Twenty Ninth Annual Biotechnology Training Retreat

Saturday,
March 7, 2020

UC Davis Genome Center

UCDAVIS
Biotechnology Program

Twenty Ninth Annual Biotechnology Training Retreat

Co-sponsored by:

UC Davis Designated Emphasis in Biotechnology Graduate Program (DEB)

UC Davis Biotechnology Program

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UC Davis Twenty Ninth Annual Biotechnology Training Retreat
March 7, 2020
UC Davis Genome Center Auditorium

8:30 – 9:10 am	**Registration/Continental Breakfast/Poster Viewing**
9:10 – 9:15 am	**Welcome** **Denneal Jamison-McClung, PhD** Director, Biotechnology Program
9:15 – 10:30 am	**Presentations** 9:15 Marcus Deloney, DEB Student..... Biomedical Engineering 9:30 Jessica Huang, DEB Student ..... BMCDB 9:45 Nitin Beesabathuni, DEB Student ..... Chemical Engineering 10:00 Marwa Zafarullah, DEB Student..... IGG 10:15 Angel Cobo, DEB Student ..... Chemistry
10:30 – 11:00 am	**Break/Poster Viewing**
11:00 – 12:15 pm	**Presentations** 11:00 Angela Zhang, DEB Student ..... Chemistry 11:15 Bianca Yaghoobi, DEB Student ..... Pharmacology & Toxicology 11:30 Korn Macharoen, DEB Student..... Chemical Engineering 11:45 Yixing Lu, DEB Student ..... Food Science 12:00 Noah Goshi, DEB Student..... Biomedical Engineering
12:15 – 1:15 pm	**Lunch/Voting on STEM-Talks and Biotech Posters**
1:15 -2:10 pm	**DEB Alumni & Industry Partner Presentations** 1:15 Juan Sanchez, PhD, CA Department of Pesticide Regulation 1:25 Cole Pearson, Marrone Bio Innovations 1:35 Zane Starkewolfe, PhD, Venture Catalyst, UC Davis 1:45 Gian Oddone, PhD, Novozymes 1:55 Anita Rajamani, PhD, Lifescience Dynamics
2:00 – 2:15 pm	**Winners Announced and Closing Remarks**

For social media, use #BiotechRetreat

2020 Poster Titles

A. **"Photoinduced 4-Vinylpyridine Graft on Cellulose Nanofibrous Membranes for High Performance Lysozyme Adsorption"**

Noha Amaly*[1,2], Yue Ma[1], Ahmed Y. El-Moghazy[1,2], Gang Sun[1]
[1]Department of Biological and Agricultural Engineering, University of California, Davis, CA
[2]Polymeric Materials Research Department, Advanced Technology and New Materials Research Institute, City of Scientific Research and Technological Applications (SRTA-City), New Borg El-Arab City 21934, Alexandria, Egypt

B. **"The Role of Nicotinic Receptors in Seizure Activity and Death Triggered by Acute Organophosphate Intoxication In a Mouse Model"**

JJ Calsbeek*, EA González, B Pressly, MA Guignet, DA Bruun, IN Pessah, PJ Lein
Molecular Biosciences, UC Davis School of Veterinary Medicine, Davis, CA

C. **"Excision of Oxidatively Damaged Bases in G-Quadruplexes by the DNA Glycosylases NEIL1 and NEIL3"**

Savannah G. Conlon*, Elizabeth R. Lotsof, Joshua D. Bumgarner, Brittany M. Anderson-Steele, Kelsey Mifflin, Aaron A. Fleming, Cynthia J. Burrows, Sheila S. David
Department of Chemistry, University of California, Davis, CA

D. **"Portable Electrochemical Aptasensor Based-On Functionalized Cellulose Nanofibers for In-situ Detection of Mycotoxins in Foods"**

Ahmed Y. El-Moghazy*[1,2], Noha Amaly [1,2], Gang Sun [1]
[1]Department of Biological and Agricultural Engineering, University of California, Davis, CA
[2]Polymeric Materials Research Department, Advanced Technology and New Materials Research Institute, City of Scientific Research and Technological Applications (SRTA-City), New Borg El-Arab City 21934, Alexandria, Egypt

E. **"Entrapment of Photoactive Membrane Protein in Mesporous Silica Gels Using Lipid Nanoparticles"**

Sukriti Gakhar*[1], Subhash H. Risbud[2], Marjorie L. Longo[1]
[1]Department of Chemical Engineering, University of California, Davis, CA
[2]Department of Material Science and Engineering, University of California, Davis, CA

F. **"Effect of Natural Genetic Variations at Incretin Receptor on Glucose Homeostasis"**

Anirudh Gaur[1]*, Anne C Hergarden[1], Sarah E. Sheridan[1], Elinor Lewis[1], Li He[1], Jennifer L. Whistler[1,2]
[1]Center for Neuroscience
[2]Department of Physiology and Membrane Biology, UC Davis

G. **"Functionalized Polymer-Graphene Fixed Target Substrates for High-Throughput, Hydrated Serial Femtosecond Crystallography Using X-Ray Free Electron Lasers (XFELS)"**

Deepshika Gilbile[1], Megan L Shelby[2], Brent Segelke[2], Thomas Grant[3], Mark S Hunter[4], Alke Meents[5], Matthew A Coleman[1,2], Matthias Frank[1,2], and Tonya L Kuhl[1]*
[1] Department of Chemical Engineering, University of California, Davis
[2]Lawrence Livermore National Laboratory
[3]Department of Structural Biology, Jacobs School of Medicine and Biomedical Sciences, Hauptman-Woodward Institute, SUNY University at Buffalo
[4]Linac Coherent Light Source, SLAC National Accelerator Laboratory
[5]Center for Free-Electron Laser Science

H. **"A Primary Neural Cell Culture Model to Study Neuron, Astrocyte and Microglia Interactions in Neuroinflammation"**

Noah Goshi*[1], Rhianna Morgan[2], Pamela Lein[2], and Erkin Seker[3]
[1] Department of Biomedical Engineering, University of California, Davis
[2] Department of Molecular Biosciences, University of California, Davis
[3] Department of Electrical and Computer Engineering, University of California, Davis

I. **"Phase Coexistence in Hybrid Lipid/Block Copolymer Liposomes"**

Naomi Hamada*, Sukriti Gakhar, Marjorie L. Longo
Department of Chemical Engineering, University of California, Davis, CA

J. **"Role of Pancreatic Delta Cells in Controlling the Glycemic Setpoint"**

Jessica L Huang*, Mark O. Huising
Department of Neurobiology, Physiology & Behavior, University of California Davis, CA

K. **"DNA Glycosylase NEIL1 Demonstrates Lesion Specificity from RNA Editing**"

Elizabeth R. Lotsof*, Jongchan Yeo, Savannah G. Conlon, Brittany M. Anderson-Steele, and Sheila S. David
Department of Chemistry, University of California, Davis, CA

L. **"Structure-Activity Relationships Guided Studies for OG:A Lesion Recognition and Repair by the Base Excision Glycosylase MutY**"

Chandrima Majumdar[1]*, Robert Van Ostrand[1], Andrea J. Lee[2], Amelia H. Manlove[1], Paige L. McKibbin[1], Michelle L. Hamm[3], Sheila S. David[1]
[1]Department of Chemistry, University of California, Davis, CA
[2]Department of Microbiology and Molecular Genetics, University of Vermont, VT
[3]Department of Chemistry, University of Richmond, Richmond, VA

M. **"Electrical-Biological Hybrid System for CO_2 Reduction In *Escherichia coli*"**

Morgan Matson*, Tanner Treece, and Shota Atsumi
Department of Chemistry, University of California, Davis, CA

N. **"Adaptation of *Escherichia coli* to Antiseptics and Disinfectants**"

Beatriz Merchel Piovesan Pereira[1,2*], Xiaokang Wang[2,3], Ilias Tagkopoulos[2,4]
[1]Microbiology Graduate Group, University of California, Davis, CA
[2]Genome Center, University of California, Davis, CA
[3]Biomedical Engineering Graduate Group, University of California, Davis, CA
[4]Department of Computer Science, University of California, Davis, CA

O. **"Defining Potential Mechanisms of Pellicle Darkening in *Juglans regia* (English Walnut)"**

Houston Saxe*, Timothy Butterfield, Bipin Balan, and Abhaya M. Dandekar
Department of Plant Sciences, University of California, Davis

P. **"Development of Disease Resistant Almond Peach Hybrid Rootstocks through Cell Culture and Improvement through Genetic Transformation"**

Sriema L. Walawage[1*], Paulo A. Zaini[1], Abhaya M. Dandekar[1]
Cooperators: Thomas Gradziel[1], Charles Leslie[1], David Tricoli[1], Takao Kasuga[2,3], Greg Browne[2,1]
[1]Department of Plant Sciences, UC Davis
[2]USDA-Agricultural Research Service
[3]Department of Plant Pathology, UC Davis

Q. **"Development and Characterizations of a Plant-Recombinant Therapeutic for Bone Loss during Space Missions"**

Yongao (Mary) Xiong*, Dexter Antonio, Kevin Yates, Somen Nandi and Karen McDonald
Department of Chemical Engineering, University of California, Davis, CA

R. **"RyR-Active Polychlorinated Biphenyls (PCBs) Cause Neurobehavioral Deficits in Larval Zebrafish"**

Bianca Yaghoobi*[1], Galen W. Miller[1], Erika B. Holland[4], Xueshu Li[2], Danielle Harvey[3], Shuyang Li[3], Hans-Joachim Lehmler[2], Pamela J. Lein[1]
[1]Department of Molecular Biosciences, University of California, Davis
[2]Department of Occupational and Environmental Health, University of Iowa, Iowa City, IA
[3]Department of Public Health Sciences, University of California, Davis
[4]Department of Biological Sciences, California State University of Long Beach

S. **"Development of a Plant-Made Therapeutic to Treat Spaceflight Osteopenia"**

Kevin Yates*[1,5], Yongao Xiong[1,5], Nancy E. Lane[2], Abhaya M. Dandekar[3], Karen A. McDonald[1,4,5], and Somen Nandi[1,4,5]
[1] Department of Chemical Engineering, University of California, Davis, CA
[2] Center for Musculoskeletal Health, University of California, Sacramento, CA
[3] Department of Plant Sciences, University of California, Davis, CA
[4] Global HealthShare® Initiative, University of California, Davis, CA
[5] Center for the Utilization of Biological Engineering in Space (CUBES), NASA Space Technology Research Institute (STRI)

DEB Oral Presentation Titles

1. **"An Engineering Approach to Measure Autophagy"**
   Nitin Sai Beesabathuni[1]*, Priya Shah[1,2]
   [1]Department of Chemical Engineering, University of California, Davis, CA
   [2]Department of Microbiology and Molecular Genetics, University of California, Davis, CA

2. **"Silicon in Medicinal Chemistry: A New Frontier in Drug Discovery"**
   Angel A. Cobo*, Annaliese K. Franz
   Department of Chemistry, University of California, Davis, CA

3. **"Degradable, Thermoresponsive Nanoparticles for Intra-Articular Delivery of Anti-Inflammatory Peptides to Osteoarthritic Cartilage"**
   Marcus Deloney[1]*, Kyra Smart[2], Blaine Christiansen[1,3], Alyssa Panitch[1,2]
   [1]Biomedical Engineering Graduate Group Davis, CA
   [2]Department of Biomedical Engineering, Davis, CA
   [3]Department of Orthopedic Surgery, Sacramento, CA

4. **"A Primary Neural Cell Culture Model to Study Neuron, Astrocyte and Microglia Interactions in Neuroinflammation"**
   Noah Goshi*[1], Rhianna Morgan[2], Pamela Lein[2], and Erkin Seker[3]
   [1]Department of Biomedical Engineering, University of California, Davis, CA
   [2]Department of Molecular Biosciences, University of California, Davis, CA
   [3]Department of Electrical and Computer Engineering, University of California, Davis, CA

5. **"Role of Pancreatic Delta Cells in Controlling the Glycemic Setpoint"**
   Jessica L Huang*, Mark O. Huising
   Department of Neurobiology, Physiology & Behavior, University of California Davis, CA

6. **"Customizable Future Supplements: Matrix Effect on Bioaccessibility of Encapsulated Micronutrients"**
   Yixing Lu*, Rewa Rai, Nitin Nitin
   Department of Food Science and Technology, University of California, Davis, CA

7. **"Effects of Kifunensine on Production and *N*-Glycosylation of a Recombinant Glycoprotein in a Transgenic Rice Cell Suspension Culture: A Bioreactor Case Study"** Kantharakorn Macharoen*[1], Qiongyu Li[2], Veronica A. Márquez-Escobar[1], Jasmine M. Corbin[1], Carlito B. Lebrilla[2], Somen Nandi[1,3] and Karen A. McDonald[1,3]
   [1]Department of Chemical Engineering, University of California, Davis, CA
   [2]Department of Chemistry, University of California, Davis, CA
   [3]Global HealthShare® Initiative, University of California, Davis, CA

8. **"PCBs, the Forever Chemicals"**

Bianca Yaghoobi*[1], Galen W. Miller[1], Erika B. Holland[4], Xueshu Li[2], Danielle Harvey[3], Shuyang Li[3], Hans-Joachim Lehmler[2], Pamela J. Lein[1]
[1]Department of Molecular Biosciences, University of California, Davis
[2]Department of Occupational and Environmental Health, University of Iowa, Iowa City, IA
[3]Department of Public Health Sciences, University of California, Davis
[4]Department of Biological Sciences, California State University of Long Beach

9. **"Longitudinal Metabolic Profiling Reveals Potential Biomarkers and Dysregulated Lipid Metabolism Associated with the Development and Progression of Fragile X-Associated Tremor/Ataxia Syndrome (FXTAS)"**

Marwa Zafarullah* [1], Susan M. Rivera[2,3,4], David Hessl[4,5], and Flora Tassone [1, 4]
[1]Department of Biochemistry and Molecular Medicine, University of California Davis, School of Medicine
[2]Center for Mind and Brain, University of California, Davis
[3]Department of Psychology, University of California, Davis
[4]MIND Institute, University of California Davis Medical Center
[5]Department of Psychiatry and Behavioral Sciences, University of California Davis Medical Center

10. **"Microbial Production of Human Breast Milk Sugars"**

Angela Zhang*
Department of Chemistry, University of California, Davis, CA 95616

DEB Alumni & Industry Partner Presentation Titles

1. **"Novozymes, a For-Planet's-Profit Company"**
   Gian Oddone, PhD (DEB Alum)
   Research Manager, Fermentation
   Novozymes Inc.

2. **"MBI, Bio-Based Solutions"**
   Cole Pearson, MSc
   Invertebrate Pest Biology, Group Leader
   Marrone Bio Innovations

3. **"The Everlasting Question- What do I do next?"**
   Anita Rajamani, PhD (DEB Alum)
   Business Analyst
   Lifescience Dynamics Limited

4. **"My Diverse Path in the Agricultural Sector"**
   Juan Sanchez, PhD (DEB Alum)
   Senior Environmental Scientist
   California Department of Pesticide Regulation

5. **"The Adventure of the DEB Circle – A personal story of bench-to-finance and back"**
   Zane Starkewolfe, PhD (DEB Alum)
   Associate Director - New Venture Resources
   Venture Catalyst, UC Davis

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Oral Presentation Abstracts

1. Nitin Sai Beesabathuni

AN ENGINEERING APPROACH TO MEASURE AUTOPHAGY

Presenter: Nitin Sai Beesabathuni
Authors: Nitin Sai Beesabathuni, Priya Shah
Graduate Group: Chemical Engineering
Preceptor: Priya Shah

Autophagy is a multi-step intracellular process by which cells recycle their misfolded proteins and damaged organelles into primary building blocks. The cellular materials are sequestered by double-membrane vesicles called autophagosomes, which fuse with lysosomes to form autolysosomes, which then degrade the sequestered material into fatty acids and amino acids. Autophagy is linked to many diseases, including cancer, neurodegenerative diseases, and infectious diseases. While the significance of autophagy in various cellular processes is well-established, robust and sensitive quantification of the dynamic autophagic process remains a challenge. Quantifying autophagy temporally allows the fundamental understanding of autophagy and will be useful for biomedical and biotechnology applications. However, many current methods lack the temporal quantification making them inadequate to characterize the dynamic nature of autophagy.

