OF SINGLE CELLS IN THE EYES OF LIVING ANIMALS UNDER NORMAL, PATHOGENIC AND REGENERATIVE CONDITIONS (EYE-POD)

Theme Leader: Edward N. Pugh, Jr., Cell Biology & Human Anatomy/ Physiology & Membrane Biology

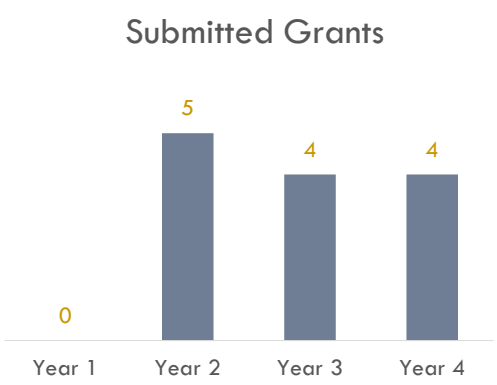
Theme Co-Leads: Nadean Brown, Cell Biology & Human Anatomy; Marie Burns, Cell Biology & Human Anatomy/ Center for Neuroscience; Hwai-Jong Cheng, Neurobiology, Physiology & Behavior/Center for Neuroscience; Fitz-Roy Curry, Physiology & Membrane Biology; Paul FitzGerald, Cell Biology & Human Anatomy; Tom Glaser, Cell Biology & Human Anatomy; Leonard Hjelmeland, UCDHS: Eye Center; Kit Lam, Biochemistry & Molecular Medicine; Jan Nolta, Internal Medicine: Hematology and Oncology; Susanna Park, UCDHS: Eye Center; Scott Simon, Biomedical Engineering; John Werner, Neurobiology, Physiology & Behavior/ UCDHS: Eye Center; Glenn Yiu, UCDH: Eye Center; Anna LaTorre, Cell Biology & Human Anatomy

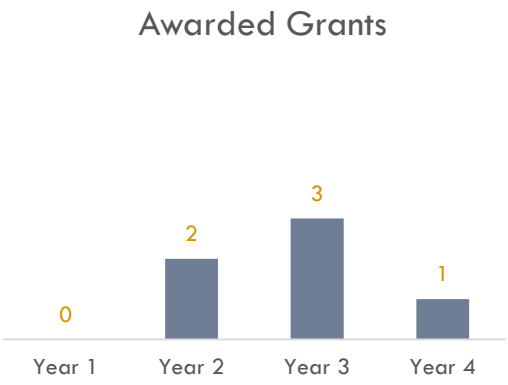
Approach

The UC Davis RISE Eye-Pod Facility is comprised of a team of engineers, biologists and clinicians from six departments within the Schools of Engineering, Medicine and Biological Science. This team is applying adaptive optics (AO) imaging to non-invasively observe marked individual cells in the eyes of live animals over their lifespan. AO technology enables simultaneous, quantitative assessment of cellular morphology and many basic functions to be used in testing of stem-cell and other therapeutic strategies in animal models of major diseases. This project is also creating a model of interdisciplinary, team-based problem solving in which students and postdoctoral scholars will learn the skills to assemble and administer such teams.

Top Impacts

- Development of first multimodal Optical Coherence Tomography (OCT) and Scanning Laser Ophthalmoscope (SLO) mouse retinal imaging system
- Improvements of Adaptive Optics SLO for mouse retinal imaging, including development of an efficient, wavefront-sensorless approach
- Conducted first *in vivo* longitudinal studies of fluorescently labeled microglia cells in response to controlled local retinal degeneration
- Conducted first experiments establishing rodent eye as a valuable non-invasive window for studying cancer nanotherapeutics (funded by the National Cancer Institute)
- Extensive development of methods for optical observation and manipulation of retinal micro-vasculature *in vivo*
- Conducted first experiments measuring photoreceptor and Retinal Pigment Epithelium (RPE) function using truly non-disruptive, all-optical (near-infrared OCT) methods





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	14	13	15	Number of Colleges	2	2	2
Number of Undergraduate Students	0	0	0	Records of Invention	0	0	0
Number of Graduate Students	0	0	1	Publications	3	6	13
Number of Post Doc Scholars	2	2	5	Workshops	0	0	0
Number of Departments	7	7	7	Presentations	5	7	12

Looking Forward

- Ongoing research efforts include neurodegeneration, neuro-inflammation, the blood-brain barrier, central nervous system cancers and therapeutics, and neuronal transplantation therapy

INITIATIVE FOR WIRELESS HEALTH AND WELLNESS

Theme Leader: Jay Han, Physical Medicine & Rehabilitation

Theme Co-Leads: Heather Young, Nursing; Lars Berglund, Internal Medicine: Endocrinology/ Clinical & Translational Science Center; Prasant Mohapatra, Computer Science; Thomas Nesbitt, UCDHS Dean's Office

