



2020 Annual Report



HSC Cores Research Facilities

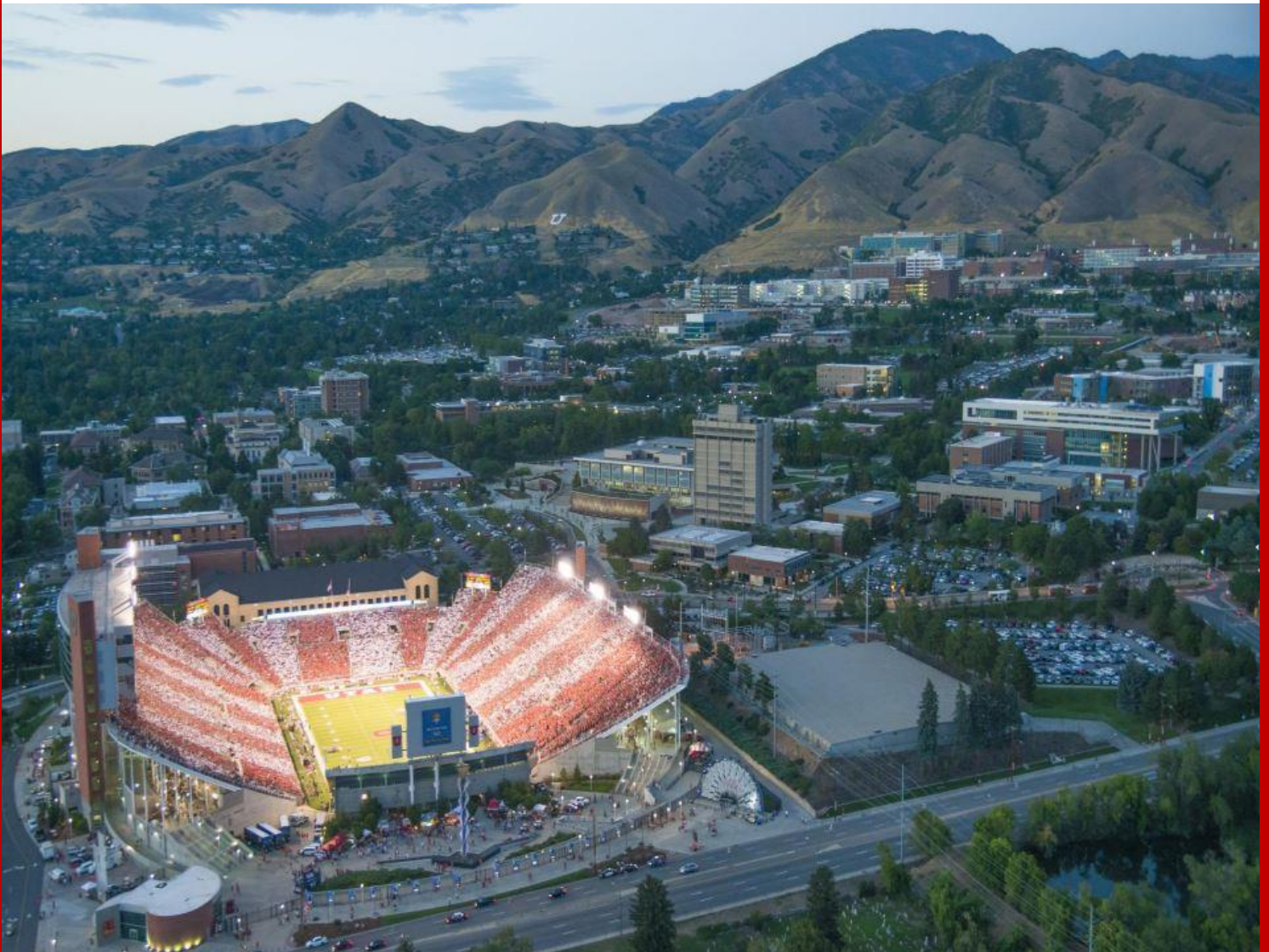


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HSC CORES Facilities

Overall Financial Summary

Revenue & Expenses

- HSC Core Facilities budgeted \$9.02 million for FY20, with expenses totaling to \$9.22 million. Approximately \$5.29 million in expenses went to salaries and benefits while \$3.93 million was spent on equipment and operating supplies.
- In FY20, \$5.6 million in services were billed, and collected from all units combined. An overhead fee of 5% (\$267,252) was used for administrative support.

Core Research Facilities

Core	Total Expenses	Equipment Expenses	Total Revenue	SVPHS	VPR	RIF/Match
Administration	\$753,903		\$772,252	\$505,000		
BIDAC	\$120,772		\$102,363	\$30,000		
Cell Imaging	\$532,051		\$434,109	\$175,000		
DNA Peptide	\$300,478		\$276,833			
DNA Sequencing	\$440,093		\$392,783			
Drug Discovery	\$148,781		\$122,066	\$80,000		
Electron Microscopy	\$783,122		\$807,784	\$20,000	\$37,500	
Flow Cytometry	\$1,059,988	\$497,318	\$1,035,320			\$497,318
Genomics	\$217,610		\$149,938			
Machine Shop	\$284,318		\$262,732	\$50,000		
Mass Spectrometry & Proteomics	\$734,611	\$461,500	\$688,626	\$145,000		\$461,500
Metabolic Phenotyping	\$155,255		\$154,695	\$70,000		
Metabolomics	\$524,334		\$470,775	\$240,000		
Mutation Generation & Detection	\$223,969		\$157,062	\$30,000		
Nuclear Magnetic Resonance	\$115,566		\$113,549	\$80,000		
PreClinical Imaging	\$296,214		\$250,854	\$50,000	\$75,000	
Small Animal Ultrasound	\$25,345		\$31,514	\$10,000		
Transgenic Mouse	\$620,206		\$675,710	\$434,603		
UTAH Center Genetic Discovery	\$1,092,300		\$1,402,153	\$1,133,798		
Zebrafish	\$519,333		\$600,413	\$150,000	\$35,000	

Service Recharge Centers

Service Recharge Center	Total Expenses	Equipment Expenses	Total Revenue	SVPHS	VPR	RIF
Genetics Science Learning Center	\$990,855		\$985,229			
Iron & Hematology	\$14,331		\$16,872			
Material Sciences-Engineering	\$59,792		\$71,440			
National Center Veterans Studies	\$111,043		\$35,055			
Nuclear Engineering	\$13,035		\$10,057			
Scalable Analytics & Informatics	\$137,799		\$78,841			

Cores Administration

Overview

The Health Sciences Center (HSC) Core Facilities operate administratively reports to the Director Dr. John Phillips, and Associate Director James Cox, who report to Dr. Will Dere. The administrative office is managed by Ms. Brenda Smith, with assistance from Ms. Audrey Gallagher, Ms. Terra Curley, and Mrs. Sovanna Behrmann. Responsibilities of the Core Administration office include - personnel management, budget preparation, financial affairs, ordering of supplies, and tracking expenses for all 29 Core Facilities and Service Recharge Centers. In addition, the Administrative Core supports general research infrastructure for the community, e.g. maintaining the X-ray film developer in the SOM and the research irradiator logging and access requests. All cores and recharge centers operate on a charge-back basis, with the Administration Core recovering 5% of the revenue collected for these billing and collection services. The management of the administrative office is performed by the HSC Core Advisory Board.

Personnel

- John D. Phillips, Ph.D., Director HSC Core Facilities
- James C. Cox, Ph.D., Associate Director HSC Core Facilities
- Brenda Smith, Director of Finance
- Audrey Gallagher, Administrative Manager
- Terra Curley, Accountant
- Sovanna Behrmann, Administrative Officer

2020 Annual Update

- In light of the global pandemic the Administrative Office was critical in obtaining and distributing safety supplies to staff, all cores remained active during the orange level status of research on campus. This was very positive and allowed individual laboratories to continue to make progress with minimum disruption.
- In FY20, the Cores Administration office was successfully able to process billing in 1 business day even though the amount of billed revenue has increased to 29 labs. The new HSC scheduling/billing system validates chartfields with the University's CIS system which has eliminated the majority of billing errors.
- In FY20 the core billed 5.58 million; however, what is most impressive, the collection rate for billed services remains at **100%**. We have developed an account management system to allow each Director to view revenue and expenses in real time. The tracking system stores fiscal data so that historical comparisons between revenue and expenses can be performed as well as validation of expenses, and operational analysis.
- The two new Service/Recharge Centers (Platform for Open Wireless Data-driven Experimental Research and Nanomaterials Characterization Lab) are now managed through the administrative office to increase accountability and reduce expenses associated with billing and collections.
- The seventh annual retreat was held on September 20th. Approximately 100 people attended. Directors had an opportunity to discuss methods for maintaining market share, engaging researchers to provide higher quality data analysis and methods to track usage. Materials Characterization, Machine Shop, Mutation Generation, Travel, Comparative Medicine, Lab Safety and Nanofab all made presentations showing their services.
- The electronic inventory system created for capital equipment tracking is still being heavily used by additional departments and groups in Health Sciences and Main Campus. Upgrades for FY20 allow more reporting and tracking of equipment and better access from hand held devices. As of July 2020, there are 72 Departments, and 6,457 items entered into the system. These items are located in 989 rooms across campus. The total asset

value of these items is \$102.4 million. This system continues to expand and is free to use by any group on campus.

FY2020 Goals

- Upgrade the electronic inventory system
- Upgrade the resource/billing system

Cores Administration Revenue & Expenses

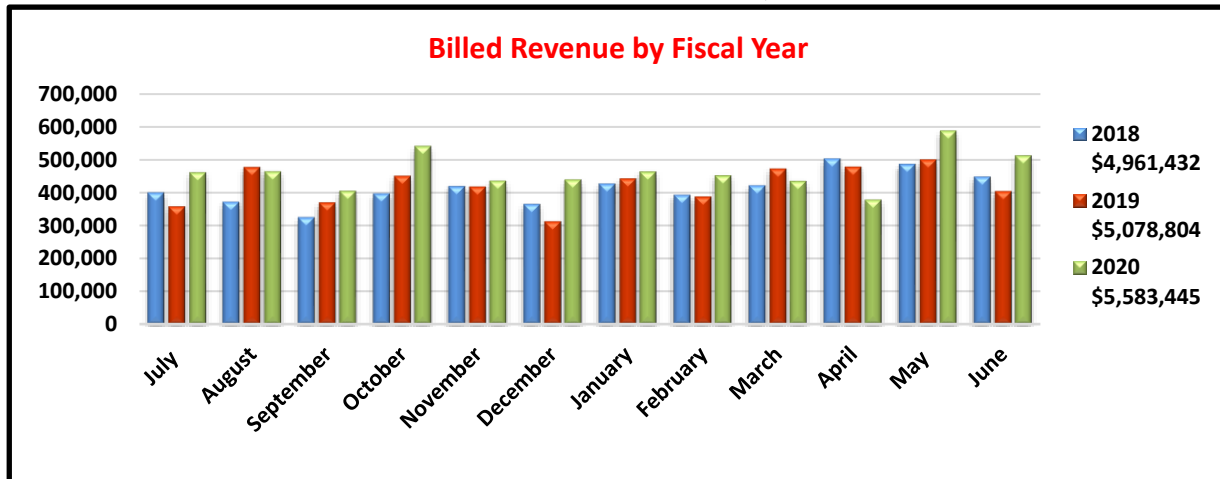
FY20 Expenses: Total \$753,903

The Cores Administration Budget covers the following expenses:

- Salaries/Benefits: \$605,790
- Fixed Expenses (IT Support for 76 staff, developer, x-ray, software): \$104,196
- Unanticipated equipment repairs and replacement: \$43,917

FY20 Revenues: Total \$772,252

- VP of Health Sciences Support: \$505,000
- FY20 Revenue Generated from Services: \$267,252



* This represents the income from the 5% administrative fee charged to each core, based on collected revenue from billed services; legend displays 5% of annual revenue collected for each fiscal year.

Advisory Board Committee

Last meeting date: February 4th, 2020

- Andy Weyrich¹, Associate Dean for Basic and Translational Sciences
- Joseph Yost¹, Professor, Neurobiology and Anatomy
- Mark Yandell¹, Professor, Human Genetics
- John Phillips¹, Director, Core Facilities
- Will Dere, Professor, Professor, Endocrinology
- David Stillman¹, Professor, Pathology
- Wes Sundquist, Professor, Biochemistry
- Brad Cairns¹, Professor, Huntsman Cancer Institute
- Carl Wittwer¹, Professor, Pathology
- Eric Schmidt¹, Professor, Medicinal Chemistry
- Matthew Rondina¹, Associate Professor, Internal Medicine

¹in attendance

Addendum

The administrative core ensures that all cores maintain a regular faculty advisory committee meeting that conforms to the following guidelines:

<http://cores.utah.edu/wp-content/uploads/2015/09/Faculty-Advisory-Committee-Responsibilities-2.pdf>

Biomedical Imaging & Data Science Core

Overview

The mission of the Biomedical Imaging and Data Science Core (BIDAC) facility is to provide advanced medical computing, scientific visualization and data science services to research groups at the University of Utah. We offer services and consulting that range from standard image processing tasks (image registration, image segmentation) to more advanced group-wise studies, including morphometric analysis, machine learning and deep learning (artificial intelligence). BIDAC leverages the computational resources and software development infrastructure of the Scientific Computing and Imaging (SCI) Institute. In partnership with CHPC and the HSC Core imaging facilities, we are actively developing new services that are based on the needs of HSC researchers and core users. As a resource for advanced medical computing, data science and data analytics, our goal is to further the scientific mission of the University of Utah by significantly enhancing the capabilities and competitiveness of HSC research laboratories.

Services

BIDAC offers a range of services including consulting, training, image processing, image analysis, image visualization, workflow development, software prototyping, and algorithm development.

Main services that have been developed and/or used during FY2020 include:

- **Deep learning analysis (artificial intelligence) for image classification, regression and segmentation.** We have been developing expertise in applying, comparing and fine-tuning state-of-the-art Convolutional Neural Networks (CNN) to enable robust image classification and/or image regression.
- **Big data engineering workflow for inpatient and outpatient medical imaging, enabling subsequent machine learning analysis.** In partnership with researchers from Radiology, the Enterprise Data Warehouse (EDW) and the Center for High Performance Computing (CHPC), we have developed software and hardware infrastructure to support secured data transfer (from the hospital PACS), HIPAA-compliant data storage and data management of large radiological datasets to enable deep learning and natural language processing analyses. Clinical studies of interest use retrospective 2D chest X-ray and 3D CT images.

Personnel

- Clement Vachet, Director

2020 Annual Update

Grant Support - BIDAC performed preliminary work and/or provided letters of support for the following grant/contract submissions:

- NIH R21 – Tolga Tasdizen, PhD, Dept. Electrical and Computer Engineering
- NIH R01 - Josh Bonkowsky, Dept. Pediatric Neurology
- University of Utah - 3i Initiative, Tolga Tasdizen, PhD

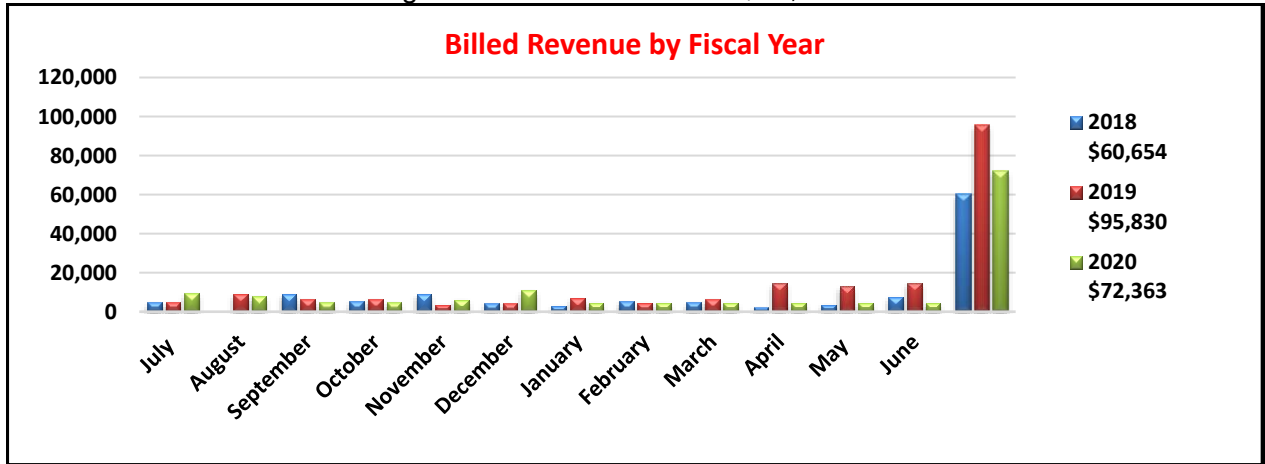
Inter-disciplinary collaborations - projects to enhance imaging capabilities have been performed with the Center for High Performance Computing (CHPC) and with Health Sciences Cores (directly or involving end-users).