We developed a new single-cell fluorescence microscopy-based methodology to measure all the steps involved in autophagy in a temporal and a quantitative manner. The methodology considers the whole autophagic process as a multistep process governed by the rate of formation of autophagosomes (R1), the rate of fusion of autophagosomes with lysosomes (or rate of formation of autolysosomes) (R2), and the rate of degradation of autolysosomes(R3). All three rates can be measured temporally using an instantaneous rate approach, thus characterizing the change in the functional state of the system over time. We developed a tandem green and red fluorescent human cell line to monitor autophagosomes and autolysosomes in real-time. This methodology would allow systematic characterization of various cell types and the effect of various biomedically

relevant perturbations such as viruses on autophagy. The methodology would further allow the kinetic analysis of the autophagic pathway in response to external perturbations such as small molecule drugs. In conclusion, this methodology will lay the foundation for quantification and kinetic analysis of the autophagic system. As a future direction, we will be applying this methodology to study the effect of the dengue virus and the Zika virus on autophagy.

2. Angel Cobo

SILICON IN MEDICINAL CHEMISTRY: A NEW FRONTIER IN DRUG DISCOVERY

Presenter: Angel Cobo
Authors: Angel A. Cobo, Annaliese K. Franz
Graduate Group: Chemistry
Preceptor: Annaliese Franz

We are interested in the synthesis of silicon-containing biomolecules as new drug targets and probe systems for biomedical research. Our rapid and selective synthetic methods allow access to silicon-containing derivatives with reduced reactivity to oxidative conditions, tunable steric demand, and modified solubility. Silicon's physical properties including its valency of 4, electropositive nature and larger steric demand make it a perfect candidate as a bioisostere for tetrahedral carbon. Our central hypothesis is that strategic and efficient incorporation of a silyl-group in our drug targets can provide enhanced bioactivity, alter metabolic fate and improve hydrophobic interactions.

Silyl-functional groups can be strategically incorporated to alter the structure and conformation of lipophilic tails (chain-length, conformation, branching, etc) to enhance lipophilicity, particularly for access to novel lipid hybrid molecules. There is substantial evidence citing improved bioactivity with increased lipophilic modifications. Our synthetic strategy efficiently incorporates a silyl group to provide unique silyl-lipid derivatives which modulates structure and conformation for lipophilic components of bioactive molecules. Our innovative platform will highlight the importance of hydrophobic groups as crucial pharmacophores, where controlling structure and conformation can be a significant element in the design of molecular probes and medicinal compounds. Considering there is no "element specific" toxicity for silicon and no current FDA approved drugs with silicon incorporation, silicon medicinal compounds provide a vast opportunity for exploration in the biochemical space, indeed making silicon a new frontier in drug discovery

3. Marcus Deloney

DEGRADABLE, THERMORESPONSIVE NANOPARTICLES FOR INTRA-ARTICULAR DELIVERY OF ANTI-INFLAMMATORY PEPTIDES TO OSTEOARTHRITIC CARTILAGE

Presenter: Marcus Deloney
Authors: Marcus Deloney, Kyra Smart, Blaine Christiansen, Alyssa Panitch
Graduate Group: Biomedical Engineering
Preceptor: Alyssa Panitch

Inflammation following joint trauma contributes to cartilage degradation and progression of post traumatic osteoarthritis (PTOA). Therefore, drug delivery vehicles that deliver effective anti-inflammatory treatments have the potential to prevent PTOA. We have developed solid and hollow, thermoresponsive nanoparticles for the controlled release of our anti-inflammatory MK2-inhibiting (MK2i) peptide for intra-articular injection to halt inflammation that contributes to the advancement of PTOA. This system exploits the thermosensitive characteristic of N-isopropyl acrylamide (NIPAm) to transition phases when passing through its lower critical solution temperature (LCST). The nanoparticles (NPs) swell below the LCST and constrict above it. Non-crosslinked poly(NIPAm) (pNIPAm), held above its LCST, formed hydrophobic cores around which shells composed of NIPAm, degradable crosslinker N, N′-bis (acryloyl) cystamine (BAC), sulfated 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), and acrylic acid (AAc) were polymerized. Removal of the non-crosslinked pNIPAm cores via diffusion produced, thermosensitive, degradable nanoparticles with low density, or hollow, cores. The data presented here revealed low-density, termed hollow, nanoparticles (hNPs) load and release significantly more MK2i than solid nanoparticles (sNPs). Furthermore, drug loading below the LCST of NIPAm results in roughly 2.5 times more therapeutic encapsulation compared to loading particles in their constricted state. Hollow nanoparticles increase drug loading compared to solid nanoparticles, are taken up into chondrocytes within 24 h, cleared from the cells within 6 days, significantly decrease

the secretion of the proinflammatory cytokine IL-6, and, via intra-articular injection, are successfully delivered into the joint space of rats. The peptide loaded nanoparticles provide a reproducible platform for intra-articular delivery of therapeutics.

4. Noah Goshi

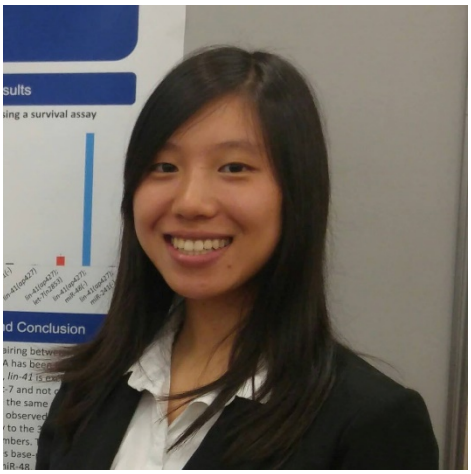
A PRIMARY NEURAL CELL CULTURE MODEL TO STUDY NEURON, ASTROCYTE AND MICROGLIA INTERACTIONS IN NEUROINFLAMMATION

Presenter: Noah Goshi
Authors: Noah Goshi, Rhianna Morgan, Pamela Lein, and Erkin Seker
Graduate Group: Biomedical Engineering
Preceptor: Erkin Seker

Interactions between neurons, astrocytes and microglia critically influence the neuroinflammatory response to insult or injury in the central nervous system. While in vitro astrocyte and microglia cultures are powerful tools to study specific molecular pathways involved in neuroinflammation, these culture models are incapable of capturing the impact of cellular crosstalk on the neuroinflammatory response. We have developed an enhanced cell culture model comprised of the three major cell types associated with neuroinflammation, neurons, astrocytes and microglia. Primary rat cortical cells were maintained in a serum-free, “tri-culture” media developed to support all three cell types. This tri-culture can be maintained for at least 14 days in vitro while retaining a physiologically-relevant representation of all three cell types. We compared the response of the tri-culture and an established neuroinflammatory model (neuron-astrocyte co-culture) to different neuroinflammatory stimuli mimicking sterile bacterial infection (lipopolysaccharide exposure), traumatic brain injury (mechanical trauma) and seizure activity (glutamate-induced excitotoxicity). In each instance the tri-culture more faithfully mimicked the in vivo neuroinflammatory response than the neuron-astrocyte co-culture. Furthermore, the tri-culture was able to capture both the neurotoxic and neuroprotective role of neuroinflammation under different circumstances. We hope that this tri-culture can be a useful tool to study neuroinflammation in vitro with improved accuracy in predicting in vivo neuroinflammatory phenomena.

5. Jessica Huang

ROLE OF PANCREATIC DELTA CELLS IN CONTROLLING THE GLYCEMIC SETPOINT



Presenter: Jessica Huang
Authors: Jessica L. Huang, Mark O. Huising
Graduate Group: Biochemistry, Molecular, Cellular and Developmental Biology
Preceptor: Mark Huising

Beta cells play a critical role in blood glucose homeostasis, as they are our sole source of insulin. While insufficient insulin secretion contributes to diabetes, too much insulin can lead to hypoglycemia and potentially be fatal. This illustrates the importance of negative feedback on β cell activity. Our lab has demonstrated that β cells co-secrete the peptide hormone Urocortin 3 (Ucn3) with insulin. Ucn3 then goes on to stimulate somatostatin secretion from delta cells, creating a negative feedback loop that is critical for the attenuation of insulin secretion. However, the full physiological relevance of this feedback inhibition is not well defined. Our lab has demonstrated that expressing Ucn3 in β cells directly causes an increase in basal glucose levels, likely by triggering somatostatin secretion from delta cells to create a negative feedback loop that attenuates insulin secretion. Therefore, we hypothesized that pancreatic delta cell secretion of somatostatin plays an important role in establishing the glycemic set point through control of β cell activity. To address this hypothesis, we specifically ablated somatostatin-expressing delta cells using diphtheria toxin. Our results show that delta cell ablation in mice leads to an immediate drop in basal glucose levels. Furthermore, mice with ablated delta cells also exhibit lower fasting glucose levels and increased glucose tolerance than their non-ablated littermates, with a more pronounced effect in males. We have also conducted continuous glucose monitoring experiments that provide further evidence that ablating delta cells leads to a lower glycemic set point. Similar experiments conducted in mice whose alpha cells were ablated did not result in a similar change in basal blood glucose levels. These data establish that pancreatic delta cells play a role in controlling the glycemic set point, likely through paracrine somatostatin signaling to beta cells.

6. Yixing Lu

CUSTOMIZABLE FUTURE SUPPLEMENTS: MATRIX EFFECT ON BIOACCESSIBILITY OF ENCAPSULATED MICRONUTRIENTS

Presenter: Yixing Lu
Authors: Yixing Lu, Rewa Rai, Nitin Nitin
Graduate Group: Food Science
Preceptor: Nitin Nitin

Health-promoting functions of plant-derived micronutrients depend on their spatio-temporal bioaccessibility during digestion, which can be affected by microstructures of the delivery matrices. Fundamental understanding of the matrix effect on bioaccessibility of micronutrients significantly influences the design of food and nutraceutical products. The goal of this study was to investigate the effect of structural complexity of delivery matrices on the release profile of an encapsulated bioactive compound (curcumin) using engineered cellular microstructures. In this study, engineered cell microstructures were constructed using a bottom-up approach to evaluate the effect of cell clustering and extracellular matrix on bioaccessibility of curcumin. The initial “building blocks” were single yeast cells as encapsulation carriers for curcumin. An increasing structural complexity was achieved by forming cell clusters, followed by addition of an extracellular alginate film. To form cell clusters, yeast cells were coated using oppositely charged polyelectrolytes through layer-by-layer deposition, and aggregated through electrostatic interaction. The cell clusters were then encapsulated in a thin layer of calcium-crosslinked alginate film. Curcumin release was measured during in vitro and in vivo digestion. Cell clusters obtained using electrostatic aided clustering of individual cells could maintain their structural stability during in vitro simulated digestion, but partially dissociate in vivo. Consistently, cell clustering on its own did not change the release profile of encapsulated curcumin compared to individual cells. The addition of extracellular alginate matrix significantly ($p<0.05$) increased the retention of curcumin for both single and clustered cells. Moreover, within the extracellular alginate film,

significantly ($p<0.05$) lower curcumin release was observed for clustered cells compared with single cells, indicating an interacting effect between cell clustering and addition of extracellular alginate film. This study adopted a novel bottom-up approach to understand the relationship between bioaccessibility of nutrients and the microstructures of delivery matrices. It clarified the direction and established a versatile platform for future development of customizable functional foods with improved controlled-release performance.

7. Korn Macharoen

EFFECTS OF KIFUNENSINE ON PRODUCTION AND N-GLYCOSYLATION OF A RECOMBINANT GLYCOPROTEIN IN A TRANSGENIC RICE CELL SUSPENSION CULTURE: A BIOREACTOR CASE STUDY

Presenter: Korn Macharoen
Authors: Kantharakorn Macharoen, Qiongyu Li, Veronica A. Márquez-Escobar, Jasmine M. Corbin, Carlito B. Lebrilla, Somen Nandi and Karen A. McDonald
Graduate Group: Chemical Engineering
Preceptor: Karen McDonald

For many therapeutic proteins, N-glycosylation is essential for protein folding, oligomerization, quality control, enzyme activity, ligand interactions, localization, and trafficking1,2. The production and N-glycosylation of recombinant human butyrylcholinesterase (BChE), a model glycoprotein and potent bioscavenger of organophosphate nerve agents and pesticides, was studied in a transgenic rice cell suspension culture (5L bioreactor) treated with kifunensine, a strong α-mannosidase I inhibitor. The media exchange was performed at day 7 of cultivation by removing spent sugar (S) rich media (N6 macronutrients3 and B5 micronutrients4; NB+S) and adding fresh sugar free (NB-S) media to induce the rice α-amylase 3D (RAmy3D) promoter to produce rice recombinant human BChE (rrBChE). Using a 1.25X concentrated sugar free medium together with 1.25X reduced working volume during the media exchange lead to a total active rrBChE production level of 79 ± 2 µg g FW-1 or 7.5 ± 0.4 mg L-1 in the presence of kifunensine, which is 1.5-times higher than our previous bioreactor runs using normal sugar-free medium with no kifunensine treatment. Importantly, the amount of secreted active rrBChE in culture medium was enhanced in the presence of kifunensine to 44% of total active rrBChE at day 5 post-induction. Coomassie stained SDS-PAGE gel and Western blot analyses reveal different electrophoretic migration of purified rrBChE bands with and without kifunensine treatment due to different N-glycoform. N-glycosylation analysis shows substantial increase of oligomannose glycans (Man5/6/7/8) in rrBChE

treated with kifunensine compared to controls. However, mass transfer limitation of kifunensine within the cell aggregates and cell wall/membrane is likely the major reason for incomplete inhibition of α-mannosidase I in this bioreactor study.

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2. Ruiz-May, E., Kim, S. J., Brandizzi, F. & Rose, J. The Secreted Plant N-Glycoproteome and Associated Secretory Pathways. *Front. Plant Sci.* **3**, 117 (2012).
3. Chih-Ching, C. *et al.* Establishment of an efficient medium for anther culture of rice comparative experiments on the nitrogen sources. *Sci. Sin.* **18**, 659–668 (1975).
4. Gamborg, O. L., Miller, R. A. & Ojima, K. Nutrient requirements of suspension cultures of soybean root cells. *Exp. Cell Res.* **50**, 151–158 (1968).