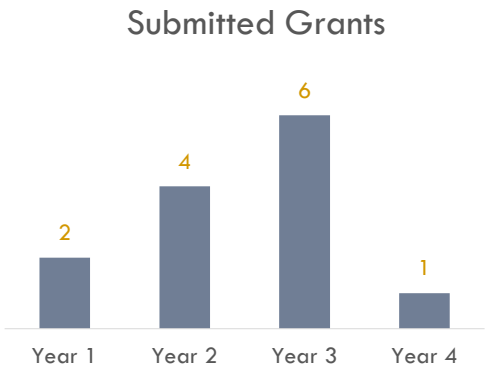
Approach

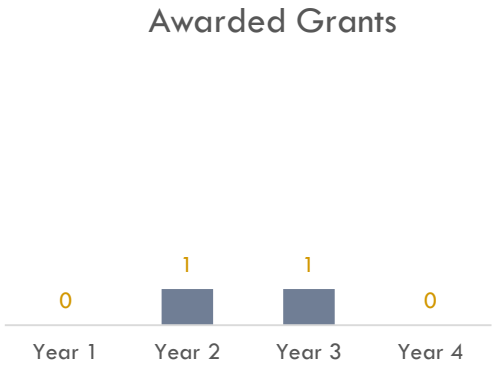
This collaborative research project is examining the feasibility and effectiveness of an innovative nurse-health-coach model of care. This model is informed by unprecedented "contextually-rich and personalized" data (physical activity, energy expenditure, geo-location, and ecologic momentary assessment) that utilizes cloud computing integrated with an electronic health record system. All of this is enabled through an individual's mobile phone during daily life. The analytic tools and sophisticated visualization techniques developed as part of this project is providing interpretable data for researchers and actionable data for healthcare providers.

The Initiative for Wireless Health and Wellness at UC Davis is providing the foundation for innovative interdisciplinary research with active industry collaboration and is serving at the frontline of mobile health progress towards improved, cost-effective healthcare and wellness.

Top Impacts

- Awarded the $2.1 million Patient-Centered Outcomes Research Institute (PCORI) grant to test mobile platform integration and nurse health
- Development of two new secure protocols for the secure generation of location proofs in ad hoc wireless environments
- Launched clinical trial to test use of mobile platform, activity sensors, and nurse health coaching within an employee wellness program. Enrolled a total of 104 subjects into a randomized, controlled clinical trial for a six-month employee health project (Healthy U Clinical Trial)





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	5	9	5	Number of Colleges	3	3	3
Number of Undergraduate Students	0	1	1	Records of Invention	0	0	0
Number of Graduate Students	2	3	3	Publications	0	11	5
Number of Post Doc Scholars	1	3	3	Workshops	1	1	0
Number of Departments	5	7	6	Presentations	6	3	3

Looking Forward

- Investigating potential industry collaborations
- Increase collaborations across disciplines to:
    - Drive new methods of research including remote monitoring of food consumption, nutrition and stress
    - Integrate lifestyle information into the electronic medical record
    - Develop personalized health and lifestyle intervention strategies based on data collected from current studies

INTERDISCIPLINARY, COLLABORATIVE, ANALYSIS OF NEUROIMMUNE-BASED SCHIZOPHRENIA (I-CAN-SZ)

Theme Leader: Kimberley McAllister, Neurology/ Neurobiology, Physiology, and Behavior

Theme Co-Leads: Cameron Carter, Psychiatry & Behavioral Sciences; David Amaral, Psychiatry & Behavioral Sciences; Melissa Bauman, Psychiatry & Behavioral Sciences; Paul Ashwood, Medical Microbiology & Immunology; Judy Van de Water, Internal Medicine: Rheumatology/Allergy; Simon Cherry, Biomedical Engineering; Julie Sutcliffe, Internal Medicine/Biomedical Engineering

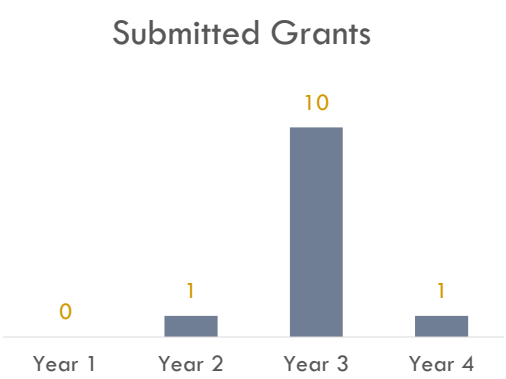
Approach

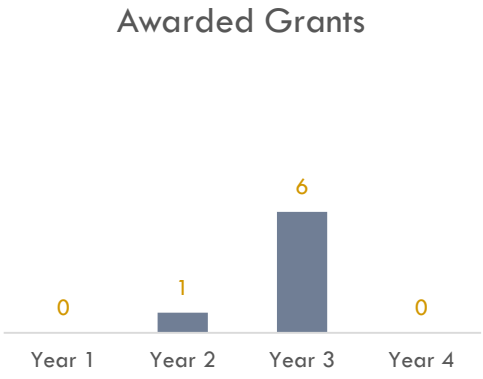
The Interdisciplinary, Collaborative, Analysis of Neuroimmune-Based Schizophrenia (I-CAN-SZ) theme brings together a collaborative, interdisciplinary group of scientists to definitively test the hypothesis that immune dysregulation contributes to the development of schizophrenia by altering brain cytokine and major histocompatibility complex class (MHCI) signaling. The group is developing novel tools to non-invasively image abnormal immune activation in the brain for diagnostic and drug discovery purposes. This high risk, high yield multidisciplinary effort to validate an immunological, developmental model of schizophrenia is based on an unprecedented approach involving coordinated experiments by five accomplished research groups with appointments in the UC Davis School of Medicine, the College of Biological Sciences, the College of Letters and Sciences, and the School of Engineering. This will be the first study to characterize changes in peripheral immune activation, neural inflammation, cortical anatomy, and behaviors simultaneously in high-risk individuals during their first-break for schizophrenia and mouse and non-human primate (NHP) immune-based model systems.