Revenue/Expenses

FY20 Expenses: Total \$120,772

FY20 Revenue: Total \$102,363

- VP of Health Sciences Support: \$ 30,000
- FY20 Revenue generated from services: \$72,363



* Legend displays total annual revenue by year earned.

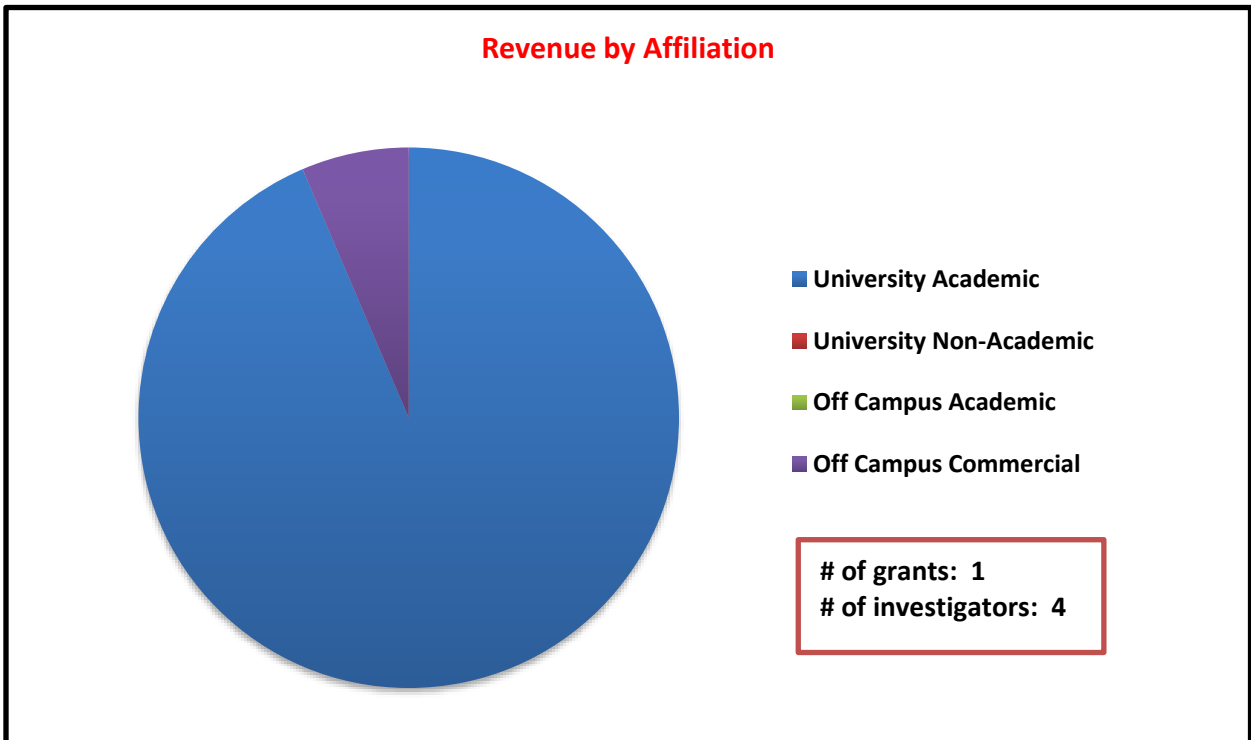
Advisory Board Committee

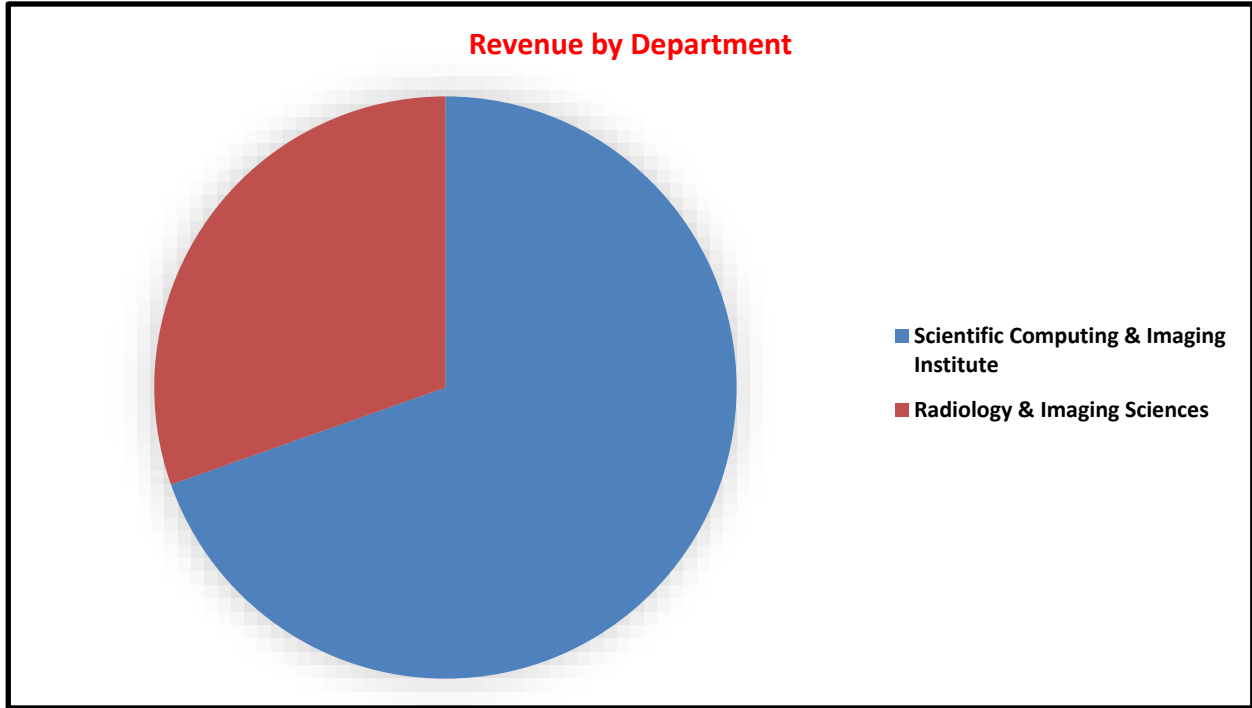
- Tolga Tasdizen, PhD, Associate Professor Electrical and Computer Engineering
- Edward DiBella, PhD, Prof. Radiology and Imaging Sciences, Director UCAIR
- Florian Solzbacher, PhD, Professor Electrical & Computer Engineering, Director CEI

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Tasdizen, Tolga	DHS
2	Schroeder, Joyce	Department
3	Genesis Innovation Group	Commercial
4	Quigley, Edward	Department

Publications

1. Bigolin Lanfredi, R., Schroeder, J., Vachet, C., & Tasdizen, T. (2020). Interpretation of Disease Evidence for Medical Images Using Adversarial Deformation Fields.
2. Bigolin Lanfredi, R., Schroeder, J. D., Vachet, C., & Tasdizen, T. (2019). Adversarial Regression Training for Visualizing the Progression of Chronic Obstructive Pulmonary Disease with Chest X-Rays, Cham.
3. Ly, C., Vachet, C., Schwerdt, I., Abbott, E., Brenkmann, A., McDonald, L. W., & Tasdizen, T. (2020). Determining uranium ore concentrates and their calcination products via image classification of multiple magnifications. *Journal of Nuclear Materials*, 533, 152082. doi: 10.1015/j.jnucmat.2020.152082

Cell Imaging Facility

Overview

The Cell Imaging Facility provides training and consultation on the use of confocal microscopy, widefield automated microscopy, two-photon, and software analysis tools for quantitative analysis of image data. The facility has Zeiss 880 Airyscan confocal, a Leica SP8 White light laser confocal, a Leica SP8 405/488/561/633, Two Olympus FV1000 Spectral confocals, two Nikon A1 confocals, two Multi-photon confocals from Prairie/Bruker. In addition, two Nikon Ti automated microscope and a spinning disk confocal (CSUW1) are available for live cell imaging. A Zeiss Axioscan Z1 slide scanner is available for automated archiving of histology and fluorescence data. Automated microscopes with one of four different stage incubators are available (CO₂, temperature, humidity, one with Hypoxia) and also available for live cell imaging. Nikon Elements, LAS X, Fluorender, Imaris software are available for 2D and 3D analysis of image data.

Services

The training and equipment provided by the facility is aimed at reducing the startup time and degree of expertise necessary for an individual user to design and execute experiments requiring microscopy and image processing. Services are offered at multiple locations in an effort to provide the service within proximity to the user base.

Goals 2021

Optimizing acknowledgement of the core for manuscripts published with data generated from the core is very important in developing a strategy to acquire additional equipment.

Equipment

HSC Location

- Nikon A1 Confocal Microscope
- Nikon A1R Confocal Microscope
- 2x Prairie Multi-Photon Confocal Microscope
- Zeiss Axioscan Z1 automated slide scanner with 100 slide loader
- EVOS FL Widefield Microscope
- Nikon Ti Automated Microscope

HCI Location

- Leica SP8 confocal with white light laser
- Leica SP8 confocal with 405, 488, 561, 633nm lasers
- Nikon Ti Automated Microscope
- Ibidi stage incubator with CO₂, temperature and hypoxia control

SMBB Location

- Olympus FV1000 Confocal Microscope

Biology ASB/Crocker Location

- Leica SP8 confocal with white light laser
- Olympus FV1000 confocal Microscope
- Zeiss 880 Airyscan Confocal
- Vutara super resolution and Optera Swept Field Confocal

Personnel

- Christopher Rodesch, Ph.D., Co-Director
- Xiang Wang, Ph.D, Co-Director
- Michael J. Bridge, Ph.D., Research Associate
- Isabelle Harward, Microscope Technician

2020 Annual Update

New Services

- Consultation is available at four locations; 5 CSC, SMBB, 5221 HCI and Building 585 HSC

New Equipment

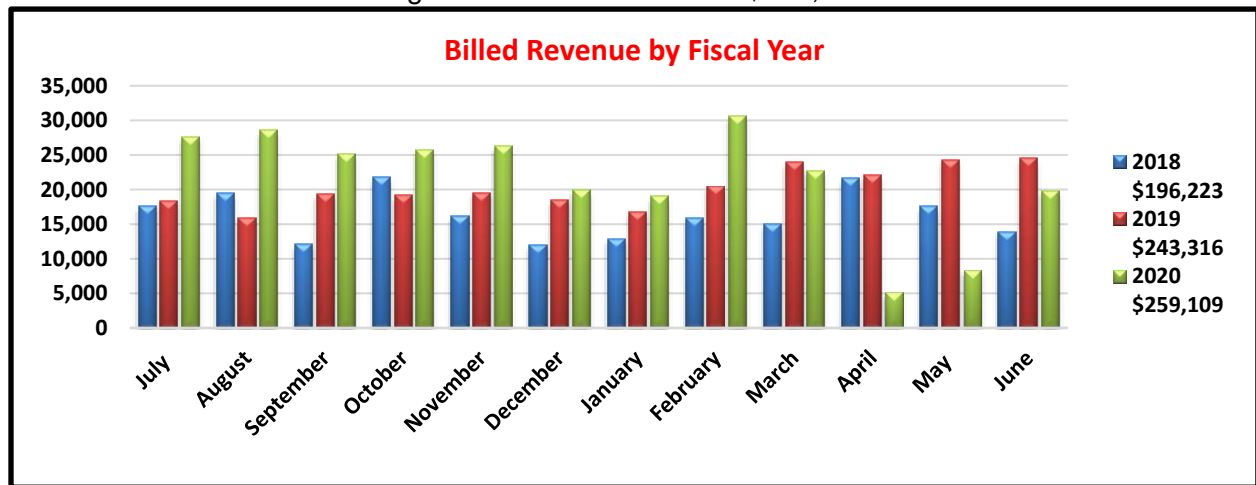
- Spinning disk confocal in Biochemistry, W1 from Visitek

Revenue/Expenses

FY20 Expenses: Total \$532,051

FY20 Revenue: Total \$434,109

- VP of Health Sciences Support: \$175,000
- FY20 Revenue generated from services: \$259,109



* Legend displays total annual revenue by year earned.

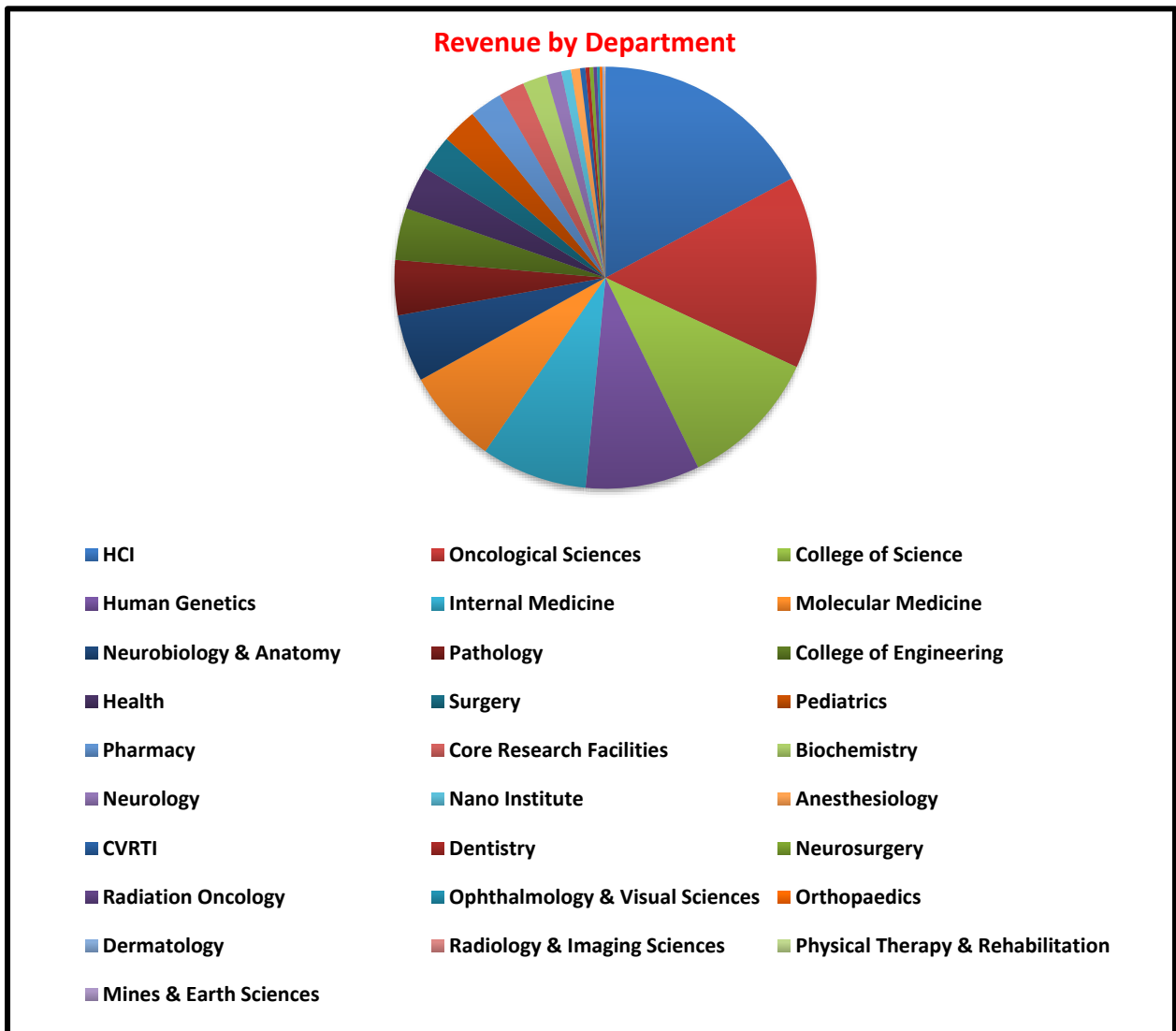
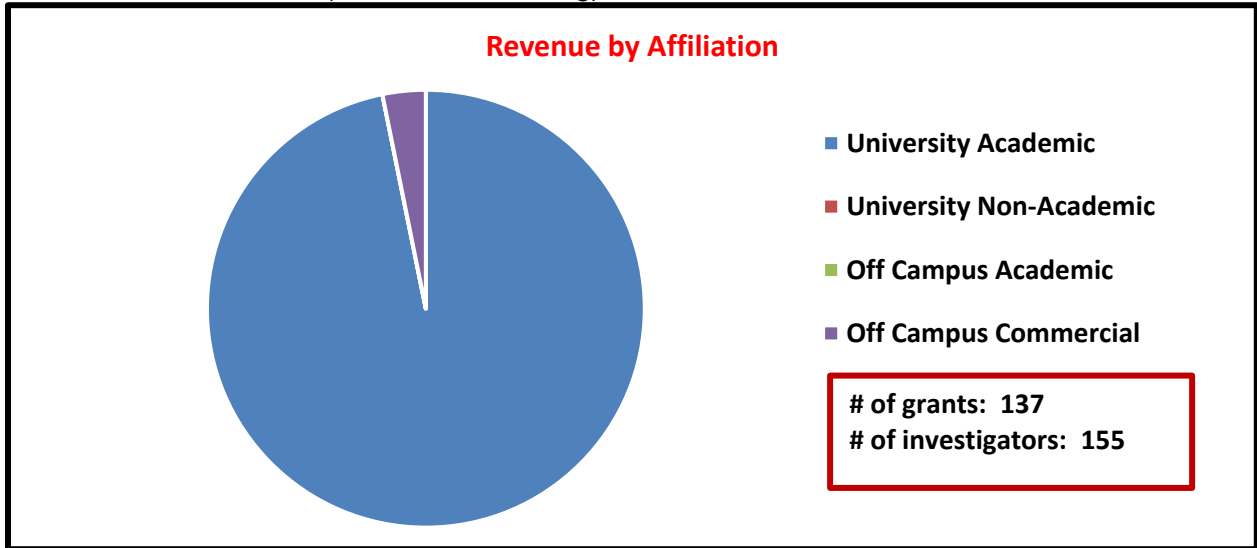
Advisory Board Committee