8. Bianca Yaghoobi

PCBS, THE FOREVER CHEMICALS

Presenter: Bianca Yaghoobi
Authors: Bianca Yaghoobi, Galen W. Miller, Erika B. Holland, Xueshu Li, Danielle Harvey, Shuyang Li, Hans-Joachim Lehmler, Pamela J. Lein
Graduate Group: Pharmacology & Toxicology
Preceptor: Pamela Lein

Despite being banned since the late 1970s, PCBs continue to pose significant risk to the developing nervous system. Early life stage (in utero or during infancy) exposure to PCBs is associated with increased risk of neuropsychiatric disorders. A common neuropathologic feature of these disorders is altered patterns of dendritic arborization in central neurons, and we have previously demonstrated that non-dioxin-like (NDL) PCB congeners alter dendritic arborization in the developing mammalian brain via sensitization of ryanodine receptors (RyR). Structure activity relationships (SAR) of RyR sensitization by PCBs (both NDL and dioxin-like congeners) have been determined using tissues from not only mammalian tissues but also rainbow trout (Oncorhynchus mykiss) muscle tissue. However, whether this SAR translates to developmental neurotoxicity (DNT) of PCBs in vivo has yet to be tested. To address this gap, we are evaluating the DNT of PCBs 28, 66, 84, 95, 138, and 153 in the zebrafish model. We first confirmed that these PCB congeners exhibited differing RyR activity in zebrafish muscle ranging from negligible (PCB 66) to moderate (PCB 153) to high (PCB 95) activity. We then tested the effects of static embryonic exposure to each of these PCB congeners on photomotor behavior. Enzymatically dechorionated embryos were exposed to varying concentrations (0.1–10 μM) of these six congeners from 6 to 120 h post-fertilization (hpf). Embryos were observed daily by stereomicroscope for mortality and gross malformations and behavioral assessments were conducted at 72, 96, and 120 hpf. The body burden of each PCB was measured by gas chromatography. At the concentrations tested, none of these PCBs caused death or overt teratology. A subset of these PCB congeners altered photomotor behavior in larval zebrafish, and the SAR for PCB behavioral effects mirrored the SAR for RyR sensitization. Quantification of PCB levels in larval zebrafish ruled out the possibility that

congener-specific effects on behavior were due to differential uptake of PCB congeners. These data support the hypothesis that RyR sensitization contributes to the in vivo DNT of PCBs. This work was supported by the NIEHS (grants ES014901 and ES011269).

9. Marwa Zafarullah

LONGITUDINAL METABOLIC PROFILING REVEALS POTENTIAL BIOMARKERS AND DYSREGULATED LIPID METABOLISM ASSOCIATED WITH THE DEVELOPMENT AND PROGRESSION OF FRAGILE X-ASSOCIATED TREMOR/ATAXIA SYNDROME (FXTAS)

Presenter: Marwa Zafarullah
Authors: Marwa Zafarullah, Susan M. Rivera, David Hess, and Flora Tassone
Graduate Group: Integrative Genetics and Genomics
Preceptor: Flora Tassone

C Fragile X-associated tremor/ataxia syndrome (FXTAS) is a neurodegenerative disorder associated with the FMR1 premutation. Much remains unknown regarding when and if individual carriers of a premutation allele will develop FXTAS, as clinical assessment fails to identify carriers at risk before significant neurological symptoms are evident. Metabolomic alterations have been minimally investigated in FXTAS, and importantly, to date, there have been no studies investigating potential metabolic changes over time that may be associated with the development of FXTAS. Thus, with the aim of identifying biomarkers for early diagnosis, disease development, and progression of FXTAS, we performed global metabolomic profiling of age-matched healthy controls, and premutation allele carriers enrolled in the first ongoing longitudinal study of premutation carriers who enter the study before exhibiting any FXTAS symptoms. In the last 7 years of the study, two distinct categories of participants have emerged: those who developed the symptoms of FXATS at subsequent visits (converters) compared to those who did not (non-converters). Using a combination of ultra-performance liquid chromatography, Q-Exactive high resolution/accurate mass spectrometer interfaced with heated electrospray ionization, and an Orbitrap mass analyzer, we identified 47 metabolites that demonstrated significant dysregulation between healthy controls and the premutation group including both converters and non-converters at Visit 1 and Visit 2. To identify key metabolic changes between converters and non-converters we performed pairwise comparisons of an analysis of variance (ANOVA) and identified 24 metabolites that showed significant changes in

expression ($P < 0.05$) in the converters as compared to the non-converters both at Visit 1 and Visit 2 suggesting their potential role as biomarkers for early diagnosis of FXTAS. Further, we found an additional 70 metabolites that were significantly different ($P < 0.05$) in converters as compared to non-converters only at Visit 2, indicating their role as biomarkers for FXTAS disease progression. Interestingly, the majority of the identified metabolites were lipids (including subcategories of ceramides, diacylglycerol, endocannabinoid, acyl carnitines, long-chain monounsaturated, polyunsaturated and saturated fatty acid, phospholipids and sphingolipids) followed by amino acids, xenobiotics, peptide, and carbohydrates. Lipids alteration has been associated with various neurodegenerative disorders, including Alzheimer's, Dementia, Parkinsonism, Multiple Sclerosis, and Huntington disease. Our findings indicate that lipid metabolism is also significantly altered in FXTAS, and more importantly, reporting the metabolic biomarkers of early diagnosis and progression of FXTAS. These results highlight the need to further investigate these identified metabolites in clinical setup for developing the much-needed targeted therapeutics for the treatment of patients with FXTAS.

10. Angela Zhang

MICROBIAL PRODUCTION OF HUMAN BREAST MILK SUGARS

Presenter: Angela Zhang
Authors: Angela Zhang
Graduate Group: Chemistry
Preceptor: Shota Atsumi

Human milk oligosaccharides (HMOSs) serve as diverse health modulators for newborn infants that affect gut microbiota, neural development, and immune response. Variation in environmental factors and the genetics of the mother affects the assortment of fucosyllated HMOS a newborn receives. Due to the difficulty in chemically synthesizing oligosaccharides and the high cost of supplementing energy cofactors in in-vitro one-pot multienzyme reaction systems, we are engineering Escherichia coli as a microbial production platform for the sustainable synthesis of fucosyllated HMOSs, 2'-fucosyllactose and lactodifucotetraose. The increased accessibility towards HMOS will help advance biological studies probing additional health benefits of these bioactive compounds and guide nutritional supplementation in commercial infant formula.

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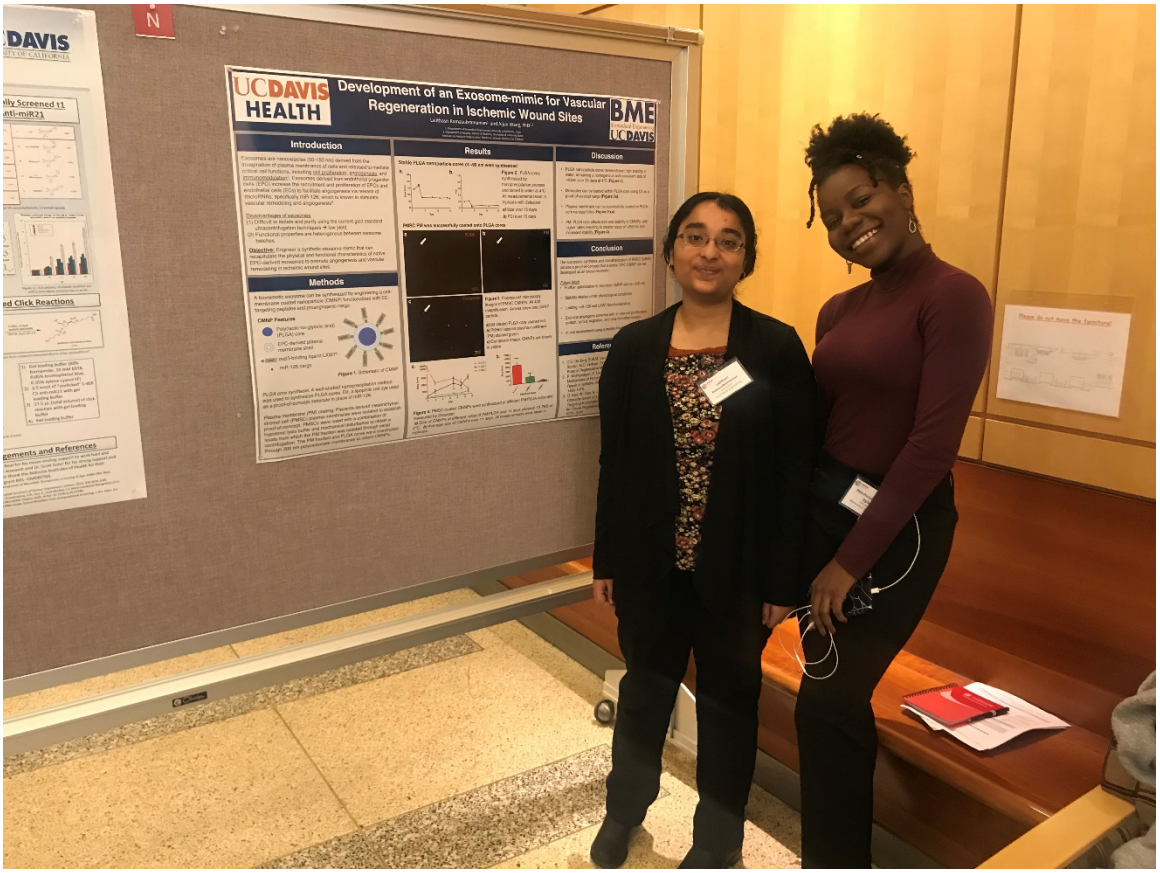
Poster Abstracts



A. Photoinduced 4-Vinylpyridine Graft on Cellulose Nanofibrous Membranes for Height Performance Lysozyme Adsorption

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Photo: Noha Amaly
Graduate Group: Biological and Agricultural Engineering
Preceptor: Gang Sun

Fabrication of membrane with elevated binding capacity and high throughput is highly desired for simplifying and improving purification efficiencies of bioproducts and biopharmaceutical industries. In this work, cellulose NF with average diameter 300 nm were successfully fabricated by electrospinning of 10 % cellulose-acetate from (1:1) acetone/N,N-dimethylacetamide followed by saponification to obtain regenerated cellulose nanofiber (RC-NFM). The obtained cellulose nanofiber functionalized by effective UV-photoinitiation grafting of 4-vinylpyridiene (VP). RC-VP NFMs were decorated with Cu (II) chelated to pyridine rings for highly selective lysozyme separation. Benefiting from these numerous chelated metal binding sites and inherent large surface area and open porous structure, RC-VP-Cu(II) nanofiber showed a lysozyme static adsorption capacity of800 mg g -1 . The lysozyme adsorption capacity remained consistent during six repeated cycles of adsorption−elution operations with reduction of 5 % of its original adsorption efficiency. Dynamic binding efficiency of 700 mg g -1 can be achieved driven solely by the gravity of protein solution. Significantly, the successful synthesis of such intriguing and economic RC-VP-Cu (II) NFM may provide a promising candidate for the next generation of protein adsorbents for rapid, massive, and cost-effective separation and purification of proteins.

Key words: Regenerated cellulose, lysozyme, photoinitiated grafting, immobilized metal affinity nanofiber membrane, selectivity

B. The Role of Nicotinic Receptors in Seizure Activity and Death Triggered by Acute Organophosphate Intoxication in a Mouse Model

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Photo: JJ Calsbeek
Graduate Group: Molecular Biosciences
Preceptor: PJ Lein

Organophosphate (OP) nerve agents and pesticides can cause status epilepticus(SE) and death by inhibiting acetylcholinesterase (AChE). Excessive accumulation of acetylcholine (ACh) at central and peripheral synapses induces a cholinergic crisis as a consequence of overstimulation of nicotinic and muscarinic receptors. The current standard of care for OP intoxication includes atropine to block muscarinic receptors, pralidoxime to regenerate active AChE, and benzodiazepine to terminate seizures. While this medical countermeasure can prevent mortality, survivors often exhibit persistent neuropathology and electrographic abnormalities. It has been posited that the limited efficacy in preventing long-term effects is due to the fact that the current therapeutic approaches do not target nicotinic receptors. To test this hypothesis, we assessed the efficacy of the non-selective nicotinic receptor antagonist, mecamylamine (MEC,) as a potential anticonvulsant in a mouse model of acute intoxication with diisopropylfluorophosphate (DFP). Adult male C56BL6/J mice were pre-treated with MEC (0.5-9.5 mg/kg, s.c.) or an equal volume (80-100 µl) of saline vehicle (VEH, s.c.) 10 min prior to administration of DFP (12.7 mg/kg, s.c.), followed one min later with intramuscular atropine (0.1 mg/kg) and pralidoxime (25 mg/kg). Their seizure behavior was monitored for 4 h and seizure severity was scored using a modified Racine scale. MEC pretreatment dose-dependently reduced or prevented DFP-induced seizure behavior relative to vehicle controls. Post-exposure administration of MEC 10 min after DFP injection also significantly reduced DFP-induced seizure behavior within minutes. These findings suggest a necessary role for nicotinic receptors in DFP-induced seizure activity. These observations identify nicotinic receptors as potential therapeutic targets, and support further investigation to identify which receptor subtypes are important in this phenomenon. This work was supported by the NINDS CounterACT Program (grant # U54 NS079202), the Department of Veterans Affairs VR&E Program, and a predoctoral fellowship from the UC Davis School of Veterinary Medicine 2019-2020 Graduate Student Support Program (GSSP).

C. Excision of Oxidatively Damaged Bases in G-Quadruplexes by the DNA Glycosylases NEIL1 and NEIL3

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Photo: Savannah G. Conlon
Graduate Group: Chemistry
Preceptor: Sheila S. David

Environmental toxins, endogenous metabolic products, and ionizing radiation can directly modify DNA or indirectly damage DNA through the generation of reactive oxygen and nitrogen species (RONS). This DNA damage arises at a rate of thousands per day compromising the integrity of the genome. The endonuclease VIII-like (NEIL) family of DNA repair glycosylases initiate repair of the damage produced by RONS. They exhibit particularly high activity toward the removal of hyperoxidized products of guanine, such as the guanidino-and spiriminodi-hydantoins (Gh and Sp), which mediate G-to-T and G-to-C transversion mutations and replication blocks. The NEIL family is also capable of excising these lesions from a variety of DNA contexts, such as duplex, single-stranded, bubble, and bulge DNA; notably, NEIL1 and NEIL3 both have the unique ability to excise Gh and Sp from G-quadruplex (G4) DNA. Due to the location of these G4 DNA structures in various oncogene and repair enzyme promoter regions, understanding how NEIL processes damaged bases in a G4 context can provide insight into the unique roles of NEIL beyond genome maintenance. We have conducted a thorough kinetic and binding affinity analysis of the repair of Gh lesions from different G4 sequences by NEIL1 and NEIL3. Specifically, under single turnover conditions, the removal of Gh by NEIL was examined in G4 sequences from the VEGF, KRAS, and RAD17promoter regions. Interestingly, the observed production curves for NEIL-catalyzed base removal are biphasic, indicating that the substrate is processed at two distinct rates, and this is highly dependent on the sequence and location of Gh within the G4. Our most striking observation indicates that a significant amount of substrate remains unprocessed despite enzyme being present in excess. This suggests that the G4 structure makes an impact on the overall extent of Gh removal. Binding studies suggest that NEIL may be binding in an unproductive manner that does not support Gh excision. Our results showcase the interaction of NEIL with G4s and provide insight into a possible dynamic relationship between the NEIL family of enzymes, DNA repair, and gene regulation.