Top Impacts

- Transformed RISE theme into a Silvio O. Conte Center from National Institute of Mental Health; funding started on April 1, 2015 and our research will be funded for the next five years by this $10 million center
- Completed experiments testing whether there are changes in connectivity in the frontal cortex (FC) of newborn maternal immune activation (MIA) mice and discovered that there is a profound deficit in the ability of MIA cortical neurons to form synapses and that this deficit requires altered MHCI levels in neurons
- Completed experiments examining RNA levels of 25 different cytokines from FC of MIA and control offspring at 5 ages of development; results indicate MIA causes long-lasting changes in expression of cytokine receptors in MIA offspring at all stages of development
- Discovered cytokine receptor expression is altered in the brains of both mouse and non-human primate (NHP) MIA offspring relative to controls; five cytokines out of 23 tested were decreased in the NHP brain and all of these overlap (in kind or in function) with those identified in the mouse MIA brains. This discovery

indicates these cytokine receptors may be part of a central molecular pathway that underlies the schizophrenia-like neuroanatomical and behavioral abnormalities in offspring





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	8	8	8	Number of Colleges	2	3	3
Number of Undergraduate Students	1	3	1	Records of Invention	0	1	1
Number of Graduate Students	5	3	7	Publications	3	6	5
Number of Post Doc Scholars	1	1	1	Workshops	0	0	0
Number of Departments	4	5	5	Presentations	8	6	12

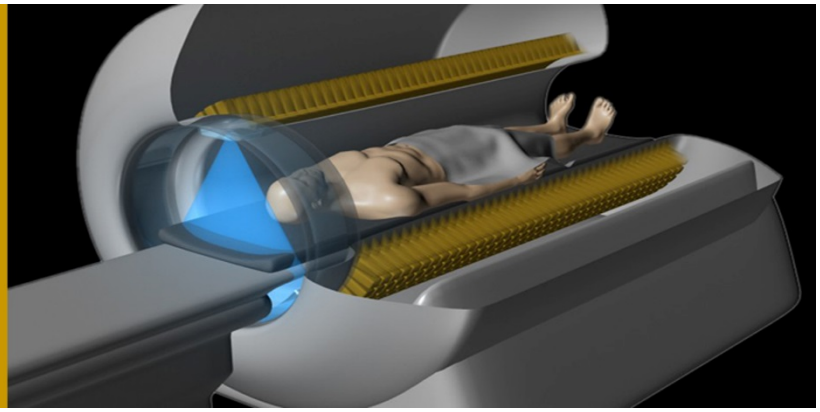
Looking Forward

- Focus on the success and ultimate renewal of the Conte Center
- Work to establish industry partnerships and/or alternate funding to pursue new therapeutics
- Grow collaborations outside of research funded by the Conte Center, including collaborations with investigators at UC Davis that work in the field of neuro-immunology as well as investigators outside of UC Davis who bring necessary expertise to study the molecular mechanisms underlying the effects of MIA in increasing risk for schizophrenia

CENTER FOR TRANSLATIONAL MOLECULAR IMAGING

The Challenge

Need for extremely sensitive medical imaging technique that allows specific molecular targets and pathways to be imaged safely and rapidly to improve diagnosis and guide treatment.



Theme Leader: Simon Cherry, Biomedical Engineering

Theme Co-Leads: Julie Sutcliffe, Biomedical Engineering/Internal Medicine; Ramsey Badawi, Radiology/ Biomedical Engineering ; Terry Jones, Radiology; Alice Tarantal, Cell Biology & Human Anatomy/ Primate Center; Jinyi Qi, Biomedical Engineering; Lars Berglund, Internal Medicine/ Clinical and Translational Science Center; Karen Kelsly, Internal Medicine: Hematology/Oncology

Approach

This theme is developing a total-body positron emission tomography (PET) scanner, EXPLORER, that will allow molecular imaging studies to be performed in humans at up to 1/40th of the radiation dose currently used, decrease the scan time by 1/40th, or increase sensitivity by 40 times for total body imaging. To accomplish this goal, the research team is:

- Conducting feasibility assessments and completing the design for EXPLORER, the world's first total-body PET scanner
- Taking a novel molecular imaging agent through preclinical evaluation, obtaining Food and Drug Administration (FDA) Investigational New Drug (IND) approval and conducting first-in-human PET studies at UC Davis.
- Coordinating and integrating molecular imaging activities at UC Davis, and creating a center to support future research and funding endeavors

Top Impacts

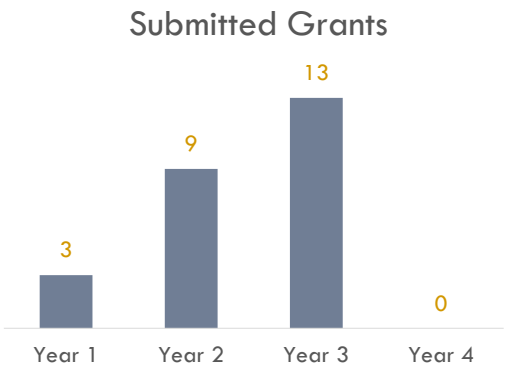
- Received $15.5 million Transformative R01 grant from National Institute of Health (NIH) and an R01 grant to sustain the center beyond end of RISE funding
- Established Nuclear Medicine Research Operations Committee to oversee molecular imaging research projects