Last meeting date: November 13, 2019.

- Marcus Babst, Associate Professor, Biology
- Sophie Caron, Assistant Professor, Biological Sciences
- James Cox, Associate HSC Cores Director
- Bruce Edgar, Professor, Oncological Sciences
- Gabrielle Kardon, Professor, Human Genetics
- Michelle Mendoza, Associate Professor, Oncological Sciences
- Minna Roh, Associate Professor, Biochemistry
- Alex Shcheglovitov, Assistant Professor, Neurobiology and Anatomy
- Mark Smith, Research Assistant Professor, Oncological Sciences

**FY20 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Top Users

1	Edgar, Bruce	NIH
2	Beckerle, Mary	NIH, Department
3	Mendoza, Michelle	American Cancer Society
4	Schlichter, Alisha	HHMI
5	Yost, H Joseph	NIH
6	Caron, Sophie	NIH, Department
7	Jorde, Lynn	NIH
8	Cairns, Brad	Department, Human Frontier Science, Univ. California San Diego
9	Jorgensen, Erik	Department
10	Kardon, Garielle	NIH, Department

Publications

- Deshpande, I., Liang, J., Hedeem, D., Roberts, K. J., Zhang, Y., Ha, B., Manglik, A. (2019). Smoothened stimulation by membrane sterols drives Hedgehog pathway activity. *Nature*, 571(7764), 284-288. doi:10.1038/s41586-019-1355-4
- Dong, Z. M., Lin, E., Wechsler, M. E., Weller, P. F., Klion, A. D., Bochner, B. S., Clayton, F. (2020). Pulmonary Eosinophilic Granulomatosis with Polyangiitis Has IgG4 Plasma Cells and Immunoregulatory Features. *Am J Pathol*, 190(7), 1438-1448. doi:10.1016/j.ajpath.2020.03.005
- Feng, H., Hockin, M., Zhang, S., Capecchi, M., Gale, B., & Sant, H. (2020). Enhanced chromosome extraction from cells using a pinched flow microfluidic device. *Biomed Microdevices*, 22(2), 25. doi:10.1007/s10544-020-0477-7
- Feng, H., Magda, J. J., & Gale, B. K. (2019). Viscoelastic second normal stress difference dominated multiple-stream particle focusing in microfluidic channels. *Appl Phys Lett*, 115(26), 263702. doi:10.1063/1.5129281
- Gandelman, M., Dansithong, W., Figueroa, K. P., Paul, S., Scoles, D. R., & Pulst, S. M. (2020). Staufen 1 amplifies proapoptotic activation of the unfolded protein response. *Cell Death Differ*. doi:10.1038/s41418-020-0553-9
- Guo, P., Nalder, S.-a., Okada, M., & Sigala, P. A. (2020). Doxycycline has Distinct Apicoplast-Specific Mechanisms of Antimalarial Activity. *bioRxiv*, 2020.2006.2011.146407. doi:10.1101/2020.06.11.146407
- Hanak, T. J., Libbey, J. E., Doty, D. J., Sim, J. T., DePaula-Silva, A. B., & Fujinami, R. S. (2019). Positive modulation of mGluR5 attenuates seizures and reduces TNF-alpha(+) macrophages and microglia in the brain in a murine model of virus-induced temporal lobe epilepsy. *Exp Neurol*, 311, 194-204. doi:10.1016/j.expneurol.2018.10.006
- Hoffman, L. M., Smith, M. A., Jensen, C. C., Yoshigi, M., Blankman, E., Ullman, K. S., & Beckerle, M. C. (2020). Mechanical stress triggers nuclear remodeling and the formation of transmembrane actin nuclear lines with associated nuclear pore complexes. *Mol Biol Cell*, 31(16), 1774-1787. doi:10.1091/mbc.E19-01-0027
- Kim, H. S., Neugebauer, J., McKnite, A., Tilak, A., & Christian, J. L. (2019). BMP7 functions predominantly as a heterodimer with BMP2 or BMP4 during mammalian embryogenesis. *Elife*, 8. doi:10.7554/eLife.48872
- Lim, K., Sima, M., Stewart, R. J., & Minter, S. D. (2020). Direct bioelectrocatalysis by redox enzymes immobilized in electrostatically condensed oppositely charged polyelectrolyte electrode coatings. *Analyst*, 145(4), 1250-1257. doi:10.1039/c9an02168j
- Mahmassani, Z. S., Reidy, P. T., McKenzie, A. I., Petrocelli, J. J., Matthews, O., de Hart, N. M., Drummond, M. J. (2020). Absence of MyD88 from Skeletal Muscle Protects Female Mice from Inactivity-Induced Adiposity and Insulin Resistance. *Obesity (Silver Spring)*, 28(4), 772-782. doi:10.1002/oby.22759
- McKenzie, A. I., Reidy, P. T., Nelson, D. S., Mulvey, J. L., Yonemura, N. M., Petrocelli, J. J., Drummond, M. J. (2020). Pharmacological inhibition of TLR4 ameliorates muscle and liver ceramide content after disuse in previously physically active mice. *Am J Physiol Regul Integr Comp Physiol*, 318(3), R503-R511. doi:10.1152/ajpregu.00330.2019
- Reidy, P. T., Yonemura, N. M., Madsen, J. H., McKenzie, A. I., Mahmassani, Z. S., Rondina, M. T., Drummond, M. J. (2019). An accumulation of muscle macrophages is accompanied by altered insulin sensitivity after reduced activity and recovery. *Acta Physiol (Oxf)*, 226(2), e13251. doi:10.1111/apha.13251

Centralized Zebrafish Animal Resource (CZAR) Facility

Overview

The CZAR Facility provides state-of-the-art systems for housing, breeding, and performing experiments with zebrafish, an emerging vertebrate model system. The CZAR currently houses approximately 6000 fish tanks with a capacity of 7750 tanks maintained on 5 independent recirculating water systems in the Health Sciences portion of campus. The CZAR also maintains and provides expertise and support services for a new 1000 tank capacity fish system installed in the Crocker Science Center building on main campus, named the “Crocker Science Research Zebrafish” (CBRZ, aka ‘sea breeze’) facility. The communal laboratory space in both locations provide areas for Zebrafish mating, embryo microinjection, and experimental procedures. The design encourages intellectual and experimental synergism among research groups, facilitating 1) large genetic screens carried out as collaborations between multiple laboratories; 2) collaborative research projects that require shared use of specific genetically marked or mutagenized animals; 3) development and distribution of resources and new technologies that advance the research efforts of all laboratories on campus; 4) a teaching environment in which the newest technologies and resources are disseminated quickly; and 5) training and experimental support for laboratories wishing to try pilot zebrafish experiments. These centralized communal spaces have been instrumental in the University’s ability to attract and recruit new Zebrafish faculty members to the University. Currently, 10 laboratories that have large-scale commitments to zebrafish research and 12 additional smaller-scale groups use the CZAR and CBRZ.

The two facilities house approximately 125,000-150,000 fish, including a large number of wild type and mutant fish strains. The CZAR staff provides zebrafish husbandry services including monitoring and troubleshooting observed health issues, testing new diets, and addressing health concerns raised by users.

Services

The CZAR Core Facility is responsible for the daily care and maintenance of the fish and aquatic systems. The facility provides the following services:

- Housing and maintaining zebrafish, monitoring their health, and providing specialized nursery care and diets resulting in high survival rates of young fry.
- Establishing practices and providing oversight to ensure the safety and health of the animals in compliance with IACUC standards and regulations.
- Propagating wild type lines and providing animals from these lines to investigators
- Providing laboratory bench space and supplies to perform experiments
- Providing and maintaining shared-use equipment including 7-8 microinjection stations with bright field stereomicroscopes, and 3 fluorescence stereomicroscopes.
- Providing education and training to investigators and students on an individual basis
- Providing specialized centralized services performed by the permanent staff, such as *in vitro* fertilization, sperm cryopreservation and storage
- Providing Quarantine facilities to house fish from outside sources to generate clean lines to import into the facility.
- Monitoring husbandry success through mating success data and nursery survival rates.

- Propagating individual lab WT or transgenic lines for a nominal fee. This service can be requested through the Cores web site.
- Offering a “Fish School” course for new users to learn best practices in handling and caring for their fish, as well as how to tell male and female fish apart.

Equipment

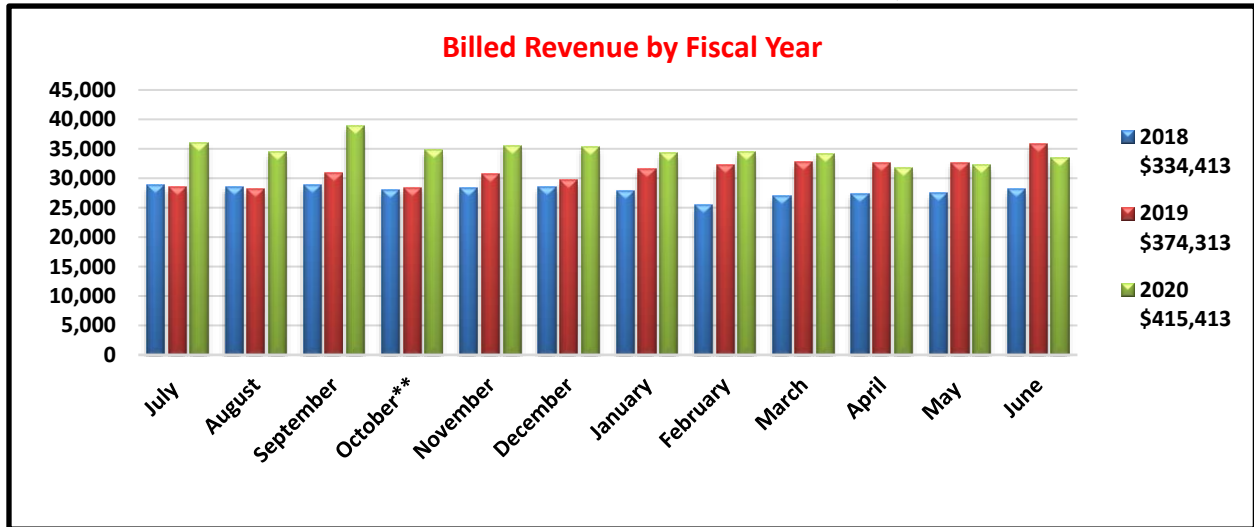
- M205 FA Leica Fluorescence Microscope
- Zeiss Fluorescence Microscope with LED light source
- Olympus Fluorescence Microscope
- 7 microinjection stations with bright field stereomicroscopes
- Analog camera and monitor to facilitate teaching microinjection in real time
- Temperature sensors throughout facility to help monitor the quality of temperature control, and record deviations that could affect fish health.

Personnel

- Maurine Hobbs, PhD, Director
- Sharon Johnson, Senior Laboratory Specialist - Zebrafish Husbandry and WT line maintenance
- Talmage Long, Technician - Nursery Manager
- Nathan Baker, Lab Assistant, CBRZ Manager

2020 Annual Update

- **New Services – Full-time staffing of CBRZ**
- **Revenue/Expenses**
FY20 Expenses: Total \$519,333
FY20 Revenue: Total \$600,413
 - VP of Health Sciences Support: \$150,000
 - VP of Research: \$35,000
 - Total FY20 Revenue Generated from Services: \$415,413



* Legend displays total annual revenue.