D. Portable Electrochemical Aptasensor based-on Functionalized Cellulose Nanofibers for In-situ Detection of Mycotoxins in Foods

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Photo: Ahmed Y. El-Moghazy
Graduate Group: Biological and Agricultural Engineering
Preceptor: Gang Sun

An ultrasensitive electrochemical aptamer-based-sensor was developed for Ochratoxin A (OTA) detection in cold brew coffee. The fabrication of the aptasensor was based on the silanized cellulose nanofibrous membranes as a supporting matrix for methylene blue(MB) redox probe labeled aptamer tethering. Cellulose nanofibrous membranes were produced by deacetylating of electrospun cellulose acetate nanofibrous membranes with a deacetylation efficacy of 97%, followed by silanization of the nanofibers surfaces by using 3-aminopropyl triethoxysilane (APTES). The impacts of fabrication steps on performance of the fabricated nanofiber-based-sensors were investigated by using electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV). The use of the nanofibrous membranes increased the active surface area on the working electrode of a screen-printed three-electrode sensor by more than two times, compared to a casted membrane, consequently enhanced the performance of the fabricated aptasensor. The developed aptasensor demonstrated high sensitivity and selectivity toward OTA in a range of 0.002-2 ng mL-1, with a detection limit of 0.81 pg mL-1. Moreover, the assembled aptamer-based-sensor successfully detected OTA in cold brew coffee samples directly without any pretreatment.

E. Entrapment of Photoactive Membrane Protein in Mesporous Silica Gels Using Lipid Nanoparticles

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Photo: Sukriti Gakhar
Graduate Group: Chemical Engineering
Preceptor: Marjorie L. Longo

Integral membrane proteins (IMPs) are an important class of proteins and constitute of more than 40% of small-molecule drug targets. Sol-gel derived silica has been used to encapsulate functional water-soluble proteins leading to development of biosensors, affinity chromatography columns and other novel biomaterials. Immobilization of functional IMPs can lead to development of high throughput drug screening devices. However, since membrane-bound proteins require lipophilic membrane structures to retain their structure and function, their encapsulation usually requires a lipid bilayer structure to be incorporated in the nanometer-sized pores. Previous studies used liposomes for protein reconstitution but found that there was membrane rupture upon encapsulation in silica gels. In this work, we encapsulate Bacteriorhodopsin (BR), a photoactive membrane protein, in silica gel monoliths in its native membrane and in lipid bilayer nanoparticles. Lipid nanoparticles were synthesized using DMPC phospholipid and amphipathic styrene-maleicacid (SMA) copolymer. PM was solubilized using DMPC/SMA mixture leading to monomerization of the native trimeric BR. Dynamic light scattering showed that the BR/DMPC/SMA nanoparticles were 10.2 ± 0.7 nm in diameter. For both membrane environments, the protein retained its bound retinal as observed via UV-vis absorbance. Thermal unfolding of the protein was investigated, and it was shown that the processing conditions of silica gel had an impact on protein stability at higher temperatures. Fluorescence and absorbance spectroscopic techniques were utilized to conclude that the retinal could dissociate from the protein structure at high temperature in both systems, however, this ejection was only accompanied by the denaturing of the protein for monomeric BR in the BR/DMPC/SMA nanoparticles.

G. Effect of Natural Genetic Variations at Incretin Receptor on Glucose Homeostasis

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Photo: Anirudh Gaurl
Graduate Group: Neuroscience
Preceptor: Jennifer L. Whistler

Glucose homeostasis is critical for human health, and is maintained by the combined action of insulin and glucagon hormone. The amount of insulin secreted after eating is also regulated by incretin gut hormones (IncretinEffect): Glucagon-like peptide-1 (GLP-1) and Glucose-dependent insulinotropic polypeptide (GIP) that stimulate insulin release from beta cells by their action on their cognate G protein-coupled receptors (GPCRs) GLP-1R and GIP-R. Due to their insulinotropic effect, incretin receptor agonists are used as therapeutic agents to maintain glucose homeostasis in type-2 diabetes. Genetic variations in the incretin receptor (R131Q/G168SGLP-1R) are known to alter insulin secretion in humans. Preliminary data from our lab show that these variations do not affect the affinity or the efficacy of GLP-1at their cognate receptor. Taken together, these findings highlight a pharmacological "mystery" as to how the genetic variations in incretin receptor can affect the ability of incretins to stimulate beta cells. This study aims to examine the effect of genetic variations in the incretin receptors on their endocytic/post endocytic trafficking and how it affects incretin response in pancreatic beta cells.HEK-293 cells stably expressing snap-tagged-wild type, R131Q and G168S GLP-1R were used to measure receptor endocytosis/sorting usingcell surface biotinylation protection/degradation assay. Preliminary data show that the G168S variant promotes receptor degradation while theR131Q variant promotes receptor recycling post endocytosis, thus supporting the hypothesis that genetic variation in GLP-1R alters their endocytic/post-endocytic sorting leading to differential incretin response in beta cells. Additionally, our lab is also interested in determining the factors that play crucial role in post-endocytic sorting of GLP-1R. GASP-1 is a GPCR sorting protein that is important forlysosomal degradation of GPCRs. To examine the role of GASP-1 in post-endocytic sorting of incretin receptors GASP-1 knock out pancreatic beta INS-1 cells were generated and used to determine cAMP accumulation and insulin release upon acute and prolonged agonist treatment. The concentration of cAMP and the amount of insulin release in wild type INS-1 cells significantly increased with the

addition of agonist compared to glucose only validating the insulinotropic effect of incretin hormones on beta cells. However, after prolonged treatment of INS-1 cells with agonist, there was no significant difference in cAMP concentration and insulin release between two treatment groups suggesting prolonged agonist exposure results in loss of responsiveness of the receptor. Interestingly, cAMP accumulation assay and insulin release using GASP1 KO INS-1 cells shows an increase in cAMP levels, insulin release and the preservation of incretin effect even after prolonged agonist treatment. The preliminary results obtained suggest GASP-1 may regulate the degradation of incretin receptors after endocytosis causing decrease in receptor number on the surface of cells that lead to loss of incretin effect in INS-1 cells.

G. Functionalized Polymer-Graphene Fixed Target Substrates for High-Throughput, Hydrated Serial Femtosecond Crystallography Using X-Ray Free Electron Lasers (XFELS)

Deepshika Gilbile[1]*, Megan L Shelby[2], Brent Segelke[2], Thomas Grant[3], Mark S Hunter[4], Alke Meents[5], Matthew A Coleman[1,2], Matthias Frank[1,2], and Tonya L Kuhl[1]

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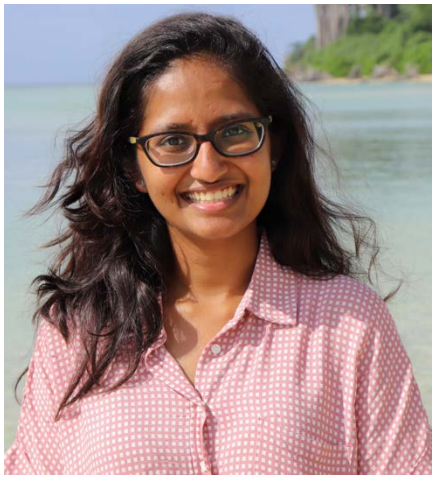

Photo: Deepshika Gilbile
Graduate Group: Chemical Engineering
Preceptor: Tonya L Kuhl

Fixed target sample delivery is an exciting alternative to widely used liquid-jet based technologies for structural biological using serial crystallography atXFELs. This technique offering advantages of low sample consumption, high hit rates, eliminating the danger of downtime due to clogging, and enabling rapid data collection. Some of the key challenges involved in fixed target delivery include optimization of microcrystal sample deposition and control of the sample environment during measurement, for example by maintaining sample hydration to obtain quality diffraction data, while minimizing added background from enclosing layers. While the use of single crystalline silicon or silicon nitride micropatterned chips with pipette-and-wick based deposition strategies have been demonstrated, the cost and fragility of the supports as well as sample loss from wicking remain challenging issues. This poster will focus on new strategies to address these issues through the development of robust, cost-effective and rapidly fabricated cyclic olefin copolymer (COC) based substrates in conjugation with tunable graphene-polymer support layers that provide long term sample hydration and protection in vacuum. The polymer films can be functionalized and UV-patterned to enable localized, surface-aided crystal growth on-chip to achieve optimal high hit-rates. These promising results pave the way for high-throughput data collection and open up opportunities for integrating microfluidics on chip towards protein dynamics studies.

H. A Primary Neural Cell Culture Model to Study Neuron, Astrocyte and Microglia Interactions in Neuroinflammation

Noah Goshi*[1], Rhianna Morgan[2], Pamela Lein[2], and Erkin Seker[3]
[1] Department of Biomedical Engineering, University of California, Davis
[2] Department of Molecular Biosciences, University of California, Davis
[3] Department of Electrical and Computer Engineering, University of California, Davis

Photo: Noah Goshi
Graduate Group: Biomedical Engineering
Preceptor: Erkin Seker

Interactions between neurons, astrocytes and microglia critically influence the neuroinflammatory response to insult or injury in the central nervous system. While in vitroastrocyte and microglia cultures are powerful tools to study specific molecular pathways involved in neuroinflammation, these culture models are incapable of capturing the impact of cellular crosstalk on the neuroinflammatory response. We have developed an enhanced cell culture model comprised of the three major cell types associated with neuroinflammation, neurons, astrocytes and microglia. Primary rat cortical cells were maintained in a serum-free, "tri-culture" media developed to support all three cell types. This tri-culture can be maintained for at least 14 days in vitro while retaining a physiologically-relevant representation of all three cell types. We compared the response of the tri-culture and an established neuroinflammatory model (neuron-astrocyte co-culture) to different neuroinflammatory stimuli mimicking sterile bacterial infection (lipopolysaccharide exposure), traumatic brain injury (mechanical trauma) and seizure activity (glutamate-induced excitotoxicity). In each instance the tri-culture more faithfully mimicked the in vivo neuroinflammatory response than the neuron-astrocyte co-culture. Furthermore, the tri-culture was able to capture both the neurotoxic and neuroprotective role of neuroinflammation under different circumstances. We hope that this tri-culture can be a useful tool to study neuroinflammation in vitro with improved accuracy in predicting in vivo neuroinflammatory phenomena.

I. Phase Coexistence in Hybrid Lipid/Block Copolymer Liposomes

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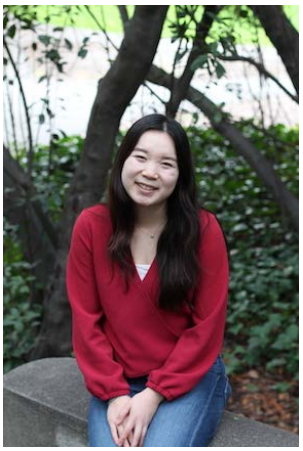

Photo: Naomi Hamada
Graduate Group: Chemical Engineering
Preceptor: Marjorie L. Longo

Hybrid biomembranes combining block copolymers and phospholipids haves shown potential promise in the areas of drug delivery and membrane protein reconstitution. The chemical diversity afforded by the inclusion of block copolymers is particularly relevant to the formation of stealth liposomes or stimulus-responsive membranes (e.g. pH-or thermo-responsive systems), which can aid in the control of drug retention and release. However, the phase behavior of these hybrid biomembranes has not been methodically explored. To this end, we have studied small (~100 nm) vesicles made of polybutadiene-block-polyethylene oxide (PBd-PEO) and dipalmitoylphosphatidylcholine (DPPC) using fluorescence spectroscopy techniques. The fluorescent probes diphenylhexatriene (DPH) and 6-dodecanoyl-2-dimethylaminonaphthalene (laurdan)provide information regarding membrane fluidity and polarity, both bulk properties related to membrane phase behavior, as functions of membrane composition and temperature. The efficiency of Förster resonance energy transfer(FRET) between fluorescent probes expected to prefer the lipid-or polymer-rich phase was also evaluated to investigate the existence of phase separation in nanoscale vesicles. These methods can be used to map the phase behavior of hybrid biomembranes as a function of temperature and composition, providing a more fundamental understanding of the phase states underlying observed behaviors of hybrid biomembranes and thus facilitating a more informed approach to their design.

J. Role of Pancreatic Delta Cells in Controlling the Glycemic Setpoint

Jessica L Huang*, Mark O. Huising
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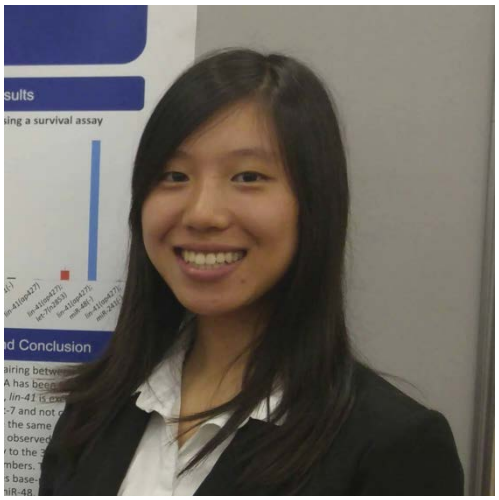

Photo: Jessica L Huang
Graduate Group: Neurobiology, Physiology & Behavior
Preceptor: Mark O. Huising

Beta cells play a critical role in blood glucose homeostasis, as they are our sole source of insulin. While insufficient insulin secretion contributes to diabetes, too much insulin can lead to hypoglycemia and potentially be fatal. This illustrates the importance of negative feedback on βcell activity. Our lab has demonstrated that βcells co-secrete the peptide hormone Urocortin 3 (Ucn3) with insulin. Ucn3 then goes on to stimulate somatostatin secretion from delta cells, creating a negative feedback loop that is critical for the attenuation of insulin secretion. However, the full physiological relevance of this feedback inhibition is not well defined. Our lab has demonstrated that expressing Ucn3 in βcells directly causes an increase in basal glucose levels, likely by triggering somatostatin secretion from delta cells to create a negative feedback loop that attenuates insulin secretion. Therefore, we hypothesized that pancreatic delta cell secretion of somatostatin plays an important role in establishing the glycemic set point through control of βcell activity. To address this hypothesis, we specifically ablated somatostatin-expressing delta cells using diphtheria toxin. Our results show that delta cell ablation in mice leads to an immediate drop in basal glucose levels. Furthermore, mice with ablated delta cells also exhibit lower fasting glucose levels and increased glucose tolerance than their non-ablated littermates, with a more pronounced effect in males. We have also conducted continuous glucose monitoring experiments that provide further evidence that ablating delta cells leads to a lower glycemic set point. Similar experiments conducted in mice whose alpha cells were ablated did not result in a similar change in basal blood glucose levels. These data establish that pancreatic delta cells play a role in controlling the glycemic set point, likely through paracrine somatostatin signaling to beta cells.

K. DNA Glycosylase NEIL1 Demonstrates Lesion Specificity from RNA Editing

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Photo: Elizabeth R. Lotsof
Graduate Group: Chemistry
Preceptor: Sheila S. David

Environmental toxins and toxicants can produce conditions of oxidative stress resulting in the formation of reactive oxygen and nitrogen species (RONS). The presence of RONS causes the oxidation of all four conical bases creating a diverse number of DNA lesions including: thymine glycol (Tg), 5-hydroxycytosine (5-OHC), 5-hydroxyuracil (5-OHU), dihydrothymine (DHT), the formamidopyridines (FapyA and FapyG), guanidinohydantoin (Gh), and spiriminodihydatoin (Sp). These DNA damaging modifications can alter coding and proper cellular function. The DNA glycosylase, NEIL1, is able to excise all of these lesions from several DNA contexts. Additionally, the pre-mRNA of NEIL1 is subject to modification by the Adenosine Deaminase Acting on RNA (ADAR1) that leads to a recoding event that converts a lysine to arginine in the lesion recognition loop of NEIL1. This leads to the presence of two isoforms of NEIL1 under different cellular conditions. Notably, the two isoforms display different enzymatic properties on Tg, where the unedited (K242) isoform showed a significantly faster rate of excision compared to edited NEIL1 (R242). We have performed detailed examinations of lesion processing by the two NEIL1 isoforms on a large number of substrates and many interesting trends have emerged. In general, unedited NEIL1 demonstrates better excision of oxidized pyrimidines than the edited isoform. The impact of RNA editing on NEIL1 activity suggests a unique regulatory mechanism for DNA repair. Aberrant editing by ADAR1 can disrupt the NEIL1balance and maybe one of the factors for the observed cancer phenotype observed with ADAR1 hyper editing. The preferences of two isoforms suggests that a proper balance of edited and unedited NEIL1 is needed for efficient DNA repair and maintenance of the genome.