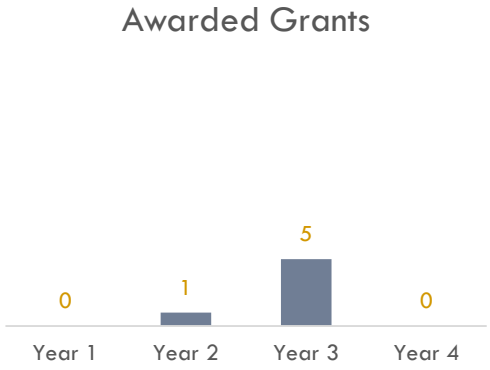
Scientific Accomplishments

- Pharmacology/toxicology studies and IND application underway
- Non-human primate/veterinary version of EXPLORER total body PET scanner currently under construction using components donated by Siemens
- Completed feasibility studies for developing EXPLORER, a total-body PET scanner that has 40-fold higher sensitivity than existing instruments and allows all the tissues and organs in the body to be viewed simultaneously

Awards

- Simon Cherry, Taplin Memorial Lectureship, Western Regional Society of Nuclear Medicine, 2014
- Ramsey Badawi, School of Medicine Dean's Award for Mentoring, UC Davis, 2015
- Ramsey Badawi, School of Medicine Dean's Team Award, UC Davis, 2015
- Simon Cherry, NIH/National Cancer Institute Outstanding Investigator Award, 2015
- Simon Cherry, Marie Slodowska-Curie Award, Institute for Electrical & Electronics Engineers, 2016
- Simon Cherry, National Academy of Engineering, 2016





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	7	8	8	Number of Colleges	1	2	2
Number of Undergraduate Students	0	4	2	Records of Invention	1	1	0
Number of Graduate Students	1	1	2	Publications	3	2	4
Number of Post Doc Scholars	1	1	2	Workshops	0	2	0
Number of Departments	4	4	7	Presentations	7	11	3

Looking Forward

- Build the world's first total-body PET scanner and perform first human imaging studies
- Obtain several FDA INDs for new and existing radiotracers to expand molecular imaging capabilities at UC Davis
- Expand the molecular imaging research program by hiring new nuclear medicine physicians and a research technologist within a kinetic modeling core
- Complete nonhuman primate/veterinary EXPLORER total-body PET scanner, evaluate performance and commence animal studies
- Obtain FDA IND and perform first human PET studies

NEW TOOLS FOR UNDERSTANDING, MONITORING, AND OVERCOMING PLANT STRESS

Theme Leader: Nelson Max, Computer Science

Theme Co-Leads: Julin Maloof, Plant Biology; David Slaughter, Biological & Agricultural Engineering; Jinyi Qi, Biomedical Engineering; Neelima Sinha, Plant Biology

Approach

This theme is focused on studying responses to drought, salinity, and nitrogen and phosphorous deprivation in tomato, the second most valuable vegetable crop in California and worldwide. The group is using RNA expression profiling to identify those genes most responsive to environmental stresses not only in domesticated tomato, but also its wild relatives which may harbor sensitized responses to environmental change.

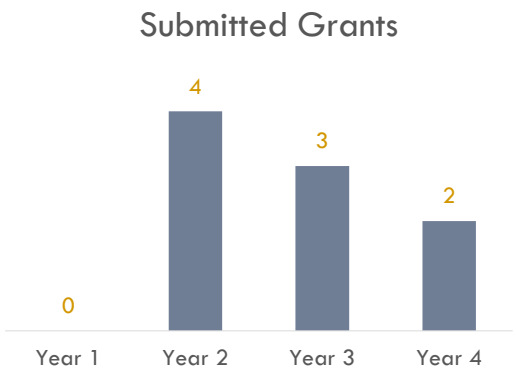
This interdisciplinary team of researchers is developing high throughput methods to measure biochemical markers of stress, including remote multi-spectral sensing, thermal imaging, and stereo reconstruction. Additionally, they are analyzing changes in the development and morphology of organs using micro-computed tomography (micro-CT).

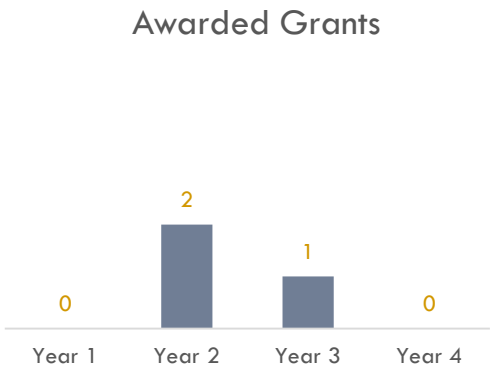
Understanding the stress response will provide guidance towards the creation of genetically engineered tomato varieties that, from the outset of specific stresses, will visibly express a reporter, changing the color or structure of the plant. Such “sentinel” plants will allow the application of water and fertilizer as needed, rather than broadcasting these resources on potentially wasteful schedules.