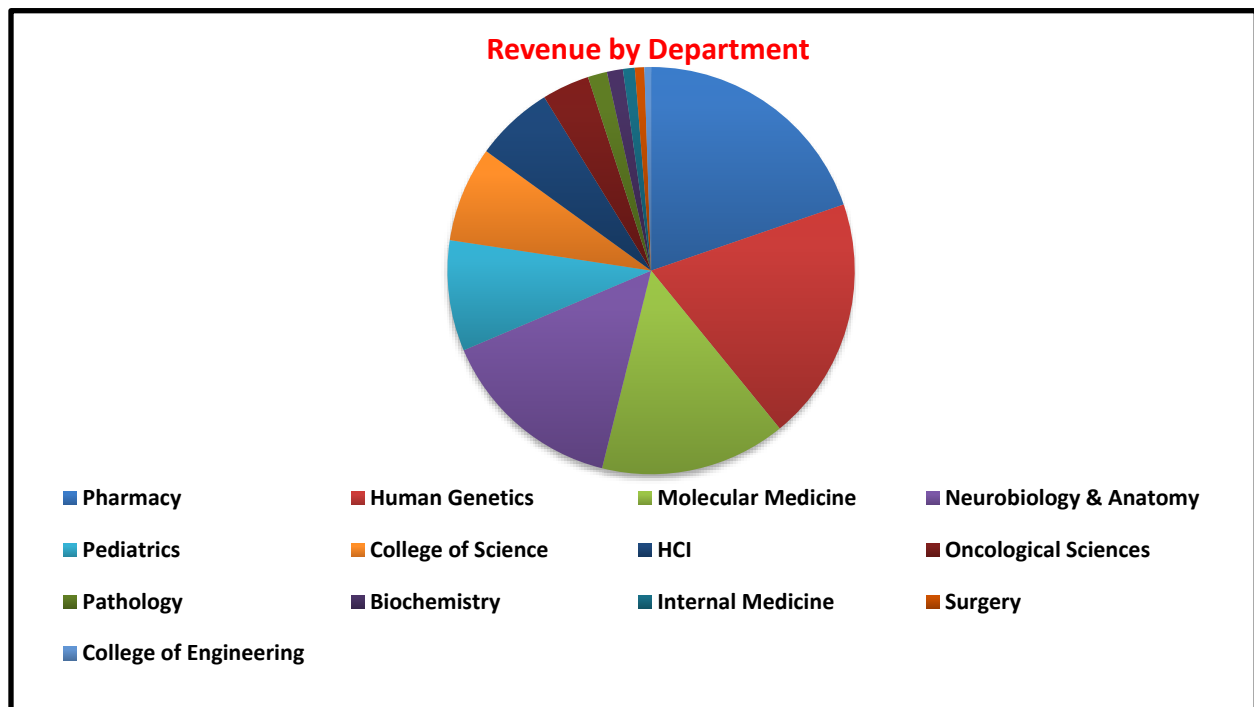
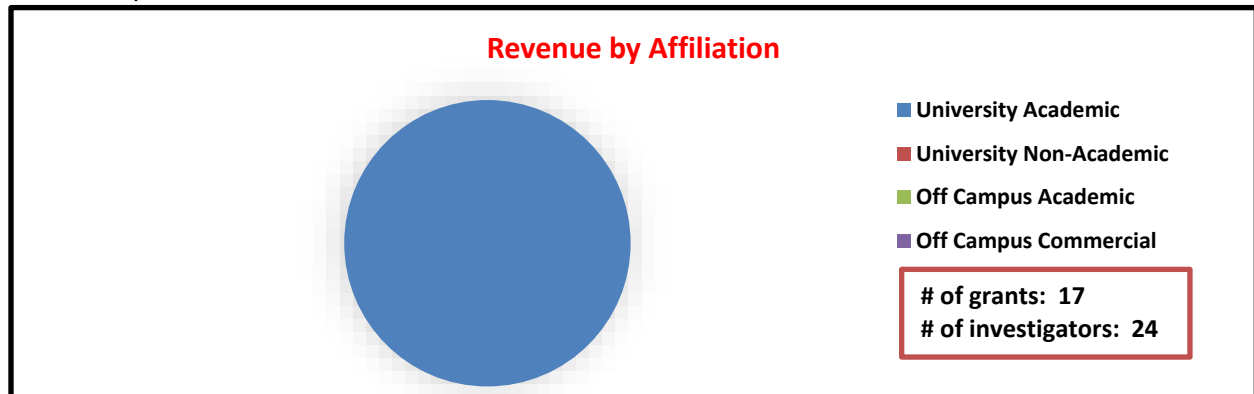
Advisory Board Committee

Last meeting date: 04/22/2020

- Richard Dorsky, Associate Professor, Neurobiology and Anatomy- Chair
- David Jonah Grunwald, Professor, Human Genetics
- Joshua Bonkowsky, Associate Professor, Neurobiology and Anatomy and Pediatrics
- Kristen Kwan, Assistant Professor, Human Genetics
- Amnon Schlegel, Assistant Professor, Internal Medicine
- Rodney Stewart, Assistant Professor, Oncological Sciences
- Randall Peterson, Dean, College of Pharmacy
- H. Joseph Yost, Professor, Neurobiology and Anatomy and Pediatrics

FY20 Scientific Impact

- **Research Support**
- Grunwald, Title: Expansion of a Zebrafish Research Core Facility, Grunwald, 1G20OD018369-01, NIH, \$500,000, 06/01/2014 – 05/31/2015.
- Grants supported by this core, as of July 2018, are listed as an appendix following this report



Top Users

1	Peterson, Randall	Department
2	Yost, H Joseph	NIH, Department
3	Grunwald, David	Department
4	Bonkowsky, Josh	NIH
5	Kwan, Kristen	NIH
6	Dorsky, Richard	Craig H Neilsen Foundation, NIH
7	Gagnon, James	Department
8	Douglass, Adam	NIH
9	Evason, Kimberly	NIH
10	Beckerle, Mary	NIH

Publications

1. Balla, K. M., Rice, M. C., Gagnon, J. A., & Elde, N. C. (2020). Linking Virus Discovery to Immune Responses Visualized during Zebrafish Infections. *Curr Biol*, 30(11), 2092-2103 e2095. doi:10.1016/j.cub.2020.04.031
2. Bryan, C. D., Casey, M. A., Pfeiffer, R. L., Jones, B. W., & Kwan, K. M. (2020). Optic cup morphogenesis requires neural crest-mediated basement membrane assembly. *Development*, 147(4). doi:10.1242/dev.181420
3. Capasso, T. L., Li, B., Volek, H. J., Khalid, W., Rochon, E. R., Anbalagan, A., Roman, B. L. (2020). BMP10-mediated ALK1 signaling is continuously required for vascular development and maintenance. *Angiogenesis*, 23(2), 203-220. doi:10.1007/s10456-019-09701-0
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5. Cassar, S., Adatto, I., Freeman, J. L., Gamse, J. T., Iturria, I., Lawrence, C., Zon, L. I. (2020). Use of Zebrafish in Drug Discovery Toxicology. *Chem Res Toxicol*, 33(1), 95-118. doi:10.1021/acs.chemrestox.9b00335
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Active Grant Support of Zebrafish Research Associated with the UofU CZAR Core Facility FY18

Zebrafish Investigator	Grant Title	Funding Source	Annual Amount of Direct Cost Funding
Bonkowsky	Trans-Cellular Activation Of Transcription To Analyze Dopaminergic Axon Reorganization	NIH/NIMH	\$300,000
Bonkowsky	Characterization Of Genetic Pathways Regulating Connectivity Disruption In Hypoxic Injury	March Of Dimes	\$88,000
Cairns	Howard Hughes Medical Institute	HHMI	\$619,981
Dorsky	Regulation Of Hypothalamic Radial Glia By Wnt Signaling	NIH/NINKS	\$250,000
Grunwald	Expansion of a Zebrafish Research Core Facility	NIH Office of the Director	\$500,000
Grunwald	Gene targeting in zebrafish: building models to assay disease genes	NIH NTNL INST CHILD	\$182,525
Grunwald	A toolkit for gene-targeting in zebrafish	NIH NTNL INST CHILD	\$383,170
Kwan	Hedgehog Signaling and Cilia in Choroid Fissure Morphogenesis and Coloboma	NIH NTNL EYE INSTITUTE	\$335,250
Li	Endothelial Toll-Like Receptor Signaling and Inflammation		\$366,912
Mulvey	Bacterial Invasion And Trafficking Within The Bladder	NIH/NIAIDIA BETE	\$250,000
Rosenblatt	The Role Of Extrusion In Controlling Epithelial Homeostasis	NIH/NIGMED	\$207,475
Rosenblatt	The Role Of Extrusion In Controlling Epithelial Homeostasis	NIH/NIGMED	\$75,000
Schlegel	Molecular Genetics Of Lipid Metabolism	NIH/NIDDIAB ETE	\$209,888
Stewart	Foxd3-Dependent Pathways In Neural Crest Migration And Metastasis	American Cancer Society	\$150,000
Tavtigian	Classifying DNA Mismatch Repair Gene Variants of Unknown Significance	NCI	\$520,565
Tristani-Firouzi	Zebrafish Model Organism Core For The Cardiovascular	NIH	\$164,000
Yost	Genome-Wide Analysis Of Cardiac Development In Zebrafish	NIH/NHLBI	\$1,570,415
Yost	Developmental Biology Training Grant	NIH/NICHD	\$253,526
Total Current Grants, Annual Direct Costs:			\$7,130,167

DNA Peptide Facility

Overview

The DNA Peptide Facility provides researchers with chemical synthesis of custom oligonucleotides and oligopeptides. The facility synthesizes standard DNA/RNA oligos and peptides with multiple purity options, ranging from crude to HPLC. This Core has the ability to incorporate a wide array of specialty modifications, including fluorophore-labeling and functional group derivatization via amino-, thiol-, and modifications compatible with click chemistry. The goal of the facility is to provide quality service with speedy turnaround times.

Services

- Routine and custom DNA synthesis
- Routine and custom RNA synthesis
- Routine and custom Peptide synthesis
- Peptide Purification
- Amino Acid Analysis

Equipment

- Dr. Oligo 192 DNA Synthesizer
- ABI 3900 DNA Synthesizer
- ABI 394 DNA Synthesizer (2)
- ABI 433 Peptide Synthesizer
- ABI 433 Peptide Synthesizer
- Beckman Coulter System Gold 125P HPLC System
- Beckman Coulter System Gold 126 HPLC System
- Hewlett Packard Series 1100 HPLC system (2)
- Beckman Coulter DU800 Spectrophotometer
- BioTek Epoch Plate Reader Spectrophotometer

Personnel

- Mike Hanson, Ph.D., Director
- Jan Mees, Lab Aide
- Meredith Ford, Lab Technician
- Evan Shaw, Lab Technician

2020 Annual Update

New Equipment

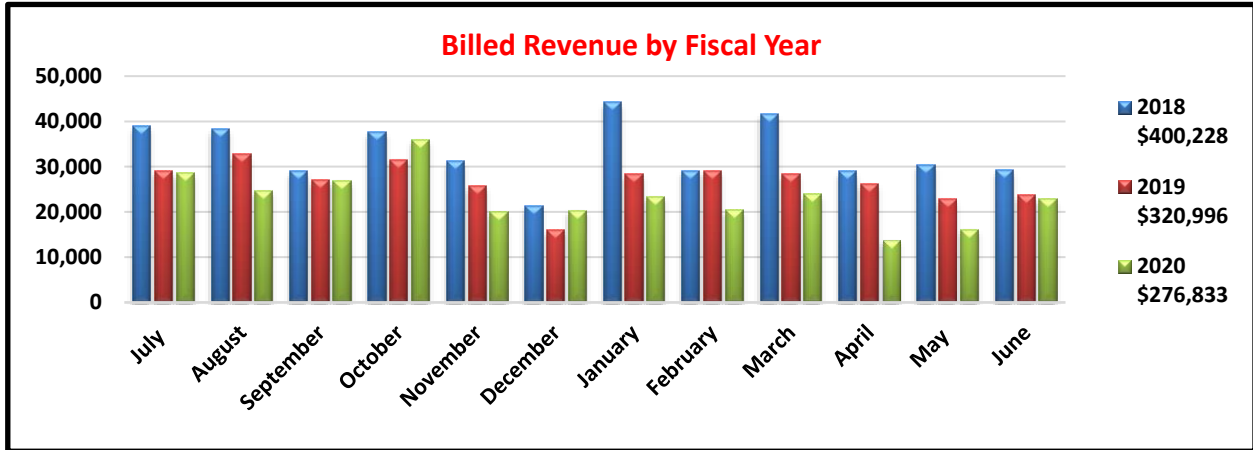
- The DNA Peptide Facility now offers a 25 nmole DNA Synthesis service. These prices make the facility much more competitive with commercial vendors.

Revenue/Expenses

FY20 Expenses: Total \$300,478

FY20 Revenue: Total \$276,833

- VP of Health Sciences Support: \$0
- FY20 Revenue Generated from Services: \$276,833



* Total billed annual revenue displayed in legend.

Advisory Board Committee

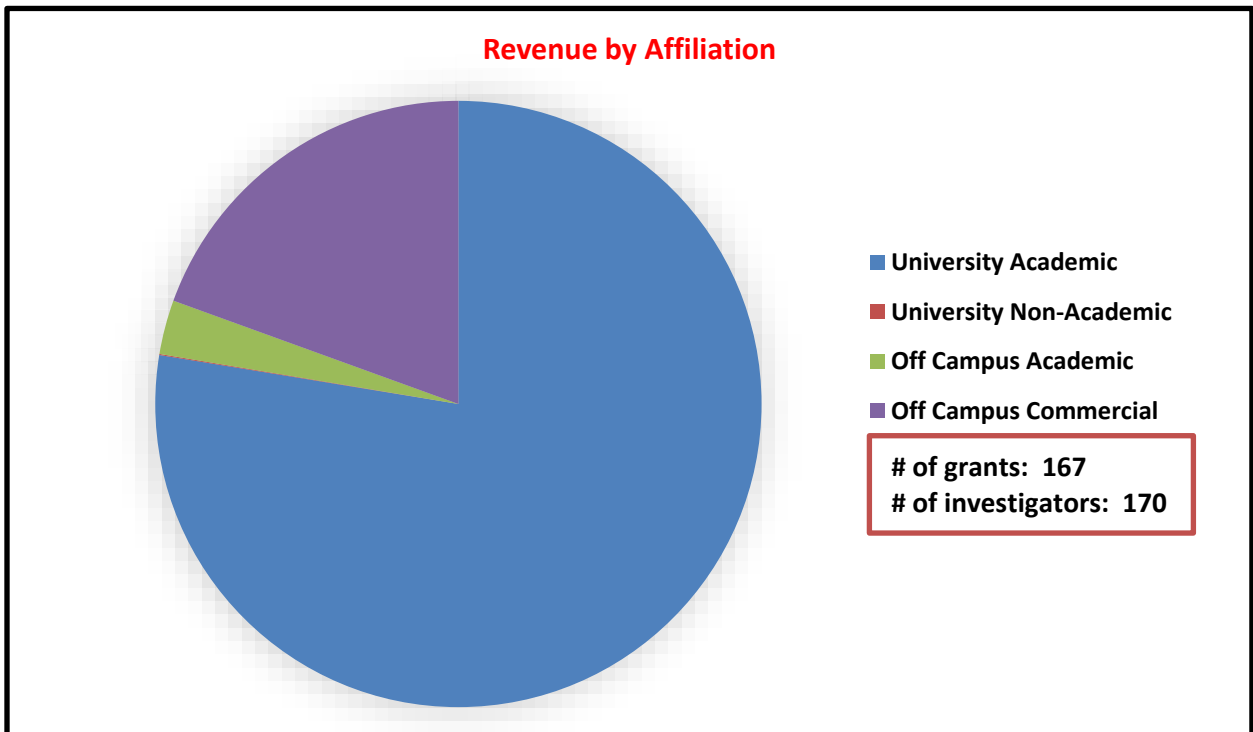
Last meeting date: June 2020

- Raphael Franzini, Professor, College of Pharmacy
- Ming Hammond, Professor, Chemistry Department
- Mahesh Chandrasekharan, Professor, Radiation Oncology

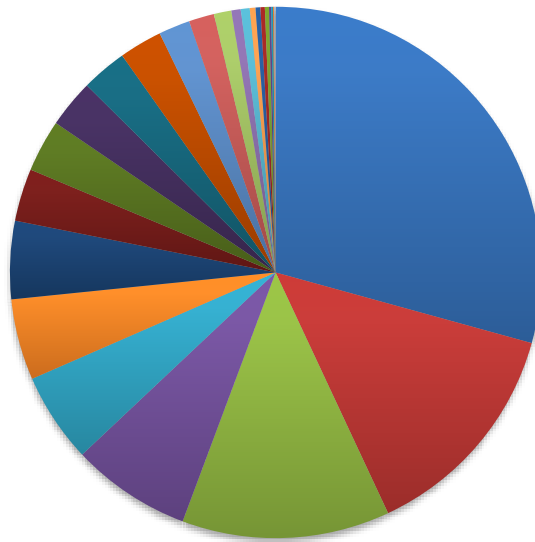
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Biochemistry
- Molecular Medicine
- Neurobiology & Anatomy
- Human Genetics
- Pharmacy
- HCI
- Pediatrics
- Neurology
- Health
- Surgery
- Chemistry
- CVRTI
- Radiation Oncology
- Pharmacology & Toxicology
- College of Science
- Pathology
- Internal Medicine
- Oncological Sciences
- Core Research Facilities
- College of Engineering
- Orthopaedics
- Ophthalmology & Visual Sciences
- Neurosurgery
- Psychiatry
- Dermatology
- Nano Institute
- Population Health Sciences

Top Users

1	BioFire Diagnostics	Commercial
2	Bass, Brenda	NIH
3	Yost, Christian	NIH, USTAR
4	Burrows, Cynthia	NIH
5	Sundquist, Wes	Department, NIH
6	Rutter, Jared	Department, Global FTD Peroxisomal Disorders
7	Silicon Therapeutics	Commercial
8	Emory University	Off Campus Academic
9	Hicks-Davey, Crystal	Off Campus Academic
10	University California Davis	Off Campus Academic