L. Structure-Activity Relationships Guided Studies for OG:A Lesion Recognition and Repair by the Base Excision Glycosylase MutY

Chandrima Majumdar[1]*, Robert Van Ostrand[1], Andrea J. Lee[2], Amelia H. Manlove[1], Paige L. McKibbin[1], Michelle L. Hamm[3], Sheila S. David[1]

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Photo: Chandrima Majumdar
Graduate Group: Chemistry
Preceptor: Sheila S. David

Reactive oxygen species (ROS) in cells can lead to the oxidation of the DNA base guanine (G) to 8-oxo-7,8-dihydroguanine (OG). This oxidative product has the ability to aberrantly code like a thymine (T), leading to the conversion of G:C base pairs to OG:A mis-pairs and then further to T:A base pairs. Although the OG:A pair thus formed is structurally almost identical to an undamaged T:A base pair, the base excision repair (BER) glycosylase, MutY is proficient at locating these lesions within the genome and catalyzing the removal of the mis-paired adenine. This step triggers a cascade of reactions by downstream repair enzymes that ultimately result in the reinstatement of the original G:C base pair. The crucial role of MutY in this pathway is highlighted by the correlation between functionally deficient variants of the human homolog, MUTYH, and a colorectal cancer predisposition syndrome called MUTYHassociated polyposis (MAP). We seek to understand the structural basis by which MutY identifies the OG:Alesion and distinguishes it from a normal, T:A using structure-activity relationships (SAR). Through the incorporation of substrate analogs of OG and A into DNA duplexes, and amino acid mutations to the enzyme, we evaluate the effects of modified steric, electronic and base pairing properties on in vitroparameters such as binding and kinetics of base cleavage, as well as on overall repair in a bacteria. In addition to SAR, single molecule -TIRF experiments reveal key recognition features employed by MutY to identify OG:A lesions. These studies also reveal that catalytically competent, but recognition deficient variants of MutY are unable to carry out repair, and suggest that corresponding variants in MUTYH may be associated with cancer. Furthermore, the SAR can help guide the design and development of MutY/MUTYH inhibitors that may find applications as cancer therapeutics.

M. ELECTRICAL-BIOLOGICAL HYBRID SYSTEM FOR CO2 REDUCTION IN ESCHERICHIA COLI

Morgan Matson*, Tanner Treece, and Shota Atsumi
Department of Chemistry, University of California, Davis, CA, 95616

Photo: Morgan Matson
Graduate Group: Chemistry
Preceptor: Shota Atsumi

We have developed an electrochemical-biological hybrid system to fix CO2. Natural biological CO2fixation processes are relatively slow. To improve the efficiency of fixation we applied electrocatalysts to reduce CO2to formate. We chose a user-friendly organism, Escherichia coli, as host. Overall, the newly constructed CO2and formate fixation pathway converts two formate and one CO2to one pyruvate via glycine and L-serine in E. coli. First, one formate and one CO2are converted to one glycine. Second, L-serine is produced from one glycine and one formate. Lastly, L-serine is converted to pyruvate. E. coli's genetic tractability allowed us to balance various parameters of the pathway. The carbon flux of the pathway was sufficient to compensate L-serine auxotrophy in the strain. Further strain improvement is focused on integrating the pathway into the genome and generating libraries using CRISPR with growth-dependent screens to select for beneficial candidates. In summary, we integrated both electrocatalysis and biological systems into a single pot to support E. coli growth with CO2and electricity. Results show promise for using this hybrid system for chemical production from CO2and electricity.

N. Adaptation of *Escherichia coli* to Antiseptics and Disinfectants

Beatriz Merchel Piovesan Pereira[1,2*], Xiaokang Wang[2,3], Ilias Tagkopoulos[2,4]

[1]Microbiology Graduate Group, University of California, Davis, CA
[2]Genome Center, University of California, Davis, CA
[3]Biomedical Engineering Graduate Group, University of California, Davis, CA
[4]Department of Computer Science, University of California, Davis, CA

Photo: Beatriz Merchel Piovesan Pereira
Graduate Group: Microbiology Graduate Group
Preceptor: Ilias Tagkopoulos

Biocides are of widespread use across the globe, and frequently under-regulated. They are of fundamental importance to control and eliminate pathogens, especially at high-risk infectious environments, such as hospitals. However, the potential for bacterial adaptation to such chemicals is high due to sub-inhibitory exposure of the microbes as a result of product misuse, the presence of bacterial biofilms, and residual chemicals in the environment. Concomitantly, bacterial strains that have adapted to one chemical, such as an antiseptic or disinfectant, can develop cross-resistance to other chemicals, such as antibiotics, with direct implications to public health. We investigated how the bacterium Escherichia coli responds during short (30 minutes,or 12 hours) and long-term (25 days)exposure to sub-inhibitory concentrations of antiseptics and disinfectants. Ten biocides of widespread use were tested individually: chlorophene, povidone-iodine, benzalkonium chloride, chlorhexidine, hydrogen peroxide, ethanol, isopropanol, glutaraldehyde, peracetic acid, and sodium hypochlorite. Transcriptional profiling (RNAseq) after short-term exposure of E.coli to biocides revealed the upregulation of biofilm regulators and other stress-related mechanisms. The long-term adapted strains were evaluated for the cross-resistance to antibiotics and the ability to form biofilms. About half (17 out of 40) of the evolved strains exhibited cross-resistance to at least one medically relevant antibiotic, and of those, 13 had increased ability to form biofilms compared to the non-adapted strain. Finally, genome-wide sequencing of the evolved strains elucidated the genetic basis of bacterial resistance and cross-resistance mechanisms. Our results provide insights on the molecular mechanisms that specifically underpin biocide adaptation in bacteria, and their potential to accelerate the emergence of antibiotic resistance in general.

O. Defining Potential Mechanisms of Pellicle Darkening in Juglans regia (English Walnut)

Houston Saxe*, Timothy Butterfield, Bipin Balan, and Abhaya M. Dandekar
Department of Plant Sciences, University of California, Davis

Photo: Houston Saxe
Graduate Group: Plant Sciences
Preceptor: Abhaya M. Dandekar

The walnut pellicle or seed coat is highly physiologically active and stress-responsive tissue. Amongst other biomolecules, walnut pellicles express phenolic pigments that accumulate during development to protect the kernel/ zygotic tissues from disease, pests, and environmental stresses. The hue and color of the walnut pellicle is a crucial consumer quality characteristic with lighter color being more desirable than its darker counterpart. Consequently, darker pellicle color can result in substantially lower premiums paid to growers for their product. To define possible mechanisms leading to pellicle darkening, we compared one light (Chandler) versus three dark pellicle varieties (Gayle's Caramel, Great Pumpkin, and Vina) of walnut during three developmental time points that span the period when pellicle tissues naturally darken. Metabolomic and transcriptomic studies of the pellicle tissues coupled with supervised and unsupervised machine learning analyses identified several genes and metabolites that may be important for pellicle color development. The management of the gaseous hormone ethylene and the accumulation of oxidative free radicles appear to be critical features of the darkening process. 1-aminocyclopropane-1-carboxylate oxidase (ACCO), superoxide dismutase (SOD), L-ascorbate peroxidase (ASCPX), oxidized glutathione (GSSG), reduced glutathione (GSH), ascorbate, and dehydroascorbate were enriched in Chandler at various time-points. These data suggest that antioxidant defense may contribute to Chandler's light color and that the expression of these genes may be influenced by ethylene. ACCO has been shown to be the rate-limiting factor in the biosynthesis of ethylene, which is known to regulate a variety of stress responses. Furthermore, a synthetic ethylene-releasing growth regulator, ethephon, is used commercially to manipulate ethylene-mediated plant physiology and is currently being used on walnuts as a harvest aid. Two deliverables of this study include developing biomarkers for pellicle color and using these biomarkers to evaluate the potential for novel use of ethephon for pellicle color improvement in walnut orchards.

P. Development of Disease Resistant Almond Peach Hybrid Rootstocks through Cell Culture and Improvement through Genetic Transformation

Sriema L. Walawage[1*], Paulo A. Zaini[1], Abhaya M. Dandekar[1]
Cooperators: Thomas Gradziel[1], Charles Leslie[1], David Tricoli[1], Takao Kasuga[2,3], Greg Browne[2,1]
[1]Department of Plant Sciences, UC Davis
[2]USDA-Agricultural Research Service
[3]Department of Plant Pathology, UC Davis

Photo: Sriema L. Walawage
Graduate Group: Plant Sciences
Preceptor: Abhaya M. Dandekar

Almonds (Prunus dulcis) are California's #2 agricultural commodity, grown on ~870,000 acres with an annual production of two billion lbs valued at $5.9 billion (farm gate value). In many production areas, soil borne disease, pests and environmental problems besiege almond productivity and reduce profitability. Many of these problems can be addressed by grafting almond scion varieties to resistant rootstocks. Currently, growers use a peach-almond hybrid rootstock that has significantly improved almond productivity for the industry, but which also increases susceptibility to certain disease, pests and environmental stressors. Creating new hybrid rootstock varieties resistant to these ailments is a path forward and the focus of this investigation. A key objective of our study is to isolate and culture plant stem cells from these hybrid tissues and to develop cell and tissue culture systems to propagate individual hybrid seed sources, leading to the development of novel hybrid rootstocks for almond orchards in California. Prunus-almond hybrid seeds were obtained using parental materials that contain resistance traits of interest. Somatic embryogenesis system was developed using immature nuts of hybrids. Embryos were proliferated, shoots and roots were induced under in vitro conditions. Foreign gene transformability was tested in somatic embryos and confirmed with DSRed and GUS makers containing plasmids using Agrobacterium mediated transformation. Embryos were mass propagated using the RITA® temporary immersion system. Somatic embryos will be encapsulated in hydrogels (Alginate) to produce gel coated seeds.

Q. Development and Characterizations of a Plant-Recombinant Therapeutic for Bone Loss during Space Missions

Yongao (Mary) Xiong*, Dexter Antonio, Kevin Yates, Somen Nandi and Karen McDonald
Department of Chemical Engineering, University of California, Davis, CA

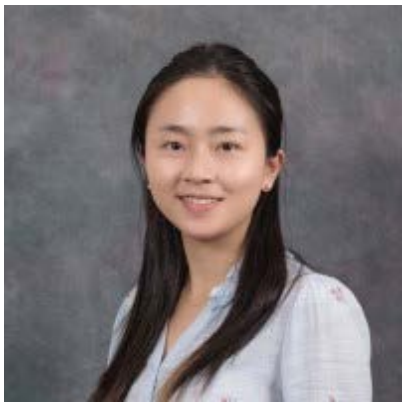

Photo: Mary Xiong
Graduate Group: Chemical Engineering
Preceptor: Karen McDonald

Microgravity-induced bone loss is a main obstacle for long term space missions. With a typically bone mineral density loss of 1.5 % per month of microgravity exposure, the chances for osteoporosis and fractures endanger astronauts' health especially during interplanetary explorations. Physical exercise as a countermeasure for bone loss is effective but cannot eliminate the problem completely. Bone regenerative therapeutics, such as Parathyroid hormone (PTH, 1-34) are FDA approved treatments for osteoporosis, have vast potential to reverse the microgravity induced bone loss that astronauts experience. However, PTH requires refrigeration, daily injection, and has a short shelf-life. These factors limit its use especially in a resource-limited environment, like space. To improve the stability and circulatory half-life of PTH, we have expressed PTH in a Fc-fusion form, PTH-Fc in lettuce Unlike most of other biologic production platforms, producing biologics in a transgenic plant requires only seeding and watering the resulting plants, a task that requires minimal resources. PTH-Fc expression in T1 generation of transgenic lettuce lines was confirmed using dot blotting, and work continues in selecting stable homozygous lines with the highest protein expression. Alternatively, a plant-based transient expression system through agroinfiltration was also investigated, allowing production of biologics for medication on demand. The binding kinetics between PTH-Fc and its target, PTH 1 receptor (PTH1R), were determined utilizing biolayer interferometry (BLI). The binding affinity between PTH-Fc and PTH1R was 1.25 μM, very close to the affinity between PTH and PTH1R (2.5μM). Its function was also confirmed in a cell-based assay, where PTH-Fc was able to stimulate the PTH1R producing cyclic adenosine monophosphate (cAMP) with an EC50of 0.67μM. These results indicate PTH-Fc has the potential to product a bone-anabolic effect similar to PTH therapy. The addition of the Fc domain allows for a longer circulatory half-life and avoids frequent redosing. Some studies have shown that the Fc domain increases the oral bioavailability of PTH-Fc, presenting a potential for oral drug delivery in unprocessed lettuce leaves. Plant based expression systems show promise for production of bone

regenerative compounds (PTH-Fc) and other medications for astronauts under resource limited environments.

R. RyR-ACTIVE POLYCHLORINATED BIPHENYLS (PCBs) CAUSE NEUROBEHAVIORAL DEFICITS IN LARVAL ZEBRAFISH

Bianca Yaghoobi*[1], Galen W. Miller[1], Erika B. Holland[4], Xueshu Li[2], Danielle Harvey[3], Shuyang Li[3], Hans-Joachim Lehmler[2], Pamela J. Lein[1]
[1]Department of Molecular Biosciences, University of California, Davis
[2]Department of Occupational and Environmental Health, University of Iowa, Iowa City, IA
[3]Department of Public Health Sciences, University of California, Davis
[4]Department of Biological Sciences, California State University of Long Beach

Photo: Bianca Yaghoobi
Graduate Group: Molecular Biosciences
Preceptor: Pamela J. Lein

Despite being banned since the late 1970s, PCBs continue to pose significant risk to the developing nervous system. Early life stage (in uteroor during infancy) exposure to PCBs is associated with increased risk of neuropsychiatric disorders. A common neuropathologic feature of these disorders is altered patterns of dendritic arborization in central neurons, and we have previously demonstrated that non-dioxin-like (NDL) PCB congeners alter dendritic arborization in the developing mammalian brain via sensitization of ryanodine receptors (RyR). Structure activity relationships (SAR) of RyR sensitization by PCBs (both NDL and dioxin-like congeners) have been determined using tissues from not only mammalian tissues but also rainbow trout (Oncorhynchus mykiss) muscle tissue. However, whether this SAR translates to developmental neurotoxicity (DNT) of PCBs in vivohas yet to be tested. To address this gap, we are evaluating the DNT of PCBs 28, 66, 84, 95, 138, and 153 in the zebrafish model. We first confirmed that these PCB congeners exhibited differing RyR activity in zebrafish muscle ranging from negligible (PCB66) to moderate (PCB 153) to high (PCB 95) activity. We then tested the effects of static embryonic exposure to each of these PCB congeners on photomotor behavior. Enzymatically dechorionated embryos were exposed to varying concentrations (0.1–10 μM) of these six congeners from 6 to 120 h post-fertilization (hpf). Embryos were observed daily by stereomicroscope for mortality and gross malformations and behavioral assessments were conducted at 72, 96, and 120 hpf. The body burden of each PCB was measured by gas chromatography. At the concentrations tested, none of these PCBs caused death or overt teratology. A subset of these PCB congeners altered photomotor behavior in larval zebrafish, and the SAR for PCB

behavioral effects mirrored the SAR for RyR sensitization. Quantification of PCB levels in larval zebrafish ruled out the possibility that congener-specific effects on behavior were due to differential uptake of PCB congeners. These data support the hypothesis that RyR sensitization contributes to the in vivo DNT of PCBs. This work was supported by the NIEHS (grants ES014901 and ES011269).