Scientific Accomplishments

- Completed design revisions and fabrication of three new hardware tools for improved understanding and monitoring of plant stress. The new tools allow greater throughput in detecting and characterizing biosensor plants, real-time monitoring of plant response to drought stress and a novel robotic system for high-throughput phenotyping of plant architecture for plants growing outdoors on a farm
- Used multi-view stereo machine vision and 3D reconstruction of plant shape models
- Achieved algorithms for reconstructing 3D plant surfaces from micro-CT scans
- Successfully developed protocol for micro-CT imaging of live plants, performed on existing varieties under non-stressed conditions; developed protocol for CT of whole plants for motion compensation
- Performed RNA sequencing on gene to analyze gene expression on stress response trials
- Completed the design and fabrication of first generation prototype platforms for two of the three plant sensing subsystems

- Completed assays of response to three stresses and repeated experiments for salt, phosphorus and nitrogen limitation
- Used CPU version of 3D linear and non-linear alignment of micro-CT data to compensate for plant motion between scans





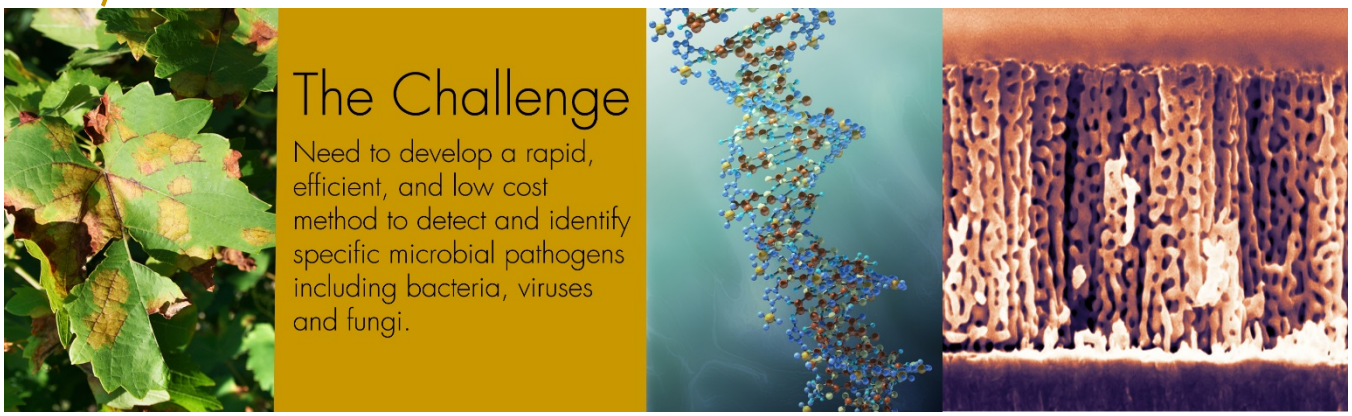
Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	5	5	5	Number of Colleges	2	2	3
Number of Undergraduate Students	0	3	5	Records of Invention	0	0	0
Number of Graduate Students	3	2	2	Publications	0	0	1
Number of Post Doc Scholars	1	3	3	Workshops	0	0	0
Number of Departments	3	3	4	Presentations	0	1	3

Looking Forward

- Complete the data analysis of the in-field phenotyping and thermal imaging data sets collected in 2015 and publish papers reporting on the new hardware tools developed and their performance
- RNA sequencing of 2015 plant stress trials
- Bioinformatics analysis of 2014 and 2015 RNA sequencing data
- Refine micro-CT scanning protocol to decrease radiation dosage by adjusting scan parameters
- Use a graphics processing unit to define and apply non-linear three dimensional space transformations

PATHOGEN IDENTIFICATION USING NANO-ENABLED ELECTRONIC DETECTION (RAPID-NEEDS)



Theme Leader: Bryce Falk, Plant Pathology

Theme Co-Leads: Erkin Seker, Electrical & Computer Engineering; Maria Marco, Food Science & Technology; Josh Hihath, Electrical & Computer Engineering; Andre Knoesen, Electrical & Computer Engineering

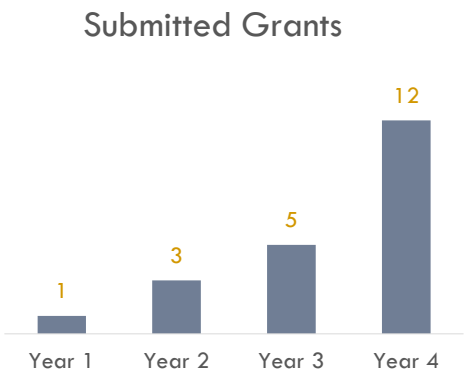
Approach

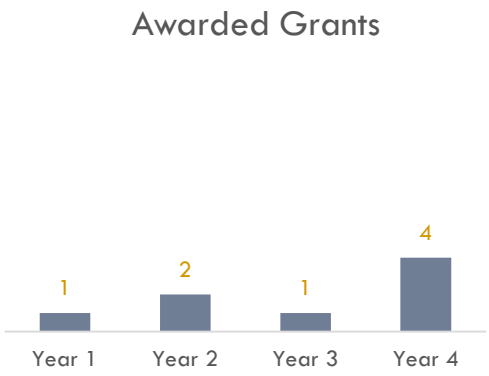
The vision of this team of researchers is to utilize recent advances in nanotechnology, electrical engineering, genomics and biotechnology expertise to develop a rapid, low-cost method for identification of microbes. The theme is using combined expertise to synthesize, characterize, and micro-fabricate electrochemical and conductance electrodes for DNA-based detection schemes for achieving pathogen identification. The long-term output is intended for cell-phone sized devices that are field-ready for agriculture and food industries. They are utilizing the rapidly increasing number of genome sequences that are available for a wide range of microbes, including plants and/or animal pathogens. Even closely related variants of a given pathogen species, which may have important differences in host range and/or pathogenicity, differ in their genome sequences. In this project, this information is exploited to detect specific pathogens. This theme's focus is to directly detect genetic information at the molecular level with electronic detection methods.