Publications

1. Fleming, A. M., Alenko, A., Kitt, J. P., Orendt, A. M., Flynn, P. F., Harris, J. M., & Burrows, C. J. (2019). Structural Elucidation of Bisulfite Adducts to Pseudouridine That Result in Deletion Signatures during Reverse Transcription of RNA. *J Am Chem Soc*, *141*(41), 16450-16460. doi:10.1021/jacs.9b08630
2. Fleming, A. M., Zhu, J., Howpay Manage, S. A., & Burrows, C. J. (2019). Human NEIL3 Gene Expression Regulated by Epigenetic-Like Oxidative DNA Modification. *J Am Chem Soc*, *141*(28), 11036-11049. doi:10.1021/jacs.9b01847
3. Fleming, A. M., Zhu, J., Jara-Espejo, M., & Burrows, C. J. (2020). Cruciform DNA Sequences in Gene Promoters Can Impact Transcription upon Oxidative Modification of 2'-Deoxyguanosine. *Biochemistry*, *59*(28), 2616-2626. doi:10.1021/acs.biochem.0c00387
4. Han, H., Schubert, H. L., McCullough, J., Monroe, N., Purdy, M. D., Yeager, M., Hill, C. P. (2020). Structure of spastin bound to a glutamate-rich peptide implies a hand-over-hand mechanism of substrate translocation. *J Biol Chem*, *295*(2), 435-443. doi:10.1074/jbc.AC119.009890
5. Lackey, H. H., Peterson, E. M., Harris, J. M., & Heemstra, J. M. (2020). Probing the Mechanism of Structure-Switching Aptamer Assembly by Super-Resolution Localization of Individual DNA Molecules. *Anal Chem*, *92*(10), 6909-6917. doi:10.1021/acs.analchem.9b05563
6. Nze, U. C., Beeman, M. G., Lambert, C. J., Salih, G., Gale, B. K., & Sant, H. J. (2019). Hydrodynamic cavitation for the rapid separation and electrochemical detection of *Cryptosporidium parvum* and *Escherichia coli* O157:H7 in ground beef. *Biosens Bioelectron*, *135*, 137-144. doi:10.1016/j.bios.2019.04.002
7. Tan, Z.; Feagin, T. A.; Heemstra, J. M. "Optical Control of Aptamer-Based Sensors Using a Photocleavable Linker" APTAMERS, v.3, 2019, p.10

DNA Sequencing Facility

Overview

The DNA Sequencing Facility provides DNA sequencing services and employs the latest technologies to generate high quality data with the goal of rapid sample turnaround at competitive prices. DNA sequencing is accomplished with the use of state-of-the-art DNA sequencers and lab robotics such as the Ion Torrent Proton, the Qiagen Q24 Pyrosequencer, 10x Genomics and the Biomek FX for liquid handling needs. Data from standard DNA sequencing services are typically reported to customers the same day as they are run. Sample information can be submitted online and sequencing data files are available online for download using a simple and secure interface. The next generation sequencing platform used has many advantages over other services, including price and sample turnover. We also have the capability of sending samples out for Illumina sequencing with approximately 3 week turnaround time.

Services

DNA Sequencing

- Standard Sanger DNA sequencing
- Primer walking on clones
- Mutation detection and resequencing custom projects
- Ion Torrent NGS sequencing
- Pyrosequencing
- 10x Genomics libraries for both single cell and phasing
- Illumina Sequencing with 3 week turnaround

Cell Line Authentication

- Human Cell Line Authentication by STR

Robotics

- Biomek FX with Span-8 and 96 head

Fragment Analysis

- RNA quality determination (RIN equivalents)
- Fragment sizing and concentrations

10x Genomics Chromium Controller

- Single Cell RNA Seq
- ATAC Seq
- Immune cell profiling

Other Services

- Lab consumables for sample submission
- Life Technologies freezer program

Equipment

Sequencers

- Ion Torrent Proton
- Qiagen Q24 Pyrosequencer
- Applied Biosystems 3730xl

Liquid Handlers

- 1 Biomek FX programmable liquid sample dispenser

Fragment Analysis

- AATI Fragment Analyzer

Personnel

- Derek Warner, Director
- Michael Powers, Senior Laboratory Specialist

**2020 Annual Update
New Equipment**

- 10x Chromium Controller

New Services

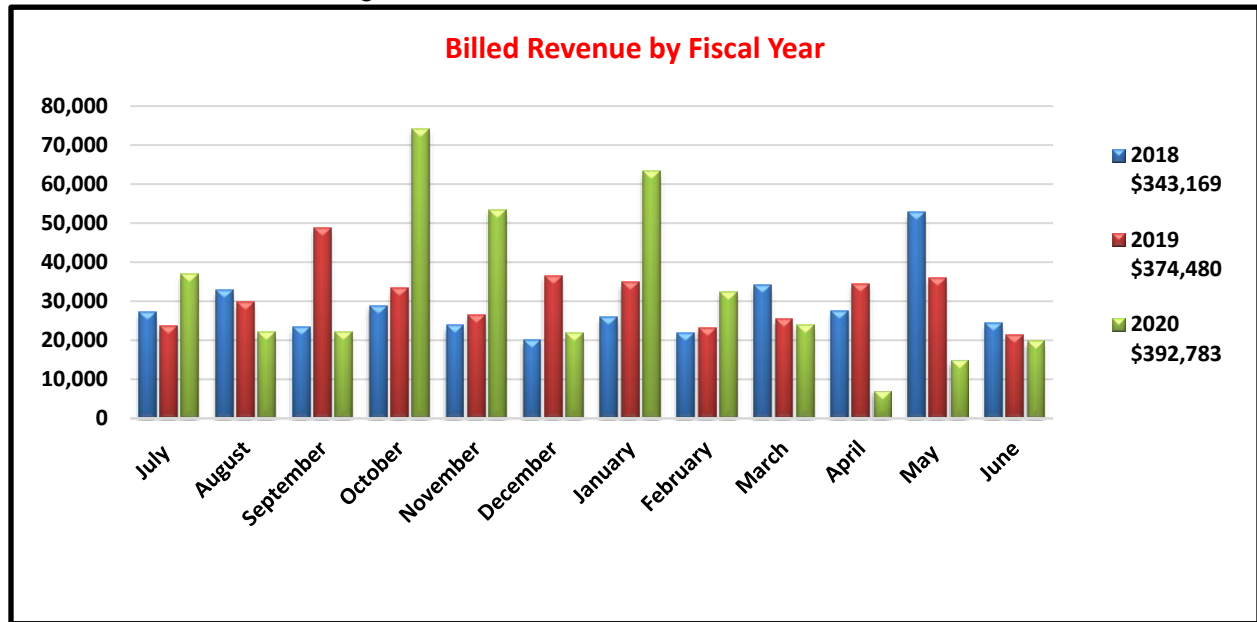
- 10x Workflows

Revenue/Expenses

FY20 Expenses: Total \$440,093

FY20 Revenue: Total \$392,783

- VP of Health Sciences Support: \$0
- FY20 Revenue generated from services: \$392,783



Advisory Board Committee

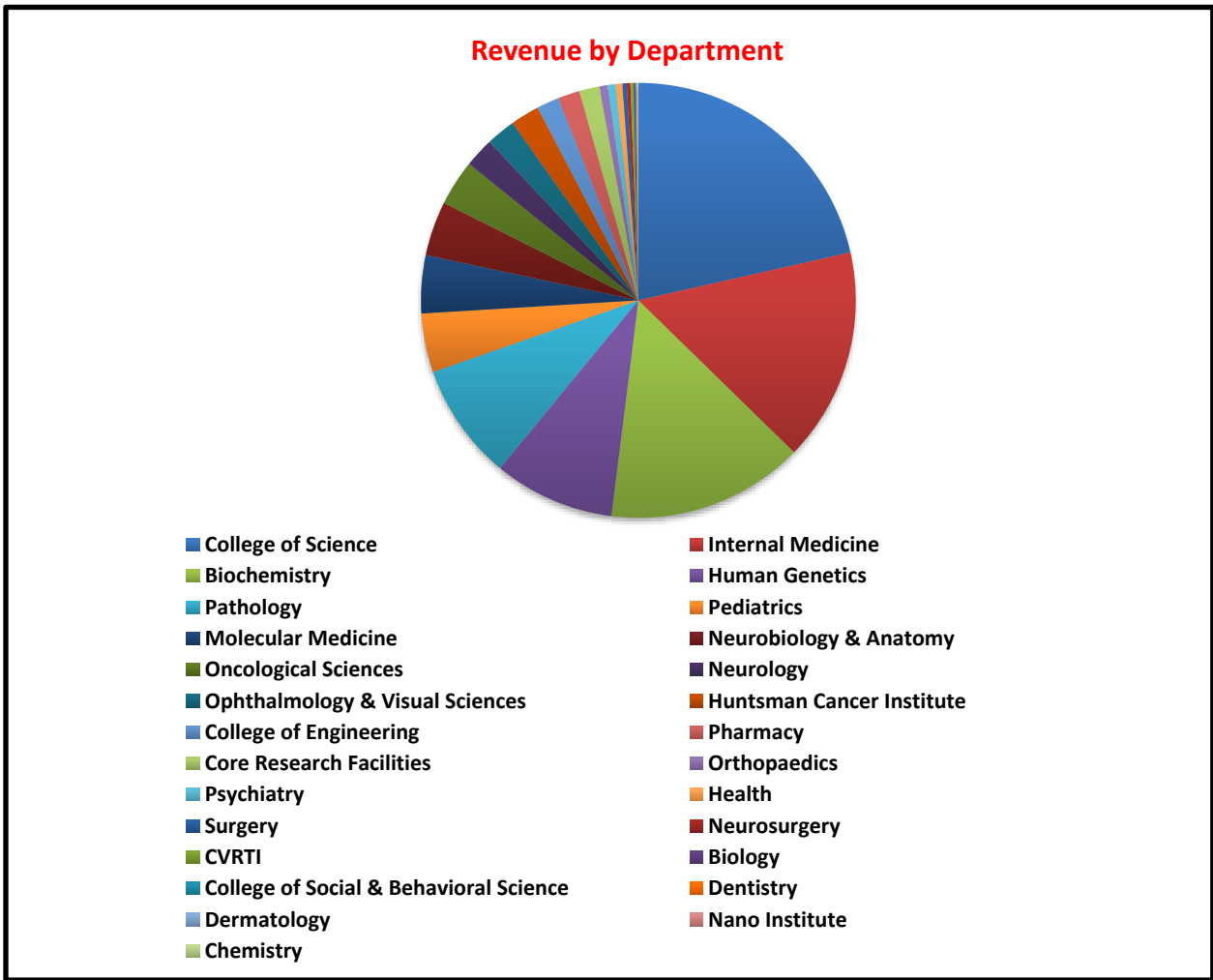
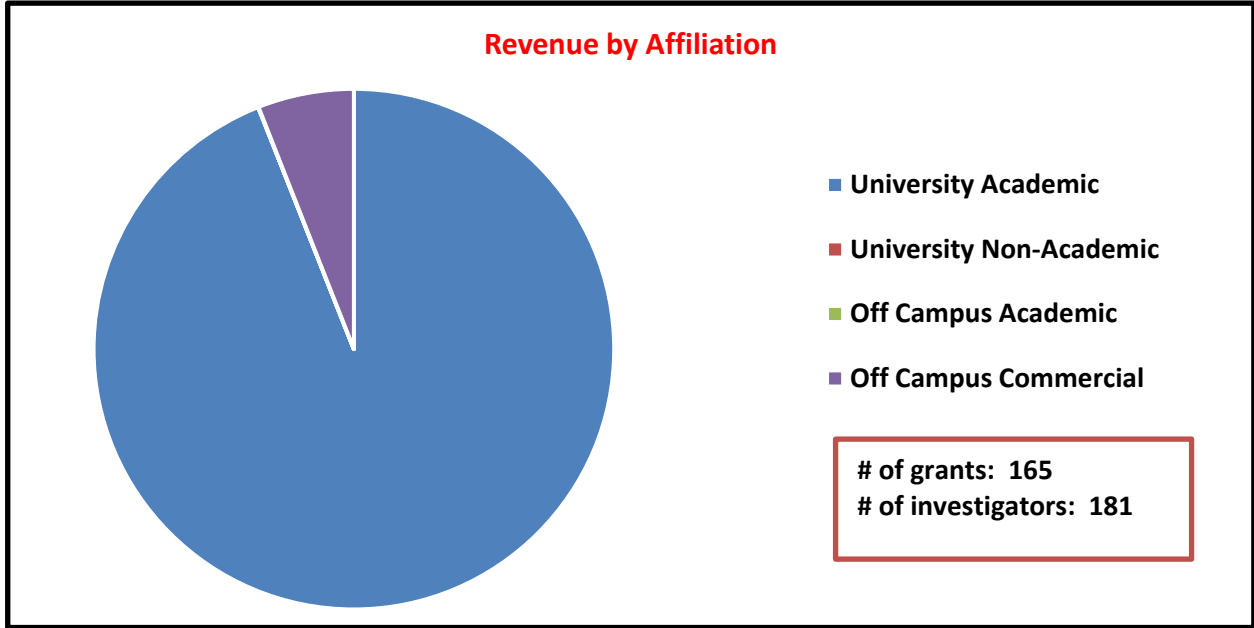
Last meeting date: January 16, 2020

- Lynn Jorde, Professor, Human Genetics
- Colin Dale, Associate Professor, Biology
- Robert Weiss, Professor, Human Genetics

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Top Users

1	Cannon-Albright, Lisa	MD Anderson, Department
2	Dearing, Denise	NSF
3	Sundquist, Wes	NIH
4	Parkinson, John S.	NIH
5	Tristani-Firouzi, Martin	NIH
6	Evalvold, Brian	Department
7	Penovich, Wanda	Department
8	Rowley, Jesse	NIH
9	Capecchi, Mario	Department
10	Hageman, Gregory	Department

Publications

- Deshpande, I., Liang, J., Hedeem, D., Roberts, K. J., Zhang, Y., Ha, B., Manglik, A. (2019). Smoothened stimulation by membrane sterols drives Hedgehog pathway activity. *Nature*, 571(7764), 284-288. doi:10.1038/s41586-019-1355-4
- Fleming, A. M., Zhu, J., Howpay Manage, S. A., & Burrows, C. J. (2019). Human NEIL3 Gene Expression Regulated by Epigenetic-Like Oxidative DNA Modification. *J Am Chem Soc*, 141(28), 11036-11049. doi:10.1021/jacs.9b01847
- Foth, M., Parkman, G., Battistone, B., & McMahon, M. (2020). RAC1 mutation is not a predictive biomarker for PI3'-kinase-beta-selective pathway-targeted therapy. *Pigment Cell Melanoma Res*. doi:10.1111/pcmr.12889
- Franzini, A., Pomicter, A. D., Yan, D., Khorashad, J. S., Tantravahi, S. K., Than, H., Deininger, M. W. (2019). The transcriptome of CMML monocytes is highly inflammatory and reflects leukemia-specific and age-related alterations. *Blood Adv*, 3(20), 2949-2961. doi:10.1182/bloodadvances.2019000585
- Gandelman, M., Dansithong, W., Figueroa, K. P., Paul, S., Scoles, D. R., & Pulst, S. M. (2020). Staufen 1 amplifies proapoptotic activation of the unfolded protein response. *Cell Death Differ*. doi:10.1038/s41418-020-0553-9
- Johnson, J. M., Verkerke, A. R. P., Maschek, J. A., Ferrara, P. J., Lin, C. T., Kew, K. A., Funai, K. (2020). Alternative splicing of UCP1 by non-cell-autonomous action of PEMT. *Mol Metab*, 31, 55-66. doi:10.1016/j.molmet.2019.10.007
- Kanth, P., Boylan, K. E., Bronner, M. P., Boucher, K. M., Hazel, M. W., Yao, R., Delker, D. A. (2019). Molecular Biomarkers of Sessile Serrated Adenoma/Polyps. *Clin Transl Gastroenterol*, 10(12), e00104. doi:10.14309/ctg.000000000000104
- Kim, H. S., Neugebauer, J., McKnite, A., Tilak, A., & Christian, J. L. (2019). BMP7 functions predominantly as a heterodimer with BMP2 or BMP4 during mammalian embryogenesis. *Elife*, 8. doi:10.7554/eLife.48872
- Krah, N. M., Narayanan, S. M., Yugawa, D. E., Straley, J. A., Wright, C. V. E., MacDonald, R. J., & Murtaugh, L. C. (2019). Prevention and Reversion of Pancreatic Tumorigenesis through a Differentiation-Based Mechanism. *Dev Cell*, 50(6), 744-754 e744. doi:10.1016/j.devcel.2019.07.012
- Levykina S, Voronova N. (2019). Comparative analysis of mitochondrial genomes of aphids *Aphis fabae mordvilko* (Börner & Janisch, 1922 и *Aphis craccivora* Koch, 1854) *Results and prospects for the development of entomology in Eastern Europe: collection of articles of the III International scientific and practical conference*, November 19–22, 2019, P.218–222
- Lu, A., Watkins, M., Li, Q., Robinson, S. D., Concepcion, G. P., Yandell, M., Fedosov, A. E. (2020). Transcriptomic Profiling Reveals Extraordinary Diversity of Venom Peptides in Unexplored Predatory Gastropods of the Genus *Clavus*. *Genome Biol Evol*, 12(5), 684-700. doi:10.1093/gbe/evaa083
- Neves, J. L. B., Imperial, J. S., Morgenstern, D., Ueberheide, B., Gajewiak, J., Antunes, A., Olivera, B. M. (2019). Characterization of the First Conotoxin from *Conus ateralbus*, a Vermivorous Cone Snail from the Cabo Verde Archipelago. *Mar Drugs*, 17(8). doi:10.3390/md17080432
- Patel, A. B., Franzini, A., Leroy, E., Kim, S. J., Pomicter, A. D., Genet, L., Deininger, M. W. (2019). JAK2 ex13InDel drives oncogenic transformation and is associated with chronic eosinophilic leukemia and polycythemia vera. *Blood*, 134(26), 2388-2398. doi:10.1182/blood.2019001385
- Ramkumar, N., Stuart, D., Wheatley, W., & Kohan, D. E. (2019). Abstract 095: Mutation in the Furin Cleavage Site of the Prorenin Receptor Attenuates Angiotensin-II Induced Hypertension and Albuminuria. *Hypertension*, 74(Suppl_1), A095-A095. doi:doi:10.1161/hyp.74.suppl_1.095
- Russelburg, L. P., O'Shea Murray, V. L., Demir, M., Knutsen, K. R., Sehgal, S. L., Cao, S., Horvath, M. P. (2020). Structural Basis for Finding OG Lesions and Avoiding Undamaged G by the DNA Glycosylase MutY. *ACS Chem Biol*, 15(1), 93-102. doi:10.1021/acscchembio.9b00639