S. DEVELOPMENT OF A PLANT-MADE THERAPEUTIC TO TREAT SPACEFLIGHT OSTEOPENIA

Kevin Yates*[1,5], Yongao Xiong[1,5], Nancy E. Lane[2], Abhaya M. Dandekar[3], Karen A. McDonald[1,4,5], and Somen Nandi[1,4,5]

[1] Department of Chemical Engineering, University of California, Davis, CA
[2] Center for Musculoskeletal Health, University of California, Sacramento, CA
[3] Department of Plant Sciences, University of California, Davis, CA
[4] Global HealthShare® Initiative, University of California, Davis, CA
[5] Center for the Utilization of Biological Engineering in Space (CUBES), NASA Space Technology Research Institute (STRI)

Photo: Kevin Yates
Graduate Group: Chemical Engineering
Preceptor: Karen A. McDonald and Somen Nandi

Extended missions in a microgravity environment alter normal physiology in the human body. One critical issue in spaceflight is loss of bone mineral density. In the process of bone homeostasis, specialized cells facilitate bone remodeling with coupled bone resorption and formation. The reduced mechanical loading in microgravity causes resorption to outpace formation, which results in loss of bone mass. Medications such as parathyroid hormone (PTH) (1-34), a peptide fragment of naturally occurring human PTH, stimulates bone formation and may be able to restore bone mass in microgravity.. However, this requires a daily subcutaneous injection for a number of months, and in a limited resource environment, this is impractical. An alternative to transporting an injectable medication is to instead build capacity to produce it during the mission, which we propose to do in transgenic plants. We are producing transgenic lettuce which expresses a fusion protein consisting of PTH (1-34) linked with a fragment crystallizable (Fc) domain of human IgG1 via a flexible linker. The Fc region is intended to eliminate the injection requirement by increasing bioavailability via oral delivery. We constructed a binary vector for expression of this PTH-Fc protein and used it to produce two varieties of transgenic lettuce via Agrobacterium tumefaciens mediated transformation of wild type lettuce. From these T0plants, we have grown T1plants, and we are in the process of generating T2plants. We have successfully developed a PCR protocol to detect our gene of interest and are in the process of optimizing it. In parallel, we are developing a protein purification method, along with quantitative and functional assays for lettuce-made PTH-Fc.

Company Affiliates

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*Company Affiliates ** Support Biotech Training at UC Davis*

- **Agilent Technologies**
- **Amgen, Inc.**
- **Amyris, Inc.**
- **Bayer Crop Science****
- **Bayer HealthCare Pharmaceuticals, Inc.**
- **BioMarin Pharmaceutical, Inc.**
- **Celgene Corp.**
- **Cytokinetics**
- **Genencor (A Danisco Division)**
- **Genentech, Inc.****
- **Igenica**
- **Marrone Bio Innovations, Inc.**
- **Novartis AG**
- **Novozymes, Inc.****
- **Nunhems**
- **OncoMed Pharmaceuticals, Inc.**
- **Sutro Biopharma, Inc.**
- **Tethys Bioscience, Inc.**

****These Biotechnology companies have donated at least $20,000 per year for a Biotechnology fellowship, have offered an internship site for our DEB graduate students, and have presented at the annual Biotechnology Training Retreat. Company representatives also serve as advisors for training grants and other education programs.

The success of our biotech fellows depends on the continued support of our affiliates. The Biotechnology Program would like to thank them for their committed sponsorship.

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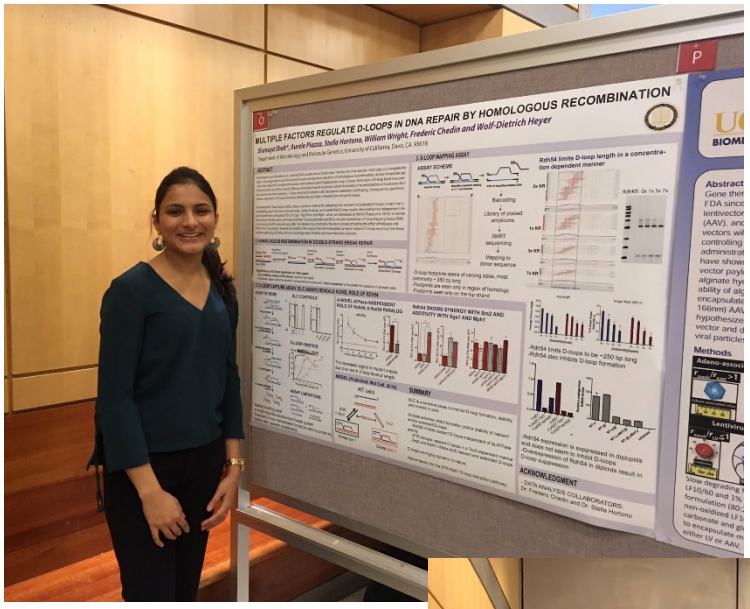
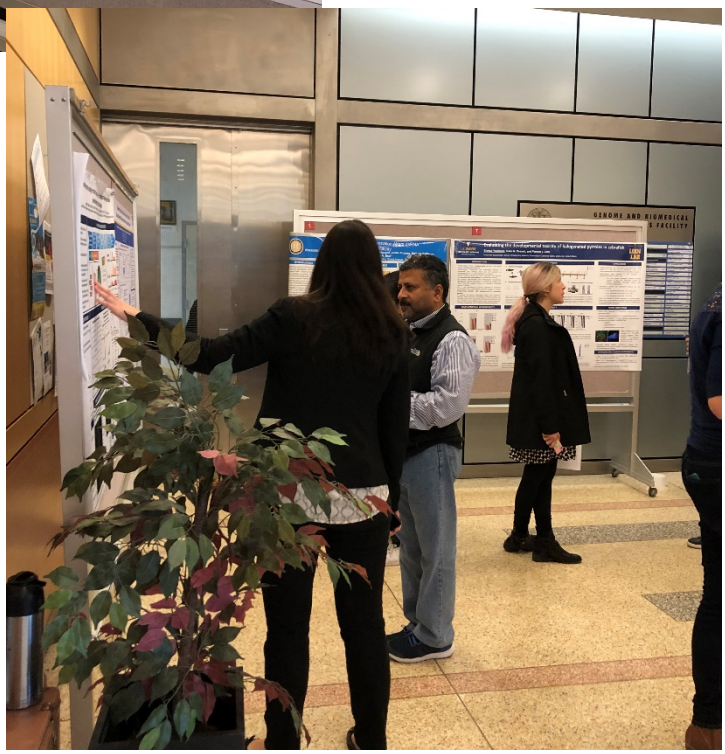
Biotechnology Program

Participants





Retreat Participants

Graduate Students	
Ismael Acedo	Grad Student, Integrative Genetics & Genomics
Nitin Beesabathuni	DEB Student, Chemical Engineering
Jonas Calsbeek	DEB Student, Pharmacology & Toxicology
Laney Casella	DEB Student, BMEGG
Angel Cobo	DEB Student, Chemistry
Savannah Conlon	DEB Student, Chemistry
Marcus Deloney	DEB Student, Biomedical Engineering
Noah Feinberg	DEB Student, Horticulture and Agronomy
Sukriti Gakhar	DEB Student, Chemical Engineering
Anirudh Gaur	DEB Student, BMCDB
Deepshika Gilbile	DEB Student, Chemical Engineering
Jake Gonzales	DEB Student, PBGG
Noah Goshi	DEB Student, Biomedical Engineering
Naomi Hamada	DEB Student, Chemical Engineering
Jessica Huang	DEB Student, BMCDB
Caroline Keller	DEB Student, PBGG
Yixing Lu	DEB Student, Food Science
Korn Macharoen	DEB Student, Chemical Engineering
Chandrima Majumdar	DEB Student, Chemistry
Morgan Matson	DEB Student, Chemistry
Matt McNulty	DEB Student, Chemical Engineering
Shiaki Minami	DEB Student, Chemical Engineering
Livingstone Nganga	DEB Student, Plant Biology
Tram Nguyen	DEB Student, Chemistry
Nkechi Chidi-Ogbolu	DEB Student, BMEGG
Sichong Peng	DEB Student, Integrative Genetics and Genomics
Beatriz Pereira	DEB Student, Microbiology
Amanda Agosto Ramos	DEB Student, Plant Biology
Niki Riazati	DEB Student, MCIP
Cintia Sagawa	DEB Student, Plant Biology
Muhammad Adil Salim	DEB Student, Microbiology
Houston Saxe	DEB Student, Horticulture and Agronomy
Shahin Shams	DEB Student, BMEGG
Jeannine Stroup	DEB Student, Microbiology
Tanner Treece	DEB Student, Chemistry
Mishi Vachev	DEB Student, Plant biology
Lei Wei	DEB Student, Microbiology
Mary Xiong	DEB Student, Chemical Engineering
Bianca Yaghoobi	DEB Student, Pharmacology & Toxicology
Kevin Yates	DEB Student, Chemical Engineering
Marwa Zafarullah	DEB Student, Integrative Genetics and Genomics

Angela Zhang	DEB Student, Chemistry
DEB Faculty	
Barbara Blanco	Plant Sciences
Julie Bossuyt	Pharmacology
Titus Brown	Genome Center
Abhaya Dandekar	Plant Sciences
Christine Diepenbrock	Plant Sciences
Roland Faller	Chemical Engineering
Annaliese Franz	Chemistry
Karen McDonald	Chemical Engineering
Somen Nandi	Chemical Engineering
Ray Rodriguez	Molecular and Cellular Biology
Erkin Seker	Electrical and Computer Engineering
DEB Alumni	
Alberto Iandolino	Bayer Crop Science
Gian Oddone	Novozyme's
Ali Rahimian	Sandstone Diagnostics
Anita Rajamani	Lifescience Dynamics
Juan Sanchez	Department of Pesticide Regulation
Zane Starkewolfe	UC Davis Venture Catalyst
Guests	
Noha Amaly	Visiting Scholar, Biological and Agricultural Engineering
Dan Fong	Researcher, Electrical and Computer Engineering, McDonald/Nandi Lab
Kara Leong	Development, Office of Research
Kiro Kelada	Researcher, Chemical Engineering, McDonald/Nandi Lab
Judith A. Kjelstrom, PhD	Director Emerita, Biotechnology Program
Abijeet Mehta, PhD	Researcher, Dermatology, Min Zhao Lab
Ahmed El-Moghazy, PhD	Researcher, Dept. of Biological & Agricultural Engineering
Cole Pearson	Industry Guest, Marrone Bio Innovations
Tom Turpen, PhD	Industry Guest, Technology Innovation Group & SensIT
Lalani Walawage	Researcher, Plant Sciences, Abhaya Dandekar Lab
Paulo A. Zaini, PhD	Researcher, Plant Sciences, Abhaya Dandekar Lab
Biotechnology Program	
Jacki Balderama	Event Manager
Marianne Hunter	Assistant Director Administration
Denneal Jamison-McClung	Director
Austin Ta	Student Assistant

UCDAVIS
Biotechnology Program

The Mission of the Biotechnology Program:

The Biotechnology Program was created in 1986 to assist in the organization of university activities related to biotechnology and to coordinate such activities with other efforts on the Davis campus. It is a central facility of the Office of Research. The Program's missions include:

- Promoting and coordinating the development of biotechnology and biotechnology - related research on the campus;
- Assisting with development of new and improved facilities for biotechnology research;
- Promoting research interactions between faculty and private industry and public agencies;
- Recommending and implementing curriculum development and training in biotechnology;
- Serving as an information and education resource on biotechnology for the campus and the public.

The Program serves as the **Administrative Home** for educational programs:

- Designated Emphasis in Biotechnology (**DEB**) graduate program
  - o http://deb.ucdavis.edu
- Advanced Degree Program (**ADP**) for corporate employees
  - o A PhD program for the working professional
- **BioTech SYSTEM** – K-14 educational consortium

Biotechnology Program Office:
Dr. Denneal Jamison-McClung – Interim Director
Marianne Hunter – Assistant Director, Administration
Jacki Balderama – Event Manager
Kelly Meade – Financial Analyst
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Website: biotech.ucdavis.edu

UCDAVIS
Biotechnology Program

Designated Emphasis in Biotechnology Program (DEB)

Goals and Mission of the DEB

The Designated Emphasis in Biotechnology (DEB) is an inter-graduate group program that allows Ph.D. students to receive and be credited for training in the area of biotechnology. The DEB provides a nurturing interactive environment to promote integration of multiple disciplinary approaches to the conduct of research and to promote learning in biotechnology. The mission is to prepare well-educated students to approach problems with creativity and flexibility. The program will provide tools for the students to be leaders, visionaries, entrepreneurs, researchers and teachers in the broad area of biomolecular technology.

DEB Mission:

- To provide well-coordinated, cross-disciplinary training of graduate students in critical areas of biomolecular technology research.
- To promote interdisciplinary research environments that integrate basic biological science, engineering and computational disciplines.
- To allow cross-disciplinary training and trainee experience in a biotechnology company or cross-college laboratory.

Students come from a wide array of disciplines: Participating graduate programs currently include **29 programs**: Agricultural & Environmental Chemistry; Animal Biology; Applied Science Engineering; Biochemistry, Molecular, Cellular & Developmental Biology; Biological Systems Engineering; Biomedical Engineering; Biophysics; Chemistry; Chemical Engineering; Civil & Environmental Engineering; Comparative Pathology; Computer Science, Electrical & Computer Engineering; Entomology; Food Science Technology; Genetics; Immunology; Materials Science & Engineering; Mechanical & Aeronautical Engineering; Microbiology; Molecular, Cellular and Integrative Physiology; Neurosciences; Nutritional Biology; Pharmacology and Toxicology; Plant Biology; Plant Pathology; Soils & Biogeochemistry; and Statistics. The DEB program supplements a student's Ph.D. curriculum and those completing the program will obtain an official designation on their diploma & transcript indicating a qualification in biotechnology. Example: **Doctoral Degree in Microbiology with a Designated Emphasis in Biotechnology**

Brief History:

The DEB was formally established in 1997 as an outgrowth of the first NIH Training Grant in Biotechnology (funded in the early 1990s). The DEB became the formal training program for the current NIH Training Grant in Biomolecular Technology (1-T32-GM08799: July 1, 2002-June 30, 2017). The DEB provides a very effective multidisciplinary biotechnology concentration, which includes exposure to bioethics, business and legal aspects of biotechnology as well as a 3-6 month internship in a biotechnology company or research laboratory in another college or national laboratory. As of 2012, the DEB has 29 affiliated graduate groups or departmentally based graduate programs. The number of students in the Designated Emphasis in Biotechnology has increased dramatically over the last several years with many being first year students. We have graduated 303 students with a DEB notation on their diplomas as of 2016.

Program Administration:

The administrative home for the DEB is the UC Davis Biotechnology Program. Dr. Denneal Jamison-McClung serves as the DEB Program Coordinator for the DEB, in addition to directing the Biotechnology Program. She works closely with the DEB chair, Abhaya Dandekar (Department of Plant Sciences) and the rest of the executive committee: Shota Atsumi (Chemistry) and David Rocke (Applied Science/Biostatistics) to oversee the day-to-day activities of the graduate program.