Scientific Accomplishments

- Examined the state of DNA and RNA detection targets in E. coli O157:H7 killed chemically or incubated on lettuce leaf surfaces
- Successfully used molecular conductance measurements of a biologically significant RNA fragment in a complex RNA population
- Made significant progress in controlling nanoporous gold surfaces as substrates for electrochemical detectors
- Demonstrated that DNA:RNA hybrids represent a superior substrate for molecular conductance measurements
- Demonstrated detection of biologically relevant sequences using the single-molecule conductance platform
- Demonstrated molecular conductance is capable of serotype-level identification
- Demonstrated molecular conductance platform has attomolar sensitivity
- Demonstrated technique to detect nucleic acids serum and purify them for further analysis

- Provided insight into the effect of electrochemical sensing electrode nano-morphology on biosensor performance
- Confirmed the presence of pathogen-specific sequences at appropriate nucleotide length for detection
- Produced and purified a modified RNase H protein capable of binding but not cleaving RNA:DNA hybrids as a potential means to improve signal detection
- Established a start-up company, Astrona Biotechnologies





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	6	6	5	Number of Colleges	2	2	3
Number of Undergraduate Students	3	7	4	Records of Invention	1	1	2
Number of Graduate Students	7	3	3	Publications	1	4	12
Number of Post Doc Scholars	0	2	4	Workshops	0	2	1
Number of Departments	4	4	3	Presentations	2	19	12

Looking Forward

- Continue to attain sustainability through various routes including avenues that include the newly established start-up company, Astrona Biotechnologies
- Participate in a National Science Foundation Engineering Research Center (ERC) proposal with Dr. Mike McCarthy from the University of Nebraska—Lincoln, “Food factories of the future”
- Apply the newly developed technologies to real-world complex mixtures for molecule detection

PROMOTE HEALTHY CROPS AND ENHANCE GLOBAL FOOD SECURITY

Theme Leader: George Bruening, Plant Pathology

Theme Co-Leads: Gitta Coaker, Plant Pathology; S.P. Dinesh-Kumar, Plant Biology; Andrew Fisher, Molecular & Cellular Biology; Ioannis Stergiopoulos, Plant Pathology; David Wilson, Molecular & Cellular Biology

Approach

Only a small fraction of microbes are plant pathogens and only a subset of those microbes result in an infection. Plant recognition of, and reaction to, pathogen effectors mediated by plant immune receptors are often determinative of pathogen success and disease or a healthy crop outcome. The well-recognized high specificity of a pathogen-plant interaction is largely a consequence of the recognition of a specific pathogen effector by a specific plant immune receptor. Mechanistic understanding, at the atomic level, of how this interaction occurs has been the core goal of this RISE theme. This understanding is expected to create the power to redirect effector-immune receptor interactions, or to enhance or diminish their strength, with the practical goal of enhancing crop protection and improving the efficiency of crop production.

More specifically, this theme is using the following tactics to achieve their goals:

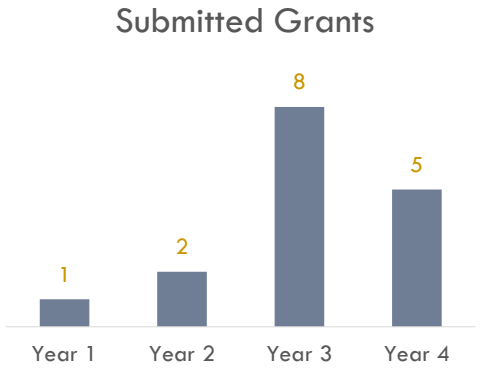
- Determining the crystal structures of several immune complex components singly and as biologically relevant complexes
- Identifying the biological activities of immune complex components and the intra- and inter-molecular changes induced during immune receptor activation
- Validating immune complex structural models for biological relevance

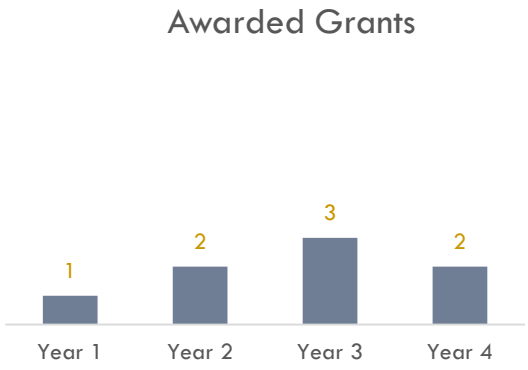
Scientific Accomplishments

- Determined the structure for a new fungal elicitor; binding properties of three fungal elicitors were compared by numerous biological and chemical tests
- Yielded several three-dimensional structures, at atomic resolution, of proteins that participate in pathogen recognition by plants
- Exploited a small lectin protein of animal origin to identify structural features; identified a subcellular binding site for which no function had been known of fungal elicitors
- Purified a few immune receptor proteins by newly developed methods that yielded highly active proteins showing extensive self-phosphorylation and trans-phosphorylation
- Applied an insect cell protein expression system to obtain large amounts of soluble immune receptor protein for crystallization; numerous attempts to produce these proteins in *Escherichia coli* (*E. coli*) or yeast were not successful