16. Rybin, M. J., O'Brien, H., Ramiro, I. B. L., Azam, L., McIntosh, J. M., Olivera, B. M., Yoshikami, D. (2020). alphaM-Conotoxin MIIIJ Blocks Nicotinic Acetylcholine Receptors at Neuromuscular Junctions of Frog and Fish. *Toxins (Basel)*, 12(3). doi:10.3390/toxins12030197
17. Snook, J. P., Soedel, A. J., Ekiz, H. A., O'Connell, R. M., & Williams, M. A. (2020). Inhibition of SHP-1 Expands the Repertoire of Antitumor T Cells Available to Respond to Immune Checkpoint Blockade. *Cancer Immunol Res*, 8(4), 506-517. doi:10.1158/2326-6066.CIR-19-0690
18. Son, J. H., Stevenson, T. J., Bowles, M. D., Scholl, E. A., & Bonkowsky, J. L. (2020). Dopaminergic Co-Regulation of Locomotor Development and Motor Neuron Synaptogenesis is Uncoupled by Hypoxia in Zebrafish. *eNeuro*, 7(1). doi:10.1523/ENEURO.0355-19.2020
19. Thompson, B. A., Snow, A. K., Koptiuch, C., Kohlmann, W. K., Mooney, R., Johnson, S., Tavtigian, S. V. (2020). A novel ribosomal protein S20 variant in a family with unexplained colorectal cancer and polyposis. *Clin Genet*, 97(6), 943-944. doi:10.1111/cge.13757
20. van Hout, M., Valdes, A., Christensen, S. B., Tran, P. T., Watkins, M., Gajewiak, J., McIntosh, J. M. (2019). alpha-Conotoxin VnIB from *Conus ventricosus* is a potent and selective antagonist of alpha6beta4* nicotinic acetylcholine receptors. *Neuropharmacology*, 157, 107691. doi:10.1016/j.neuropharm.2019.107691
21. Vertelko V, Shulinski R, Voronova N (2019). Software development for the targeted assembly of target genes from genome-wide insect sequencing data. *Results and prospects for the development of entomology in Eastern Europe: collection of articles of the III International scientific and practical conference*. Minsk: A. Varaksin, 2019. – P.90-92
22. Voronova, N. V., Levykina, S., Warner, D., Shulinski, R., Bandarenka, Y., & Zhorov, D. (2020). Characteristic and variability of five complete aphid mitochondrial genomes: *Aphis fabae mordvilko*, *Aphis craccivora*, *Myzus persicae*, *Therioaphis tenera* and *Appendisetia robiniae* (Hemiptera; Sternorrhyncha; Aphididae). *Int J Biol Macromol*, 149, 187-206. doi:10.1016/j.ijbiomac.2019.12.276
23. Voronova, N. (2019). The genetic basis of insecticide resistance in aphids: an evolution that plays against us. *Results and prospects for the development of entomology in Eastern Europe: collection of articles of the III International scientific and practical conference*, P.100–102.
24. Voronova N, Levykina S, Mishuk E, Vyshydkevich V (2019). Aphid's mitochondrial genomes: evolution's patterns, features and restrictions. Factors in experimental evolution of organisms: comp. of scientific res. *National Academy of Sciences of Ukraine, Institute of Molecular Biology and Genetics, Ukr. partnership of geneticists and breeders named after Vavilov*, V. 25. – P. 373-374.
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26. Voronova N, Shulinski R, Bandarenka Y, Vertelko V, Zhorov D. (2019). *Aphis craccivora* koch, 1854 (Hemiptera; aphididae): gene composition detoxification system. Results and prospects for the development of entomology in Eastern Europe: collection of articles of the III International scientific and practical conference, November 19–22, 2019, Minsk. Minsk: A. Varaksin, 2019. – P.103–105.
27. Voronova, N. V., Warner, D., Shulinski, R., Levykina, S., Bandarenka, Y., & Zhorov, D. (2019). The largest aphid mitochondrial genome found in invasive species *Therioaphis tenera* (Aizenberg, 1956). *Mitochondrial DNA Part B*, 4(1), 730-731. doi:10.1080/23802359.2018.1561217
28. Yuan, M., Abdellaoui, S., Chen, H., Kummer, M. J., Malapit, C. A., You, C., & Minteer, S. D. (2020). Selective Electroenzymatic Oxyfunctionalization by Alkane Monooxygenase in a Biofuel Cell. *Angew Chem Int Ed Engl*, 59(23), 8969-8973. doi:10.1002/anie.202003032

Drug Discovery Facility

Overview

The Drug Discovery Facility provides small molecule compound collections for screening in biologic assays. The facility delivers low-cost and efficient access to chemical libraries for screening, a diverse array of equipment for automation, and synthetic chemistry support for the characterization and validation of compounds to be further developed as therapeutics, diagnostics and biological sensors or tools.

Uniqueness

The University of Utah possesses the scientific and medical talent, innovation research culture, and state-of-the-art research facilities to contribute substantially to the discovery of small molecule drugs. However, significant challenges still remain in translation of basic scientific discoveries into potential human therapeutics. The uniqueness of the Drug Discovery Facility is it coordinates the cooperative efforts of individual research groups in a wide variety of different drug discovery studies, ultimately leading to discover novel chemical probes and new pharmaceutical lead compounds.

The most valuable assets at the facility are the private/proprietary chemical collections that could result in new intellectual property. These unique molecules of therapeutic potential offer the facility to assist in the translation of fundamental discoveries in biology into novel therapeutics and commercial opportunities. It's anticipated that the discovery of candidate lead compounds from the facility will stimulate interest in commercial development of technology at the University of Utah through licensing agreements with pharmaceutical industry partners and the production of new start-up biotechnology companies.

Services

- High-throughput screening
- Small molecule chemical libraries
- Pooled CRISPR-Cas9 libraries/Screening
- Assay development
- Consultation on target identification/validation, hit to lead optimization, PK/PD/Efficacy
- Chemical support for drug discovery
- CRISPR gene editing in cells

Viral Packaging Service

- Small/large scale viral (lentivirus, adenovirus, adeno-associated virus) packaging, titrations, concentrations and transductions of cells of interest.
- Lentivirus delivery of Cas9 and sgRNA

Equipment/Compound Collection

Automated Liquid Handling Stations:

- Tecan EVO100/MCA96 Liquid Handler with sterile bio-hoods
- Tecan EVO100/MCA384 Liquid Handler with sterile bio-hoods
- HP D300 Digital Dispenser
- Axygen Platemax semi-automatic plate sealer
- KingFisher Duo Prime System – Automated DNA/RNA Extraction and Protein/Cell Purification

Automated Detection Systems:

- Molecular Devices ImageXpress XLS Automated High-Content System
- Bio-tek Plate Neo 2 Plate Reader with stacker

CRISPR Libraries:

- The genome-scale CRISPR-Cas9 knockout (GeCKO) v2 library
- The human CRISPR Brunello lentiviral pooled libraries
- Subset CRISPR libraries: a) human Lentiviral sgRNA library-kinases, and b) human Lentiviral sgRNA library-nuclear proteins

Commercial Compound Libraries:

- Chembridge Diverset EXP(50K) and CL (50K)
- Microsource Spectrum Collection
- NIH Clinical Collection
- Epigenetics Screening Library
- Kinase Inhibitor Library
- NCI Diversity Set IV
- Natural Products Set III
- Enamine 3D Diversity Set (50K)
- NIH Approved Oncology Drugs Set II
- NIH Natural Products Set IV
- Mechanistic Set III
- **University of Utah metabolite library v1.0**

Private/Proprietary Chemical Collections:

- UUPCC – University of Utah Private Chemical Collection
- Dept. of Chemistry Library
- Ireland Natural Product Collection

Personnel

- Bai Luo, Ph.D., Director

2020 Annual Update**New Service:**

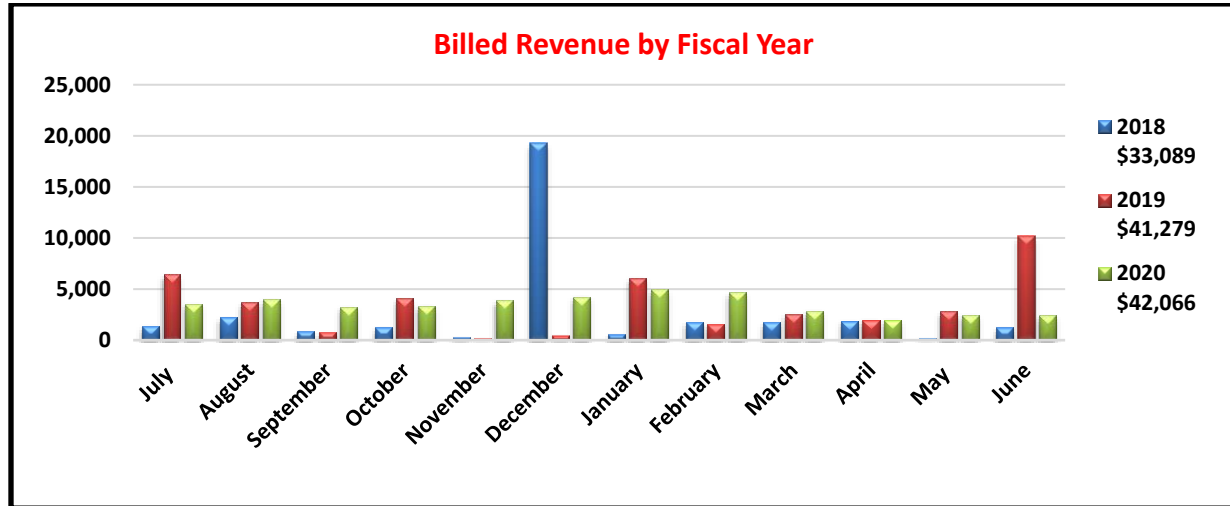
- **CRISPR Knockout/Knockin Cell Line Production** – In collaboration with the Mutation Generation and Detection Core, we started to offer a full cell line generation service from sgRNA design/construction to final cell line generation/verification.

Revenue/Expenses

FY20 Expenses: Total \$148,781

FY20 Revenue: Total \$122,066

- VP of Health Sciences Support: \$80,000
- FY20 Revenue Generated from Services: \$42,066



* Total annual revenue displayed in legend.

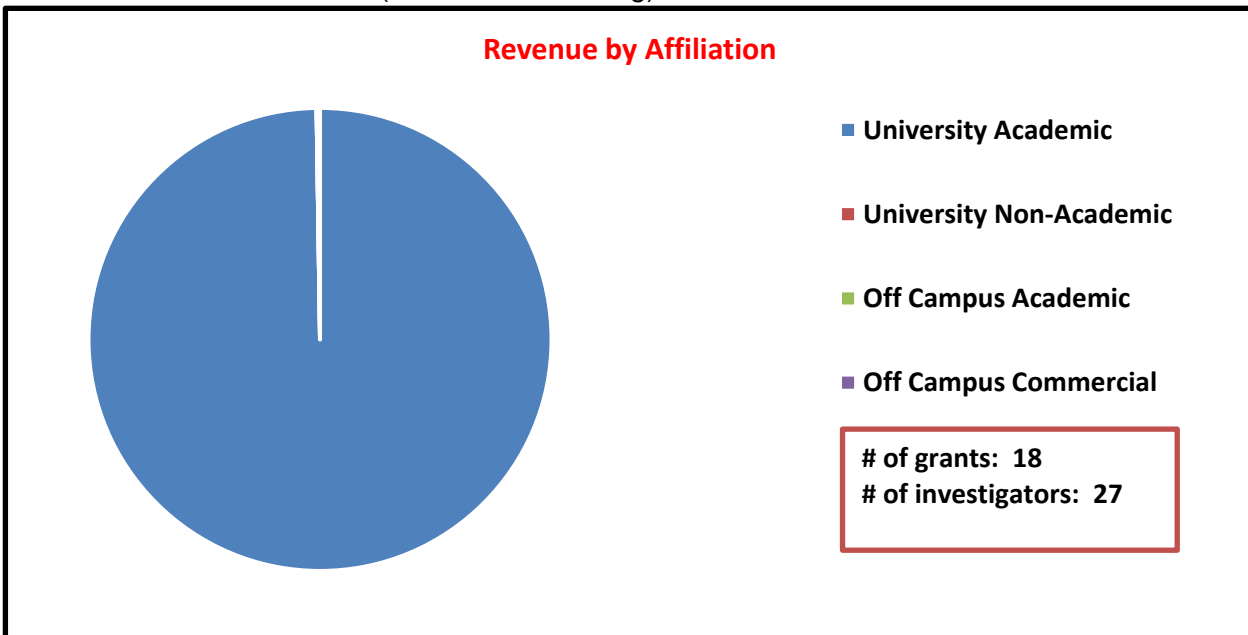
Advisory Board Committee

- Darrell Davis, Professor, College of Pharmacy
- Ryan Looper, Associate Professor, Chemistry Department
- John Phillips, Professor, Internal Medicine
- Jared Rutter, Professor, Department of Biochemistry
- Bryan Welm, Associate Professor, HCI

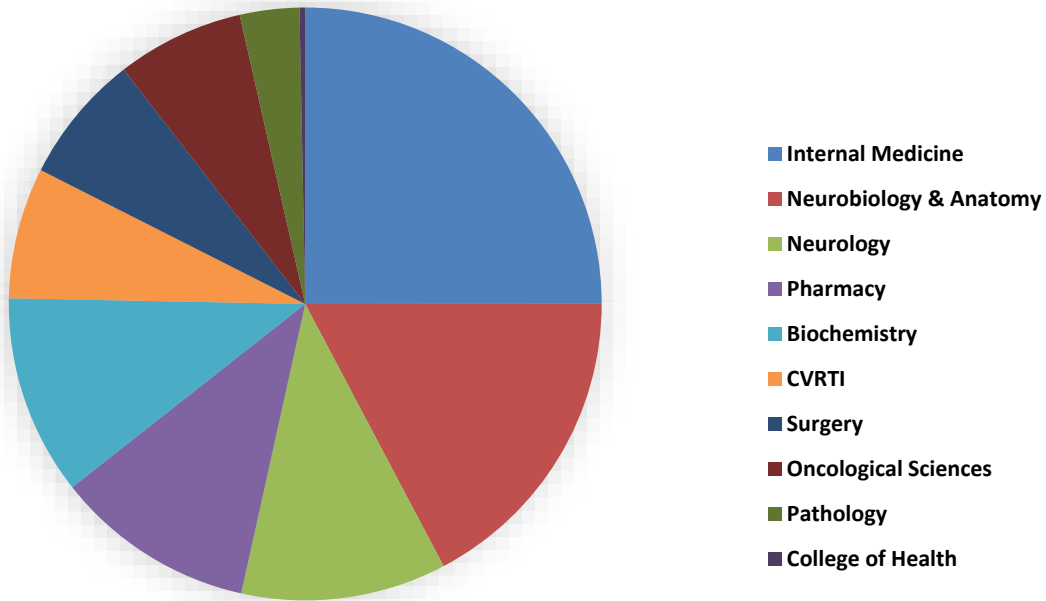
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



Top Users

1	Zhu, Weiquan	Department
2	Penovich, Wanda	Department
3	Rutter, Jared	Department
4	Shepherd, Jason	NIH, Ziegler Foundation
5	Chaudhuri, Dipayan	University of Utah Research Foundation
6	Peterson, Randall	Department
7	Agarwal, Jay	Department
8	Williams, Megan	University of Utah Research Foundation
9	Edgar, Bruce	NIH
10	Wynne, Brandi	American Society of Nephrology

Goals for FY21

- Expand CRISPR Screening Service
- Increase user base/revenue
- Present services in various department seminar series

Publications

No publications acknowledged this facility in FY20.