Course Work:

The DEB has a required core curriculum for students regardless of whether their graduate major is in biological science, engineering, statistics, etc. A key feature of the DEB is its requirement for a research internship at a cooperating biotechnology company or a cross-college site. When the students complete their Ph.D. requirements as well as the DEB requirements, their diploma notes not only their graduate major, but also that they have completed the DEB (e.g., "Ph.D. in Chemical Engineering with a Designated Emphasis in Biotechnology").

We have created a website for the Designated Emphasis in Biotechnology (deb.ucdavis.edu/) to advertise the program.

1. **Course Requirements**:

a. **DEB 263** (2 units): Biotechnology Fundamentals and Application (winter quarter, alternate odd numbered years)

An interdisciplinary course which includes: introduction to modern recombinant DNA technology; rate processes of biological systems, optimization of bioreactor performance; practical issues in biotechnology; and some specific case studies of the development of biotechnology products and processes. Grading: Letter grade; two one-hour exams, one research paper (team project) on a selected topic relevant to biotechnology, and regular reading assignments.

b. **DEB 282** (variable): Biotechnology Internship (may be done any quarter)

The internship will expose qualified graduate students to research activities in a biotechnology company, to company culture, to legal and business aspects of industry, and to another career option. A minimum of 3 months internship at a local biotechnology company or cross college or national laboratory (i.e. Lawrence Berkeley Laboratory, Lawrence Livermore National Laboratory, etc.). S/U grading; research performance (student report) will be evaluated by the professor in charge and in consultation with the company trainer.

c. **DEB/ECH 294** (1 unit): Current Progress in Biotechnology (fall, winter and spring quarters). Three quarters of seminar are required for the DEB Program.

This course is an interdisciplinary seminar, featuring speakers from industry as well as academia. The students will have an opportunity to discuss the seminar topic with the lecturers, to learn about biotechnology research activities at companies and to network with speaker. Grading: S/U grading, attendance is required, and a summary report on the seminars is required at the end of the quarter.

d. **MIC 292** (1 unit): From Discovery to Product - An Introduction to Biotechnology at the Industrial Level. (winter quarter; even numbered years). MIC 292 is an approved **seminar elective** for the DEB program (may substitute for one quarter of DEB/ECH 294).

This course is designed to provide a unique opportunity to gain insight into basic and applied biotechnology at the industrial level. Lectures are presented by senior scientists from Novozymes Biotech, Inc. in Davis California (www.novozymes.com). A tour of the industrial facilities will be arranged. Grading: S/U grading, attendance is required, and a summary report on the seminars is required at the end of the quarter.

e. **GGG 296** (2 units): Scientific Professionalism and Integrity (fall quarter) or approved bioethics course.

The course will allow the student to become familiar with their roles and responsibilities as a professional scientist and/or instructor. While some standards of acceptable scientific behavior will be presented in class, most of the time will be spent discussing various "gray zone" scenarios, in which proper conduct is unclear. Grading: S/U grading; active class participation in class discussions is required. **This course is currently highly recommended, but will be required, pending approval.**

2. **Qualifying Exam Requirements**:

The Ph.D. qualifying exam should demonstrate appropriate knowledge with the area of biotechnology. At least one faculty member of the designated emphasis shall participate in the qualifying examination.

3. **Thesis Requirements**:

The dissertation committee shall include at least one faculty member of the designated emphasis. The major professor must be a participating DEB member.

4. **Additional Requirements**:

Regular attendance at the annual Biotechnology Training retreat and at the informal Pizza Chalk Talk Seminars (talks by students and faculty on current research) is expected.

DEB Program Students as of March 2020

Last Name	First Name	Grad Group Long Name
Adhikari	Sambid	Biophysics
Agosto Ramos	Amanda	Plant Biology
Alim	Chidera (Dera)	Molecular, Cellular & Integrative Physiology
Andrew	Peter	Pharmacology & Toxicology
Arbaugh	Benjamin	Biological Systems Engineering
Arenas	Rigoberto	Chemistry
Arreola	Eric	Biochemistry, Molecular, Cellular & Developmental Biology
Bandoy	DJ Darwin	Integrative Pathobiology
Bassein	Jed	Immunology
Beesabathuni	Nitin Sai	Chemical Engineering
Bekkering	Cody	Plant Biology
Bendiks	Zachary	Microbiology
Berg	Anastasia	Biochemistry, Molecular, Cellular & Developmental Biology
Bettadapur	Akhila	Biochemistry, Molecular, Cellular & Developmental Biology
Bolandparvaz	Amirhossain	Biomedical Engineering
Bui	Glory	Microbiology
Bull (Middleton)	Tawni	Horticulture and Agronomy
Calsbeek	Jonas	Pharmacology and Toxicology
Camacho	Lizbeth	Microbiology
Casella	Alena	Biomedical Engineering
Chidi-Ogbolu	Nkechinyere	Biomedical Engineering
Cobo	Angel	Chemistry
Conlon	Savannah	Chemistry
Connolly	Morgan	Microbiology
Contreras Llano	Luis Eduardo	Biochemistry, Molecular, Cellular & Developmental Biolog
Cowie	Anna	Plant Biology
Craft	Julia	Microbiology
Cryan	Elli	Plant Biology
Danielson	Rachel	Soils & Biogeochemistry
Davis	Destiny	Plant Biology
Deloney	Marcus	Biomedical Engineering
Denish	Pamela	Biophysics
Depew	Claire	Immunology

Dhananjayan	Nithin	Biophysics
Doherty	Erin	Chemistry
Duarte Sagawa	Cintia Helena	Plant Biology
Eetemadi	Ameen	Computer Science
Elizaldi	Sonny	Immunology
Emami	Shiva	Food Science
Feinberg	Noah	Horticulture and Agronomy
Flores	Amber	Plant Biology
Garcia	Javier	Biochemistry, Molecular, Cellular & Developmental Biology
Gaur	Anirudh	Biochemistry, Molecular, Cellular & Developmental Biology
Gilbile	Deepshika	Chemical Engineering
Godinez	Dayn	Pharmacology & Toxicology
Gonzales	Jake	Chemistry
Gonzalez	Eduardo	Pharmacology & Toxicology
Goshi	Noah	Biomedical Engineering
Gouran	Mona	Plant Biology
Graddy	Charles	Microbiology
Grajo	Herra	Chemistry
Greenwood (nee-Blankenship)	Brittany	Microbiology
Groth	Benjamin	Microbiology
Guercio	Angelica	Integrative Genetics and Genomics
Gutierrez	Orangel	Integrative Genetics & Genomics
Hamada	Naomi	Chemical Engineering
Harriman	Rian	Immunology
Hatch	Cameron	Plant Biology
Heiss	Britta	Microbiology
Hennessey	Carly	Molecular, Cellular and Integrative Physiology
Hitomi	Alex	Biological Systems Engineering
Ho	Jamie	Biochemistry, Molecular, Cellular & Developmental Biology
Hu	Michelle	Pharmacology and Toxicology
Huang	Jessica	Biochemistry, Molecular, Cellular & Developmental Biology
Huang	Kuei-Pin	Molecular, Cellular and Integrative Physiology
Igwe	Alexandria	Microbiology
Irber Jr	Luiz Carlos	Computer Science
Jacobsen	Casey	Chemistry

Jami	Khaled	Chemistry
Joslin	Shannon	Integrative Genetics & Genomics
Karki	Agya	Chemistry
Kawakita	Ryan	Biological Systems Engineering
Keller	Caroline	Plant Biology
Khuu	Cindy	Biochemistry, Molecular, Cellular and Developmental Biology
Kim (nee Jin)	Hyunsoo Gloria	Microbiology
Kwon	Hwoi Chan	Biophysics
Lee	Sharon	Biochemistry, Molecular, Cellular & Developmental Biology
Lee	So Youn (Emily)	Biomedical Engineering
Lewald	Kyle	Integrative Genetics and Genomics
Li	Riyao	Chemistry
Lin	Jonathan	Microbiology
Liu	Yulong	Biochemistry, Molecular, Cellular & Developmental Biology
Lombardi	Rachel	Food Science
Lotsof	Elizabeth	Chemistry
Louie	Mikaela	Biochemistry, Molecular, Cellular & Developmental Biology
Lowen	Jeremy	Biomedical Engineering
Lu	Yixing	Food Science
Lu	Shan	Molecular, Cellular & Integrative Physiology
Ma	Linda	Biochemistry, Molecular, Cellular & Developmental Biology
Macharoen	Kantharakorn	Chemical Engineering
MacMahon	Jeremy	Pharmacology & Environmental Toxicology
Madera	Mary	Plant Biology
Majumdar	Chandrima	Chemistry
Malig	Maika	Integrative Genetics and Genomics
Markel	Kasey	Plant Biology
Matson	Morgan	Chemistry
McNulty	Matthew	Chemical Engineering
Meier	Nathan	Plant Biology
Merchel Piovesan Pereira	Beatriz	Microbiology
Minami	Shiaki	Chemical Engineering
Mitchell	Keith	Integrative Genetics & Genomics
Mizzi	Jessica	Microbiology

Monteleone	Leanna	Chemistry
Munoz	Oscar	Pharmacology & Toxicology
Murphy	Katherine	Plant Biology
Naranjo	Anna	Animal Biology
Nganga	Livingstone	Plant Biology
Nguyen	Tram Quynh	Chemistry
Nguyen	Alan	Immunology
Noguchi	Glyn	Biochemistry, Molecular, Cellular & Developmental Biology
Nojoomi	Saghi	Molecular, Cellular and Integrative Physiology
North	Ryan	Biomedical Engineering
Odell	Sarah	Plant Biology
Olson	Rachel	Integrative Genetics & Genomics
Pacifici	Noah	Biomedical Engineering
Park	SeHee	Chemistry
Parry	Beau	Microbiology
Peng	Sichong	Integrative Genetics & Genomics
Pham	Kevin	Chemistry
Ramachandran	Mythili	Pharmacology and Toxicology
Ramasubramanian	Lalithasri	Biomedical Engineering
Randol	Jamie	Integrative Genetics and Genomics
Riazati	Niknaz	Molecular, Cellular and Intergartive Physiology
Robinson	Guy	Plant Biology
Rodriguez	Elys	Chemistry
Rollins	Zachary	Chemical Engineering
Rossidivito	Gabrielle	Plant Biology
Salim	Muhammad Adil	Microbiology
Sambre	Pallavi	Materials Science & Engineering
San Juan	Jessica	Chemistry
Sariano	Peter	Biomedical Engineering
Saxe	Houston	Horticulture and Agronomy
Sayre	Jordan	Microbiology
Sepela	Rebecka	Biochemistry, Molecular, Cellular & Developmental Biology
Shams	Shahin	Biomedical Engineering
Shankle	Kyle	Plant Biology
Sharifi	Masuda	Biochemistry, Molecular, Cellular & Developmental Biology

Sharifi	Osman	Biochemistry, Molecular, Cellular & Developmental Biology
Shaw	Claire	Animal Biology
Siegel	Noah	Immunology
Siemon	Matthew	Plant Biology
Sinclair	Rosalie	Plant Biology
Sparks (Horton)	Kayla	Pharmacology and Toxicology
Steele	Daniel	Plant Biology
Steliotes	Emily	Agricultural and Environmental Chemistry
Stevens	Eric	Microbiology
Stewart	Robert	Biochemistry, Molecular, Cellular & Developmental Biology
Stroup	Jeannine	Microbiology
Su-Feher	Linda	Biochemistry, Molecular, Cellular & Developmental Biology
Sule	Rasheed	Biochemistry, Molecular, Cellular & Developmental Biology
Suleiman	Rene	Microbiology
Thai	Victoria	Biomedical Engineering
Thuy-Boun	Alexander	Chemistry
Treece	Tanner	Chemistry
Truong	Tina	Medical Microbiology and Immunology
Vachev	Mishi (Michaela)	Plant Biology
Van Ostrand	Robert	Chemistry
Wang	Marilyn	Immunology
Wei	Lei	Microbiology
Wen	Anita	Pharmacology and Toxicology
Westmont	Taylor	Immunology
Wong	Bailey	Chemistry
Wright	Alonna	Microbiology
Wyatt	Sydney	Integrative Genetics and Genomics
Xie	Bin	Biophysics
Yaghoobi	Ariga Bianca	Pharmacology & Toxicology
Yam	Phoebe	Integrative Genetics & Genomics
Yang	Xiaoxiao	Chemistry
Yates	Kevin	Chemical Engineering
Yothers	Cody Watson	Chemistry
Yuan	Yue	Chemistry
Zacanti	Kelly	Animal Biology

Zafarullah	Marwa	Integrative Genetics and Genomics
Zhang	Angela	Chemistry
Zhang	Yue (Tiffany)	Chemistry
Zheng	Zimin	Chemistry
Zhu	Yihui	Integrative Genetics and Genomics
Zumpano	Danielle	Molecular, Cellular and Integrative Physiology

DEB Faculty Trainers as of March 2020

Venkatesh Akella	Electrical and Computer Engineering
John Albeck	Molecular and Cellular Biology
Rajeevan Amirtharajah	Electrical and Computer Enginering
Paul Ashwood	Medical Microbiology and Immunology, School of Medicine
Shota Atsumi	Chemistry
Matthew Augustine	Chemistry
Sharon Aviran	Biomedical Engineering
Keith Baar	Neurobiology, Physiology and Behavior, Physiology and Membrane Biology, School of Medicine
Alan Balch	Chemistry
Enoch Baldwin	Molecular and Cellular Biology Chemistry
Daniela Barile	Food Science and Technology
Nicole Baumgarth	Center for Comparative Medicine, Pathology, Microbiology and Immunology, School of Veterinary Medicine
Andreas Baumler	Medical Microbiology and Immunology, School of Medicine
Peter Beal	Chemistry
Laurel Beckett	Public Health Sciences
Craig Benham	Mathematics, Biomedical Engineering
Alan Bennett	Plant Sciences, College of Agricultural and Environmental Sciences
Trish Berger	Animal Science
Don Bers	Pharmacology, School of Medicine
Charles L. Bevins	Medical Microbiology and Immunology, School of Medicine
David Block	Viticulture and Enology, Chemical Engineering
Eduardo Blumwald	Plant Sciences, College of Agricultural and Environmental Sciences
Laura Borodinsky	Physiology and Membrane Biology, School of Medicine, Institute for Pediatric Regenerative Medicine
Alexander (Sandy) Borowsky	Pathology and Laboratory Medicine
Julie Bossuyt	Pharmacology, School of Medicine
Richard Bostock	Plant Pathology
Kent Bradford	Plant Sciences, College of Agricultural and Environmental Sciences

Siobhan Brady	Plant Biology, Genome Center
Anne Britt	Plant Biology
Titus Brown	Genome Center, Population Health and Reproduction, School of Veterinary Medicine, Coastal and Marine Sciences Institute
Sean Burgess	Molecular and Cellular Biology
Judy Callis	Molecular and Cellular Biology
Kermit Carraway	Biochemistry and Molecular Medicine, School of Medicine
Luis Carvajal-Carmona	Biochemistry and Molecular Medicine, School of Medicine, Genome Center
Clare Casteel	Plant Pathology
Frederic Chedin	Molecular and Cellular Biology, Genome Center
Xi Chen	Chemistry
Tsung-Yu Chen	Neurology, School of Medicine, Center for Neuroscience
Xinbin Chen	Surgical and Radiological Sciences, School of Veterinary Medicine, Internal Medicine, School of Medicine
Hongwu Chen	Biochemistry and Molecular Medicine, School of Medicine
Chao-Yin Chen	Pharmacology, School of Medicine
Holland Cheng	Molecular and Cellular Biology
Simon Cherry	Biomedical Engineering
Nipavan Chiamvimonvat	Internal Medicine (Cardiology), School of Medicine
Joanna Chiu	Entomology and and Nematology, College of Agricultural and Environmental Sciences
Blaine Christiansen	Orthopaedic Surgery
Gitta Coaker	Plant Pathology, College of Agricultural and Environmental Sciences
Luca Comai	Genome Center, Plant Biology
Douglas Cook	Plant Pathology, College of Agricultural and Environmental Sciences
Gino Cortopassi	Molecular Biosciences, School of Veterinary Medicine
Stephen Cramer	Chemistry
Abhaya Dandekar	Plant Sciences, College of Agricultural and Environmental Sciences
Satya Dandekar	Medical Microbiology and Immunology, School of Medicine
Sheila David	Chemistry
Cristina Davis	Mechanical and Aeronautical Engineering
Scott Dawson	Microbiology and Molecular Genetics
Wenbin Deng	Biochemistry and Molecular Medicine, School of Medicine