Awards

- Graduate student Nicholas Hurlburt, West Coast Protein Crystallography Workshop, Asilomar, California. Winner of Best Poster award for "Structural and mutational studies of the chitin-binding fungal effector protein, PfAvr4," 2015
- Graduate student Stephen Bolus, who participated in this RISE project in year 1, was awarded a National Science Foundation graduate fellowship and continues to work on immune receptors





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	6	8	6	Number of Colleges	1	2	2
Number of Undergraduate Students	3	2	8	Records of Invention	0	0	0
Number of Graduate Students	7	5	6	Publications	2	2	1
Number of Post Doc Scholars	0	2	2	Workshops	0	0	2
Number of Departments	1	2	2	Presentations	8	21	13

Looking Forward

- The theme will further characterize biochemical functions and contribution to pathogen infection biology to determine which amino acids in a structure are essential for effector, adaptor or immune receptor function in order to design and engineer plant immune receptors with altered specificity

CENTER OF HEALTH FOR ADVANCING MICROBIOME AND MUCOSAL PROTECTION (CHAMMP)

Theme Leader: Satya Dandekar, Medical Microbiology & Immunology

Theme Co-Leads: Bruce German, Food Science & Technology; David Mills, Food Science &Technology/Viticulture & Enology; Mark Underwood, Pediatric Neonatology; Richard Pollard, Infectious Diseases; Ralph deVere White, Comprehensive Cancer Center/Urology; Thomas Prindiville, Gastroenterology & Hepatology; Carlito Lebrilla, Chemistry; Daniella Barile, Food Science & Technology; Dennis Hartigan-Oconnor, Medical Microbiology & Cell Biology; Emanual Maverakis, Dermatology, Helen Raybould, Vet Med: Anatomy, Physiology, & Cell Biology

Approach

This team of researchers is applying novel approaches to repair and protect the fragile intestine in critical populations. More specifically, their goals are to:

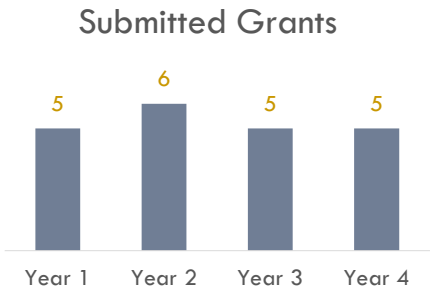
- Determine the effects of a combination of prebiotic milk oligosaccharides and *Bifidobacterium* species in establishing the microbiota in premature infant gut
- Develop novel approaches to investigate the effects of the chronic viral infections on the gut microbiome and to examine implications for the gut repair and immune defenses
- Investigate the role of probiotics in carcinogenesis
- Generate collaborative opportunities among researchers and the private sector to develop biomarkers, diagnostics and new products for the protection of the fragile intestine and prevention/resolution of inflammation.

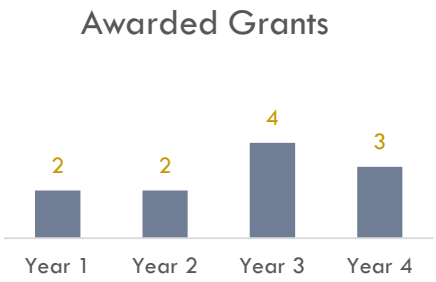
Top Impacts

- Provided support to secure significant investment in the start-up company launched from UC Davis (Evolve Biosystems) that is producing and marketing symbiotic products for infants
- Established contract research agreements with several large corporations (Yili Dairy, Abbott), and notably a 5 year agreement with Mengniu Dairies of China to establish a formal partnership for research with applications in the USA and China

Scientific Accomplishments

- Developed novel clinical applications of probiotics for the protection of premature infants by supporting gut development and digestion
- Established glycomic and glycoproteomic analysis for milk and other biofluids
- Evaluated gut microbiota changes during subclinical chronic viral infections and impact on the host innate immune sensing and generation of host responses to vaccines in the non-human primate model
- Comparative evaluation of the gut microbiota changes during subclinical chronic cytomegalovirus (CMV) infection versus immune deficiency causing chronic human immunodeficiency virus (HIV) infection and implications in viral persistence
- Identified novel drug combinations of cancer drugs for HIV eradication strategies and preliminary evaluation of cancer drugs in HIV infected patients
- Identified early mucosal signaling leading to inflamed gut which in turn supports HIV infection and dissemination; gut inflammation was dampened by *Lactobacillus* plant arum and *Bifidobacter infantis*
- Modeled lactose hydrolysis for efficiency and selectivity: towards the preservation of *sialyloligosaccharides* in bovine colostrum whey permeate
- Optimized enzymatic reaction conditions to produce structurally complex oligosaccharides
- Evaluated the effects of pH, transmembrane pressure, feed flow, and diafiltrations on the recovery and purity of oligosaccharides during nanofiltration
- Optimized the fermentation of monosaccharides at laboratory and pilot scale to maximize the purity of recovered oligosaccharides during nanofiltration
- Generated pilot-scale quantities of purified (monosaccharide free) oligosaccharides from bovine colostrum, human milk and goat milk
- Worked on the conversion of agricultural streams into nutraceuticals and fuel
- Optimized the use of kefir grains as an alternative methods to produce purified oligosaccharides