Electron Microscopy

Overview

The Electron Microscopy (EM) Core Laboratory utilizes transmission electron microscopy and scanning electron microscopy to determine cellular structures, the morphology of biological macromolecules, the three-dimensional structures of biological macromolecules and cells, and the size and structure of nanoparticles and other small particles. The EM facility also prepares specimens for the microscope. The EM facility has four spatially distinct locations to serve the needs of the clinical and research groups. The main facility is in SMBB, and two transmission electron microscopes (TEMs) are located there. Two TEMs and one scanning electron microscope (SEM) are located in CSC. RB LAB and BIOL each house one TEM.

Services

Clinical Services:

- Thin-section electron microscopy of tissue biopsies (technical portion of clinical EM)

Research Services:

- Training on the TEMs, SEM, microtomes, sample preparation, and 3D image reconstruction
- Sections ("thick" and "thin") cut on microtome or ultramicrotome
- Prepare tissue and cellular specimens via embedding, drying, osmification, thin-sectioning, and cryogenic methods.
- Prepare particulate and macromolecular samples by staining, metal coating, and cryogenic methods
- Record SEM images
- Record TEM images of dry specimens or cryogenic, hydrated specimens
- Image specimens via three-dimensional electron microscopy, including tomography
- High-resolution imaging (in some cases distances $< 3 \text{ \AA}$ can be resolved)
- Remote access to TEMs and SEM

Equipment:

- JEOL JEM-1400 Plus, transmission electron microscope
- ThermoFisher Tecnai 12, transmission electron microscope
- Two Hitachi 7100, transmission electron microscopes
- ThermoFisher Tecnai F20, transmission electron microscope, with Gatan K2 Summit direct electron detector
- ThermoFisher Titan Krios, transmission electron microscope, with Ceta camera, Gatan energy filter, Volta phase plate, and Gatan K3 direct electron detector
- Zeiss GeminiSEM 300 scanning electron microscope
- Leica UC7 ultramicrotome, with cryogenic attachments
- Three Leica UC6 ultramicrotomes
- Leica UCT ultramicrotome
- Reichert Ultracut E ultramicrotome
- Leica JUNG RM2055, microtome
- ThermoFisher Vitrobot, vitrification robot
- Two automatic tissue processors
- Pelco laboratory microwave oven
- Sputter coater
- Glow discharger
- Baltec HPM010 high-pressure freezer

- Freeze substitution machine
- Critical-point dryer
- Access to university's high-performance computing nodes (CHPC)

Personnel

- David Belnap, Ph.D., Director
- Nancy Chandler, Senior Laboratory Specialist
- Bryan Gustafson, Laboratory Technician
- Willisa Liou, Ph.D., Senior Laboratory Specialist
- Linda Nikolova, Senior Laboratory Specialist
- David Timm, Ph.D., Director of Cryo-EM

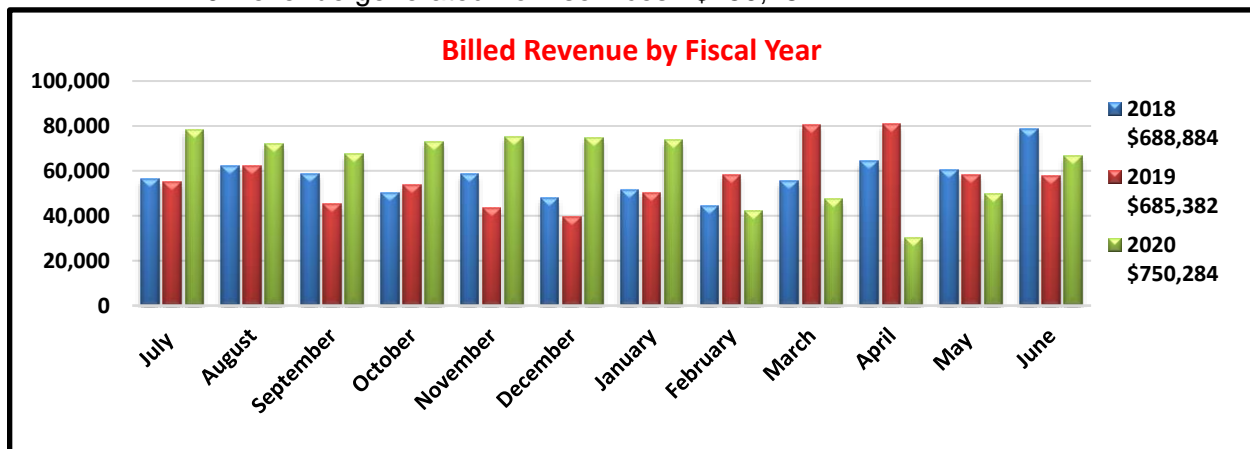
2020 Annual Update

Revenue/Expenses

FY20 Expenses: Total \$783,122

FY20 Revenue: Total \$807,784

- VP of Health Sciences Support: \$20,000
- VP of Research Support : \$37,500
- FY20 Revenue generated from services: \$750,284



*Legend displays total annual revenue by year earned.

Advisory Board Committee

Last in-person meeting date: March 2, 2017. Email contact since.

- Erik Jorgensen, Distinguished Professor, Department of Biology
- Patricia Revelo, Professor, Department of Pathology
- Erhu Cao, Assistant Professor, Department of Biochemistry
- Richard Rabbitt, Professor, Department of Bioengineering

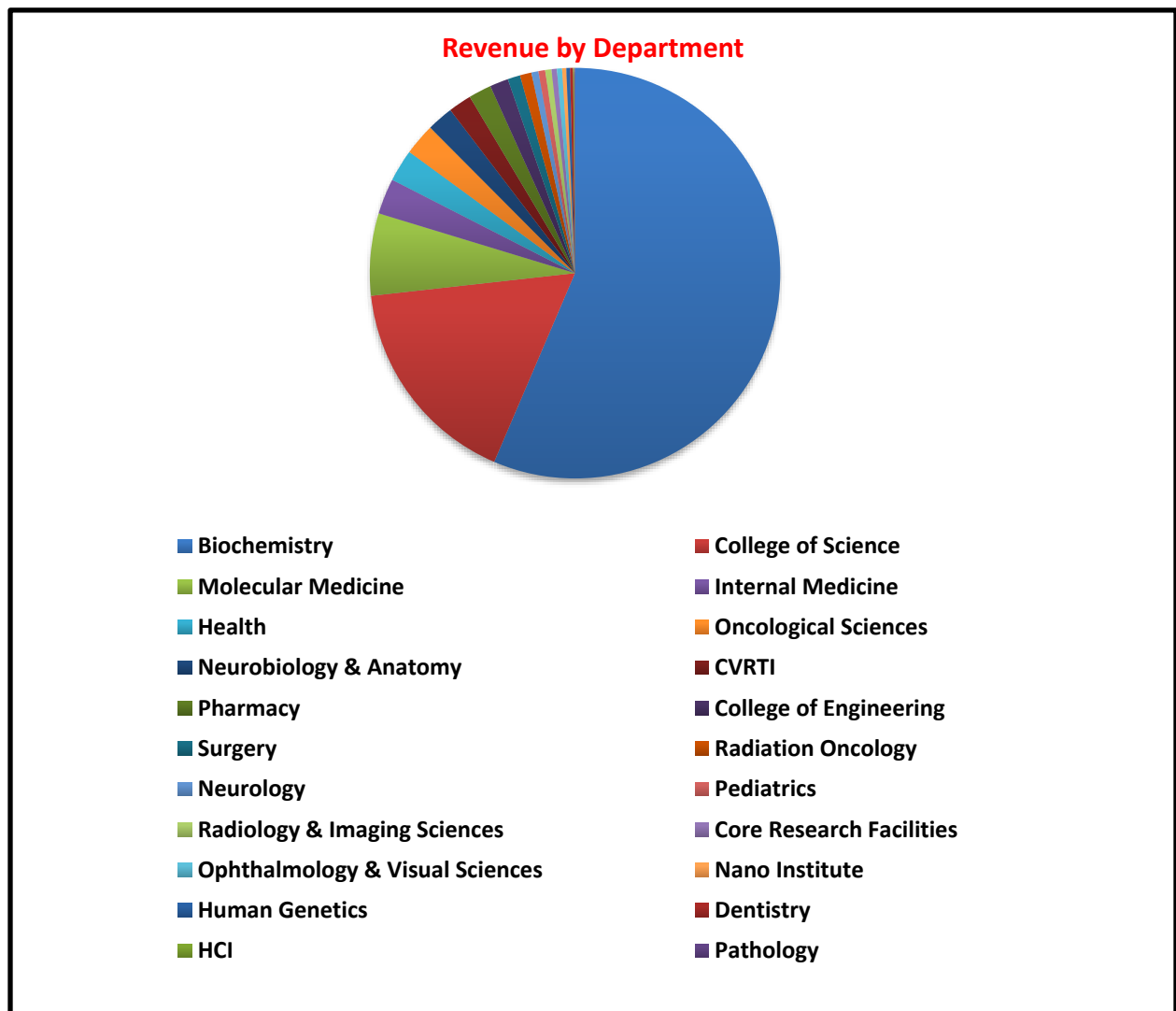
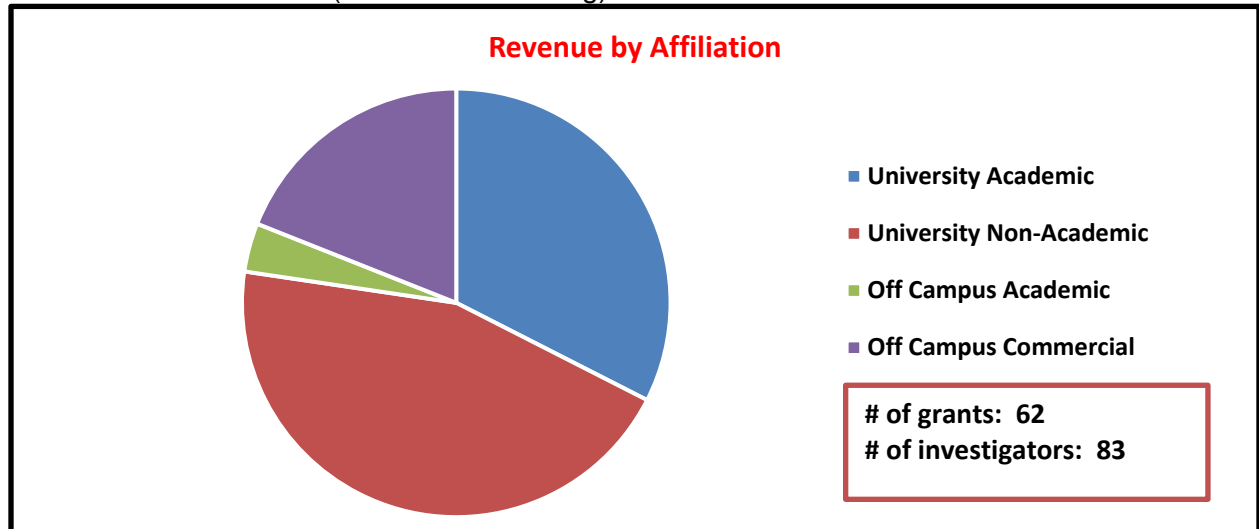
Cryo-EM Implementation Committee

Last meeting date: August 27, 2020.

- Julia Brasch, Assistant Professor, Department of Biochemistry
- Christopher Hill, Distinguished Professor and Co-Chair, Department of Biochemistry
- Wesley Sundquist, Distinguished Professor and Co-Chair, Department of Biochemistry
- Erhu Cao, Assistant Professor, Department of Biochemistry
- Peter Shen, Assistant Professor, Department of Biochemistry
- Heidi Schubert, Research Associate Professor, Department of Biochemistry

**FY20 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Top Users

1	ARUP	University Non-Academic
2	Shen, Peter	Department
3	Saint John's Medical Center	Off Campus Commercial
4	Hill, Christopher	Department, NIH
5	Primary Children's Medical Center	Off Campus Commercial
6	Attostat	Off Campus Commercial
7	Cao, Erhu	Department, NIH
8	Utah State University	Off Campus Academic
9	Jorgensen, Erik	Department
10	Saffarian, Saveez	NIH, NSF

Goals for FY21

- Continue obtaining high-quality TEM data from new Titan Krios microscope
- Maintain high-quality clinical services
- Increase research usage
- Increase usage of microscopes
- Improve efficiency of labs by consolidation or other means
- Become proficient at tomography and micro electron diffraction methods

Publications

No known publications acknowledged this facility in FY 20.

Flow Cytometry Facility

Overview

The Flow Cytometry Facility offers quantitative, multi-parameter fluorescence analysis, and cell sorting services that assists over 90 investigators including a subset of industry clients. The expertise and instrumentation to perform most flow cytometric assays that have been described in the literature are available within the expertise of the collective personnel and the physical resources of the Flow Cytometry Facility. The facility offers investigators the entire spectrum of cytometric experiment management, if desired, all the way from initial design consultation to the creation of graphics for publication.

Uniqueness

The Flow Cytometry facility is recognized for the most part as an instrumentation based service lab. However, we believe that education is a crucial component for the growth and sustainability of the facility. First, facility staff are encouraged to maintain state of the art knowledge in order to pass this information along to the users for obtaining optimal experimental results. Secondly, we believe that education in the field of flow cytometry for users will lead to more complex experimental design that ensures positive outcomes that in turn will increase overall usage. To this end, we provide multiple levels of education from one on one consultation to routine seminars covering a variety of topics. Although this may not be unique when compared to other Core facilities, it is a noticeable quality of our services when compared to other non-centralized instrumentation on campus.

Services

The assays offered by the facility range from routine cell cycle analysis and immunophenotyping to complex multi-laser applications and high-speed cell sorting. Examples of the assays available include, but are not limited to the following:

- DNA content/cell cycle measurement
- Immunofluorescence analyses
- Characterization of cell populations based on scattered light intensity measurements and autofluorescence
- Cell sorting including viable, sterile cell sorting
- Intracellular calcium flux
- A range of apoptosis assays
- Fluorescence Resonance Energy Transfer (FRET)
- Nanoparticle characterization
- Bivariate and univariate chromosome analysis
- Receptor-ligand interactions
- Cell proliferation studies including BrdU incorporation and CFSE tracking
- Viability assays (membrane exclusion and metabolic viability)
- Various function assays including oxidative metabolism, neutrophil function (oxidative burst, phagocytosis) cytoplasmic pH, membrane potential
- Kinetic analyses
- Signal transduction pathway analyses (simultaneous assessment of multiple intracellular phosphorylated epitopes combined in complex multi-color assays)
- Sample preparation and staining

Consultation and training is provided in order to define projects in the early stages of development to make optimal and efficient use of flow cytometry. The staff will prepare samples including staining, data collection, quality control, data analysis/interpretation, and creation of graphics. Alternatively, if the investigator chooses, the facility can provide consultation only on any of the above services so that the research is entirely in the hands of the investigator.