Megan Dennis	Biochemistry and Molecular Medicine, School of Medicine, Genome Center, MIND Institute
Elva Diaz	Pharmacology, School of Medicine
Savithramma Dinesh-Kamur	Plant Biology Plant Biology, Genome Center Genome Center
Zhi Ding	Electrical and Computer Engineering
Georgia Drakakaki	Plant Sciences, College of Agricultural and Environmental Sciences
Jason Eiserich	Internal Medicine (Nephrology), School of Medicine, Physiology and Membrane Biology, School of Medicine
Nael El-Farra	Chemical Engineering
JoAnne Engebrecht	Molecular and Cellular Biology
Marc Facciotti	Biomedical Engineering
Bryce Falk	Plant Pathology
Roland Faller	Chemical Engineering
Zhiliang (Julia) Fan	Biological and Agricultural Engineering
Oliver Fiehn	Genome Center, Molecular and Cellular Biology
Vladimir Filkov	Computer Science
Carrie Finno	Population Health & Reproduction
Andrew Fisher	Molecular and Cellular Biology, Chemistry
Paul Fitzgerald	Cell Biology and Human Anatomy, School of Medicine
Annaliese Franz	Chemistry
Christopher Fraser	Molecular and Cellular Biology
David Furlow	Neurobiology, Physiology, and Behavior
Melanie Gareau	Anatomy, Physiology and Cell Biology, School of Veterinary Medicine
Angie Gelli	Pharmacology, School of Medicine
Damian Genetos	Anatomy, Physiology and Cell Biology, School of Veterinary Medicine
Steven George	Biomedical Engineering
Paul Gepts	Plant Sciences, College of Agricultural and Environmental Sciences
J. Bruce German	Food Science and Technology
Jacquelyn Gervay-Hague	Chemistry
Soheil Ghiasi	Electrical and Computer Engineering
Paramita Ghosh	Biochemistry and Molecular Medicine, School of Medicine, Department of Urology, School of Medicine
Mark Goldman	Neurobiology, Physiology and Behavior, Center for Neuroscience
Aldrin Gomes	Neurobiology,Physiology & Behavior and Physiology & Membrane Biology, School of Medicine
Tom Gradziel	Plant Sciences, College of Agricultural and Environmental Sciences

Eleonora Grandi	Pharmacology, School of Medicine
Jeffrey Gregg	Pathology and Laboratory Medicine
Ting Guo	Chemistry
Paul Hagerman	Biochemistry and Molecular Medicine, School of Medicine
Fawaz Haj	Nutrition
Bruce Hammock	Comprehensive Cancer Center
Stacey Harmer	Plant Biology
Dennis Hartigan-O'Connor	Medical Microbiology and Immunology, School of Medicine
Dominik Haudenschild	Orthopaedic Surgery, School of Medicine,
Volkmar Heinrich	Biomedical Engineering
Johannes Hell	Pharmacology, School of Medicine
Paul Henderson	Hematology/Oncology, Internal Medicine
Matthias Hess	Animal Science
Wolf-Dietrich Heyer	Microbiology and Molecular Genetics
Fereydoun Hormozdiari	Genome Center, MIND Institute, Biochemistry and Molecular Medicine, School of Medicine
David Horsley	Mechanical and Aerospace Engineering
You-Lo Hsieh	Textiles and Clothing
Mark Huising	Physiology and Membrane Biology, School of Medicine, Neurobiology, Physiology and Behavior
Neil Hunter	Microbiology and Molecular Genetics, Cell Biology and Human Anatomy, School of Medicine
M. Saif Islam	Electrical and Computer Engineering
Roslyn-Rivkah Isseroff	Dermatology
Tina Jeoh	Biological and Agricultural Engineering
Wilsaan Joiner	Neurobiology, Physiology and Behavior & Dept. of Neurology, School of Med
Thomas Jue	Biochemistry and Molecular Medicine, School of Medicine
Linda Katehi	Electrical & Computer Engineering
Carl Keen	Nutrition
Darshan Kelley	Nutrition, USDA ARS Western Human Nutrition Research Center
Rick Kiehl	Electrical and Computer Engineering
Dan Kliebenstein	Plant Sciences, College of Agricultural and Environmental Sciences, Center for Population Biology, Genome Center
Paul Knoepfler	Cell Biology and Human Anatomy, School of Medicine, Genome Center
Anne Knowlton	Internal Medicine (Cardiology), School of Medicine, Pharmacology, School of Medicine
Patrice Koehl	Computer Science, Genome Center

Ian Korf	Molecular and Cellular Biology, Genome Center
Dietmar Kueltz	Animal Science
Tonya Kuhl	Chemical Engineering
Hsing-Jien Kung	Biological Chemistry and Molecular Medicine, School of Medicine
Anna La Torre	Cell Biology and Human Anatomy, School of Medicine
J. Clark Lagarias	Molecular and Cellular Biology
Kit Lam	Biochemistry and Molecular Medicine, School of Medicine
Donald Land	Chemistry
Delmar Larsen	Chemistry
Janine LaSalle	Medical Microbiology and Immunology, School of Medicine, Genome Center, MIND Institute
Jerold Last	Internal Medicine, Pulmonary and Critical Care, School of Medicine
Kent Leach	Biomedical Engineering
Carlito Lebrilla	Chemistry
Pamela Lein	Molecular Biosciences, Veterinary Medicine
Harris Lewin	Genome Center, Evolution and Ecology
Jamal Lewis	Biomedical Engineering
Su-Ju Lin	Microbiology and Molecular Genetics
Bo Liu	Plant Biology
Gang-yu Liu	Chemistry
Marjorie Longo	Chemical Engineering
Angelique Louie	Biomedical Engineering
Paul Luciw	Pathology and Laboratory Medicine, Center for Comparative Medicine
Neville C Luhmann, Jr.	Electrical and Computer Engineering
Elizabeth Maga	Animal Science
Maria Marco	Food Science and Technology
Laura Marcu	Biomedical Engineering
Verónica Martínez Cerdeño	Pathology and Laboratory Medicine, School of Medicine
Karen McDonald	Chemical Engineering
Richard J. McKenney	Molecular and Cellular Biology
Frank McNally	Molecular and Cellular Biology
John McPherson	Biochemistry and Molecular Medicine, School of Medicine
Stephen McSorley	Anatomy, Physiology & Cell Biology, Center for Comparative Medicine
Juan Medrano	Animal Science, College of Agricultural and Environmental Sciences

Maeli Melotto	Plant Sciences
Richard Michelmore	Genome Center, Molecular and Cellular Biology, Medical Microbiology and Immunology, School of Medicine, Plant Sciences, College of Agricultural and Environmental Sciences
Michael Mienaltowski	Animal Science
Lee Miller	Neurobiology, Physiology and Behavior, Center for Mind and Brain
Lisa Miller	Anatomy, Physiology and Cell Biology, School of Veterinary Medicine
David Mills	Food Science and Technology
Maria Mudryj	Medical Microbiology and Immunology, School of Medicine
William J. Murphy	Dermatology, Internal Medicine (Hematology/Oncology)
James Murray	Animal Science, College of Agricultural and Environmental Sciences
Florence Negre-Zakharov	Plant Sciences, College of Agricultural and Environmental Sciences
Douglas Nelson	Microbiology and Molecular Genetics, Coastal and Marine Sciences Institute
John Newman	Nutrition, USDA ARS Western Human Nutrition Research Center
Nitin Nitin	Biological and Agricultural Engineering
Stephen Noctor	Psychiatry and Behavioral Sciences, School of Medicine
Jan Nolta	Cell Biology and Human Anatomy, School of Medicine
Alex Nord	Neurobiology, Physiology and Behavior, Center for Neuroscience, Genome Center, Psychiatry and Behavioral Sciences, School of Medicine
Jodi Nunnari	Molecular and Cellular Biology
Anita Oberbauer	Animal Science
Martha O'Donnell	Physiology and Membrane Biology, School of Medicine
Tingrui Pan	Biomedical Engineering
Alyssa Panitch	Biomedical Engineering
Rebecca Parales	Microbiology and Molecular Genetics
Atul Parikh	Biomedical Engineering
Anthony Passerini	Biomedical Engineering
Isaac Pessah	Molecular Biosciences, School of Veterinary Medicine
Ronald Phillips	Chemical Engineering
Kent Pinkerton	Anatomy, Physiology and Cell Biology, School of Veterinary Medicine, Pediatrics, School of Medicine
David Pleasure	Neurology and Pediatrics, School of Medicine
Robert Powell	Chemical Engineering
Martin Privalsky	Microbiology and Molecular Genetics

Jinyi Qi	Biomedical Engineering
Gerald Quon	Molecular and Cellular Biology, Genome Center, Comprehensive Cancer Center
Katherine Ralston	Microbiology and Molecular Genetics
Katherine Rauen	Pediatrics
Helen Raybould	Anatomy, Physiology and Cell Biology, School of Veterinary Medicine
Alexander Revzin	Biomedical Engineering
Crystal Ripplinger	Pharmacology
Subhash Risbud	Materials Science and Engineering
William Ristenpart	Chemical Engineering
David Rocke	Biomedical Engineering
Jorge Rodrigues	Land, Air and Water Resources
Ray Rodriguez	Molecular and Cellular Biology
Pamela Ronald	Plant Pathology, College of Agricultural and Environmental Sciences, Genome Center
Alan Rose	Molecular and Cellular Biology
Lesilee Rose	Molecular and Cellular Biology
Pablo Ross	Animal Science
Jeffrey Ross-Ibarra	Plant Sciences, College of Agricultural and Environmental Sciences
John Rutledge	Cardiology/Cardiovascular Medicine, Internal Medicine
Jon Sack	Physiology and Membrane Biology, School of Medicine, Anesthesiology and Pain Medicine, School of Medicine
Earl Sawai	Pathology, Microbiology and Immunology, School of Veterinary Medicine
Kate Scow	Land, Air and Water Resources
David Segal	Genome Center, Biochemistry and Molecular Medicine, School of Medicine, UC Davis MIND Institute, Pharmacology
Erkin Şeker	Electrical and Computer Engineering
Barbara Shacklett	Medical Microbiology and Immunology, School of Medicine
Priya Shah	Microbiology and Molecular Genetics, Chemical Engineering, College of Engineering
Frank Sharp	Neurology, School of Medicine, UC Davis MIND Institute
Justin Siegel	Biochemistry and Molecular Medicine, School of Medicine, Genome Center, Chemistry
Eduardo Silva	Biomedical Engineering
Christopher Simmons	Food Science and Technology
Sergi Simó	Cell Biology and Human Anatomy, School of Medicine
Scott Simon	Biomedical Engineering

Neelima Sinha	Plant Biology
David Slaughter	Biological and Agricultural Engineering
Carolyn Slupsky	Nutrition
Athena Soulika	Dermatology
Daniel Starr	Molecular and Cellular Biology
Francene Steinberg	Nutrition
Ioannis Steriopoulos	Plant Pathology
Pieter Stroeve	Chemical Engineering
Alexei Stuchebrukhov	Chemistry
Dawn Y. Sumner	Earth and Planetary Sciences
Gang Sun	Textiles and Clothing
Ilias Tagkopoulos	Computer Science
Cheemeng Tan	Biomedical Engineering
Dean Tantillo	Chemistry
Alice Tarantal	Pediatrics, School of Medicine, Cell Biology and Human Anatomy, School of Medicine, California National Primate Research Center
Flora Tassone	Biochemistry and Molecular Medicine, School of Medicine
Steven Theg	Plant Biology
Li Tian	Plant Sciences, College of Agricultural and Environmental Sciences
Michael Toney	Chemistry
Jose Torres	Medical Microbiology and Immunology
Renee Tsolis	Medical Microbiology and Immunology, School of Medicine
Richard Tucker	Cell Biology and Human Anatomy, School of Medicine
Judy Van de Water	UC Davis Center for Children's Environmental Health, Internal Medicine, School of Medicine
Alison Van Eenennaam	Animal Science
Marta Van Loan	Nutrition
Jean VanderGheynst	Biological and Agricultural Engineering
Rachel Lee Vannette	Entomology and Nematology
Mariel Vazquez	Microbiology and Molecular Genetics
John Voss	Biochemistry and Molecular Medicine, School of Medicine
Bart Weimer	Population Health & Reproduction, Veterinary Medicine
Robert H. Weiss	Internal Medicine (Nephrology), School of Medicine
Valerie Williamson	Entomology and Nematology
David Wilson	Molecular and Cellular Biology
Matthew J. Wood	Environmental Toxicology

Reen Wu	Internal Medicine, Pulmonary and Critical Care
Stefan Wuertz	Civil and Environmental Engineering
Heike Wulff	Pharmacology, School of Medicine
Kevin Xiang	Pharmacology, School of Medicine
Lifeng Xu	Microbiology and Molecular Genetics
Soichiro Yamada	Biomedical Engineering
John Yoder	Plant Sciences, College of Agricultural and Environmental Sciences
Glenn Young	Food Science and Technology
Aiming Yu	Biochemistry and Molecular Medicine, School of Medicine
Philipp Zerbe	Plant Biology
Ruihong Zhang	Biological and Agricultural Engineering

The Value of Internships

Over the last 20 years (even before the formal DEB program was established), we have placed pre-doctoral students in a variety of biotechnology companies for their industrial research experience. They include:

Advanced Micro Devices (AMD)
Agilent Technologies
AgraQuest (a Bayer company)
Alza
Amgen
Amyris
Antibodies, Inc.
Aqua Bounty
Bayer
Berlex Biosciences
BioMarin Pharmaceuticals, Inc.
Carollo
Celera AgGen
Cytokinetics
DuPont
Exelixis
Expression Systems
Genencor
Genentech
Hoffmann Eitle
ICOS
Igenica
Institut Charles Sadron
Marone Bio Innovations
Maxygen
Novartis (formerly Chiron)
Novozymes
Nunhems
OncoMed
Scios
Somagenics
Syntex

Recovery Sciences
Roche Biosciences
Sutro Biopharma
State Water Control Resources Board
Tethys Bioscience, Inc.
Unilever
Ventria Biosciences
and others

Industry Partners gain many things from internships:

- Access to highly talented creative researchers
- Opportunity to gain inside track on future employees
- Through students, further collaboration with scientists on campus
- Participate in the annual retreat to meet UC scientists students, potential interns, other company scientists
- Potential to use UC facilities through the collaboration
- Opportunity to participate in weekly campus seminars

Students gain much from internships:

- Ability to work in a highly creative non-academic environment
- Opportunity to participate in focused team approach to defined research goals
- Ability to use equipment and facilities not available on campus
- Discover the type of environment, which suits future career goals
- Participate in industry seminars
- Enhanced curriculum vitae: reference letters and new skills
- Access to potential employment opportunities

Currently, there are ~220 students enrolled, so we need more Academic-Industry Partnerships.