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	7	9	12	Number of Colleges	3	3	4
Number of Undergraduate Students	2	12	12	Records of Invention	0	3	1
Number of Graduate Students	1	13	4	Publications	0	37	67
Number of Post Doc Scholars	2	8	5	Workshops	0	0	0
Number of Departments	6	7	10	Presentations	6	40	66

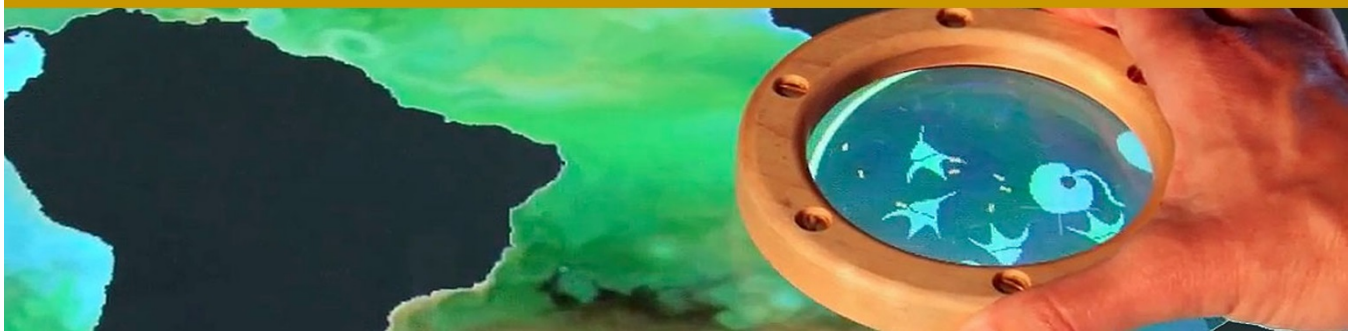
Looking Forward

- Continue to attain sustainability through various routes in parallel

UC DAVIS CENTER FOR VISUALIZATION

The Challenge

We observe an explosive growth of data in almost all scientific research and practices, which create tremendous challenges to people who attempt to manage and utilize the data.



Theme Leader: Kwan-Liu Ma, Computer Science

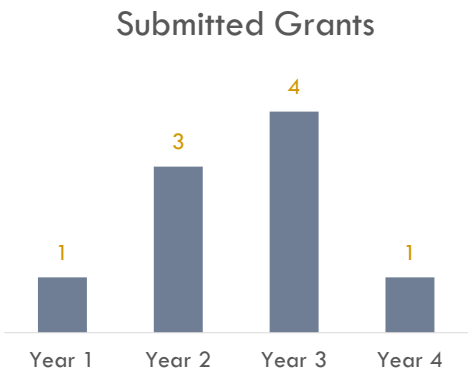
Theme Co-Leads: Ramsey Badawi, Biomedical Engineering/ Radiology; Robert Faris, Sociology; Tom Turrentine, Institute of Transportation Studies; Susan Verba, Design

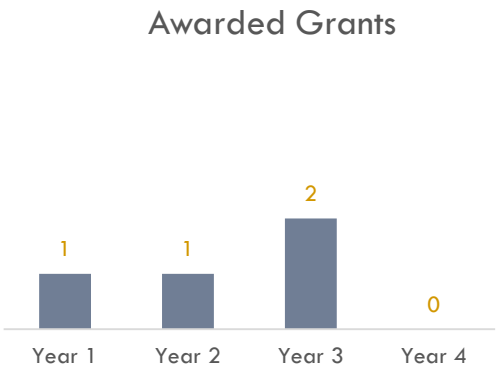
Approach

By working with domain scientists, this theme is creating high-resolution, interactive, data-driven visualizations that provide new insights into scientific and social media data to serve as a central point of access to advanced technology. The theme is also developing a unique cyber infrastructure which includes visualization, interface and display technologies that can inspire faculty to develop new research and teaching methods. The group is developing custom visualization solutions for selected campus research units and converting promising prototype systems and tool-kits into products targeting niche market while teaching students advanced visualization and analysis techniques.

Top Impacts

- Established collaborations with the Exploratorium and MIT
- Completed the first exhibit, “Living Liquid”
- Developing a second exhibit for visualizing pelagic predators and a third exhibit to teach genome evolution and syntenic mappings between extant and ancestral species
- Involved multiple UC Davis faculty members beyond the original RISE theme
- Conducted outreach to new disciplines; published several strong research papers; won new research grants
- Received the best paper award at the 23rd Symposium on Graph Drawing and Network Visualization





Metrics Overview

Key Metrics	Yr 1	Yr 2	Yr 3	Key Metrics	Yr 1	Yr 2	Yr 3
Number of Faculty	6	9	5	Number of Colleges	3	3	3
Number of Undergraduate Students	2	3	2	Records of Invention	0	0	0
Number of Graduate Students	5	8	7	Publications	26	28	12
Number of Post Doc Scholars	1	2	2	Workshops	0	1	3
Number of Departments	4	7	6	Presentations	19	18	18

Looking Forward

- Consider technology transfer opportunities
- Future milestones:
    - Seek industry partnerships
    - Actively seek extramural funding
    - Involve additional undergraduate students in projects
    - Offer a visualization workshop on campus