Equipment

Sorters

- BD FACSAria-5 laser
- Propel Labs Avalon-2 laser
- BD FACSAria-4 laser

Analyzers

- BD FACSCanto
- BD LSRFortessa
- Beckman Coulter Cytoflex LX
- Beckman Coulter Cytoflex S
- Beckman Coulter Cytoflex
- BD Celesta
- Cytex DxP
- Cytex Aurora
- Amnis Imagestream (pending funding)

Personnel

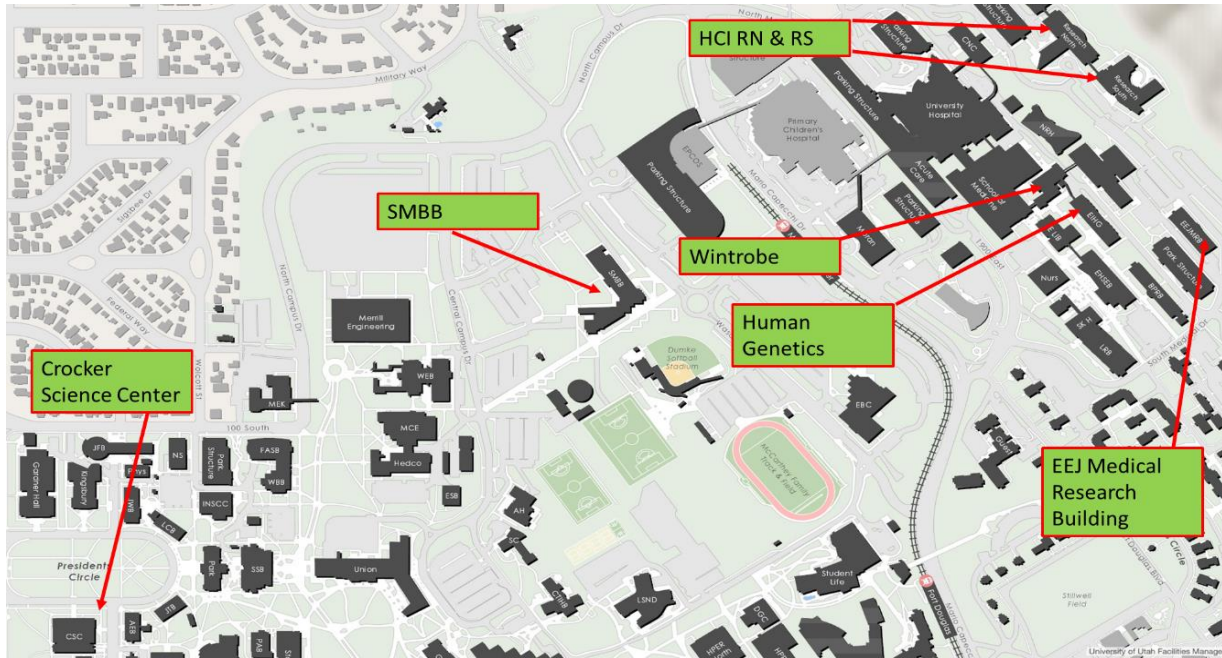
- James Marvin, Director
- Tessa Galland, Senior Lab Technician
- Nidhi Choksi, Senior Lab Technician
- Kirk Heitpas, Lab Technician
- Josh Monts, Senior Lab Technician

FY20 Annual Update

New Equipment

The Flow Cytometry Core has continued to provide instrumentation oversight including training and quality control measures for the Pathology department. In FY20 both the Pathology department as well as the Flow Cytometry Core Facility purchased 5 laser spectral analyzers from Cytex. These instruments provide an incredible increase in the amount of colors that are now achievable in a single tube. Panels including up to 30 colors are now routinely acquired. FY20 also saw a continuation of the recent expansion of satellite instruments. The newest addition was a 4 laser Cytoflex S that was installed in SMBB. Below is a map of campus showing where the Flow Core now has instrumentation. In addition, although we are still waiting for our official funding announcement, we are confident that an Amnis Imagestream will be funded and installed shortly.

In order to address the growing concern over biosafety measures with cell sorting, we have installed a BioBubble enclosure around both the Aria Cell Sorters. These cabinets essentially create negative pressure around the sorter and add another layer of protection for the sorter operator.



Staffing

Josh Monts is the newest addition to the Flow Cytometry Core Facility. Josh had 3 years previous experience working in a core facility so he was able to plug in immediately with very little training and supervision.

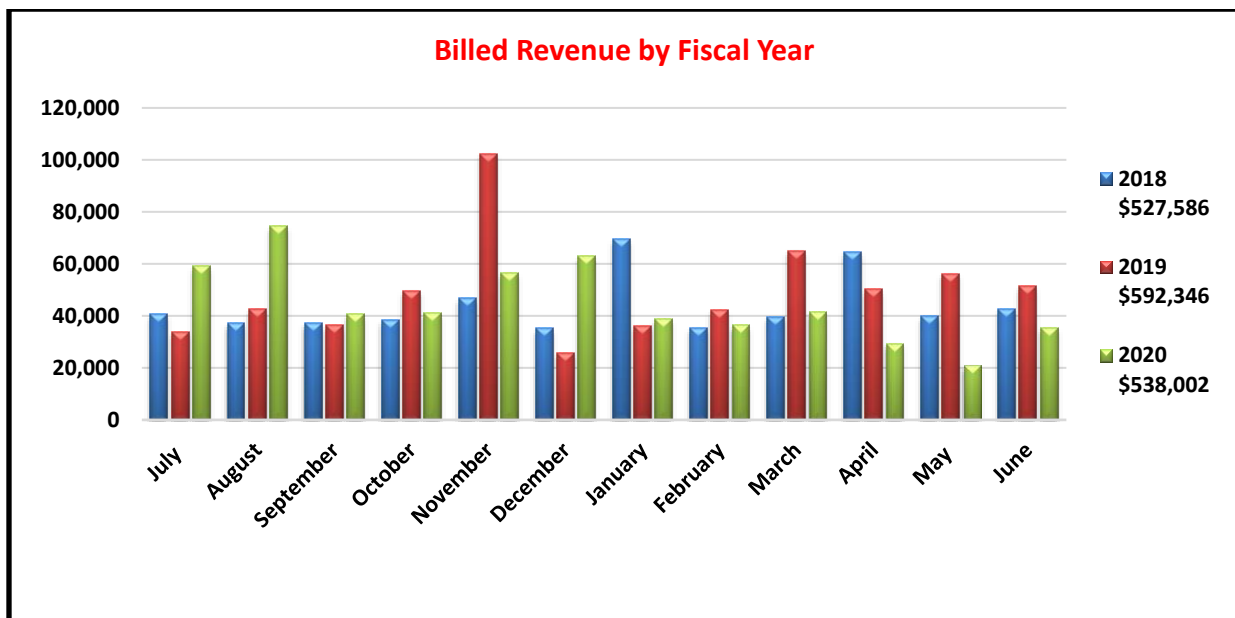
Revenue/Expenses

FY20 Expenses: Total \$1,059,988

FY20 Equipment Expenses: \$497,250

FY20 Revenue: Total \$1,035,320

- VP of Research Support (RIF): \$242,375
- Dept. Support for Equipment: \$254,943
- FY20 Revenue generated from services: \$538,002



* Total annual revenue displayed in legend.

Advisory Board Committee

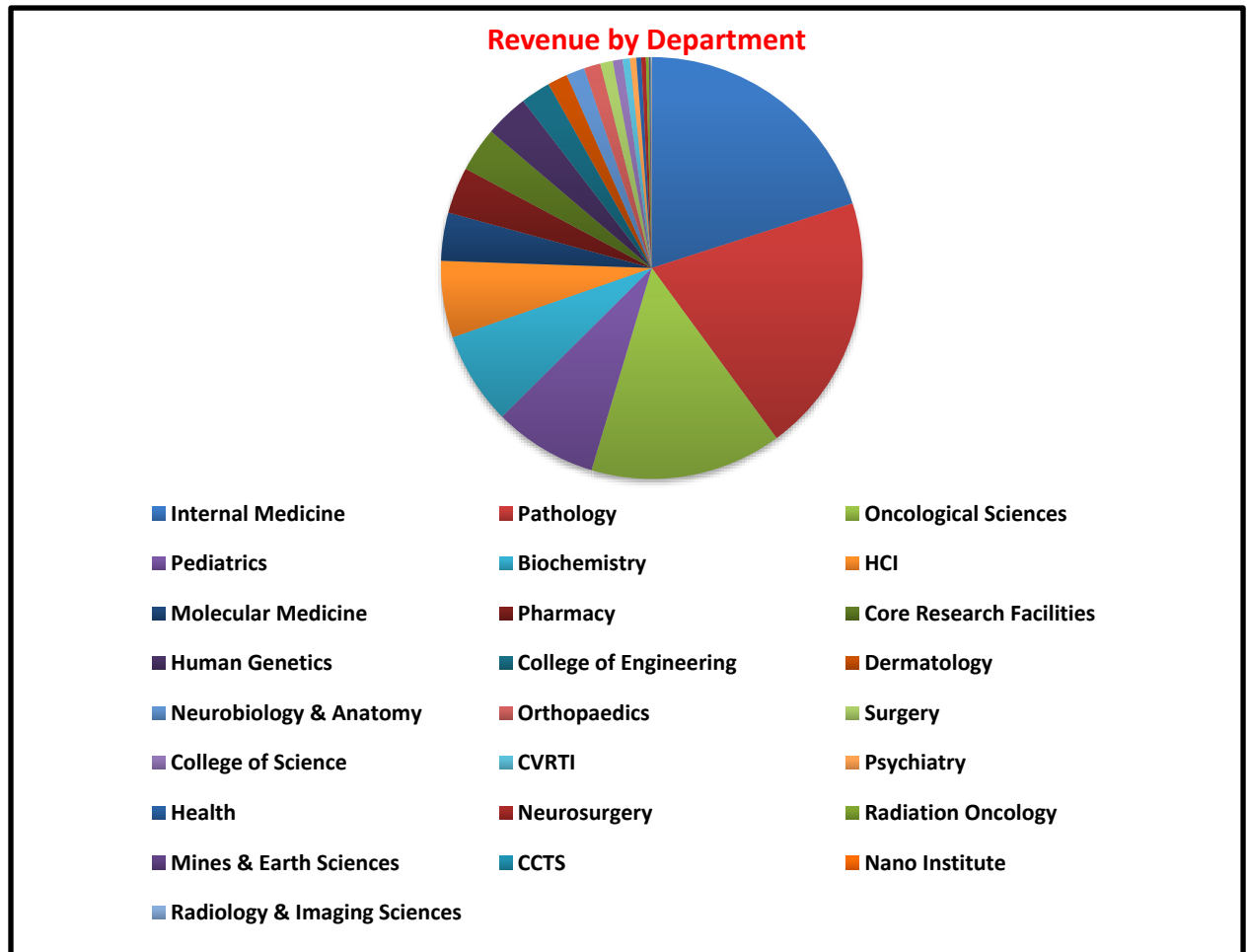
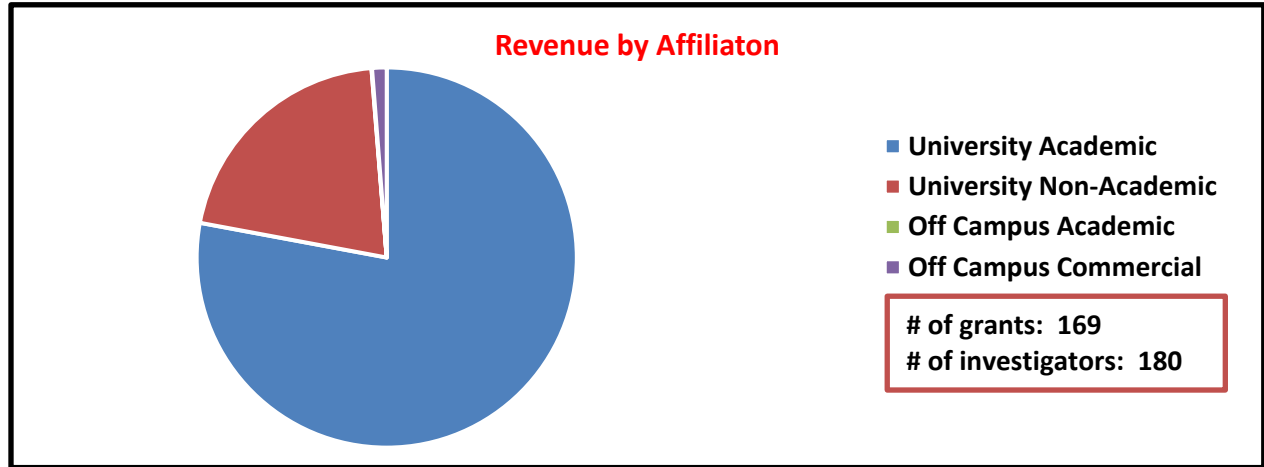
Last meeting date: November 29, 2018

- Matthew Williams, Assistant Professor, Pathology Advisory Board Chair
- Ryan O’Connell, Assistant Professor, Pathology
- Thomas O’Hare, Associate Professor, Hematology
- Daniel Leung, Assistant Professor, Internal Medicine

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Top Users

1	ARUP	Off Campus
2	Camp, Nicola	Department
3	Schiffman, Joshua	Arizona State University, Hyundai Motor Co., Peel Therapeutics, Sarcoma Alliance for Research, Department
4	Williams, Matthew	Department, NIH
5	Atanackovic, Djordje	Department, Sanofi US Services, Inc.
6	Evavold, Brian	Department, NIH
7	Leung, Daniel	NIH
8	Welm, Alana	NIH, DOD, Aslan Pharmaceuticals
9	Fairfax, Keke	Department, NIH
10	McMahon, Martin	NIH, Pfizer, American Assoc. for Cancer, Department

Goals for FY20

We are anticipating in FY20 the arrival of a new Cytex Aurora. This instrument is different than most traditional instruments and is capable of detecting over 30 colors at once. This instrument will involve a large amount of training and consultation. We anticipate developing some complex phenotypic panels in order to better customize training and support for this instrument. The flow core is also gathering information to determine if a new cell sorter is needed. We would likely be looking at a 4-laser low end instrument that can easily be set up for self-run usage. A leading example of this would be the Sony SH800. Additionally, the flow lab is considering an instrument that is specifically designed for small particle detection. Similar to previous years, we are continuing to focus on user and staff education through increased seminars and sample prep projects.

Publications

- Eide, C. A., Zabriskie, M. S., Savage Stevens, S. L., Antelope, O., Vellore, N. A., Than, H., Deininger, M. W. (2019). Combining the Allosteric Inhibitor Asciminib with Ponatinib Suppresses Emergence of and Restores Efficacy against Highly Resistant BCR-ABL1 Mutants. *Cancer Cell*, 36(4), 431-443 e435. doi:10.1016/j.ccell.2019.08.004
- Franzini, A., Pomicter, A. D., Yan, D., Khorashad, J. S., Tantravahi, S. K., Than, H., Deininger, M. W. (2019). The transcriptome of CMML monocytes is highly inflammatory and reflects leukemia-specific and age-related alterations. *Blood Adv*, 3(20), 2949-2961. doi:10.1182/bloodadvances.2019000585
- Gholamin, S., Youssef, O. A., Rafat, M., Esparza, R., Kahn, S., Shahin, M., Cheshier, S. H. (2020). Irradiation or temozolomide chemotherapy enhances anti-CD47 treatment of glioblastoma. *Innate Immun*, 26(2), 130-137. doi:10.1177/1753425919876690
- Hutter, G., Theruvath, J., Graef, C. M., Zhang, M., Schoen, M. K., Manz, E. M., Cheshier, S. H. (2019). Microglia are effector cells of CD47-SIRPalpha antiphagocytic axis disruption against glioblastoma. *Proc Natl Acad Sci U S A*, 116(3), 997-1006. doi:10.1073/pnas.1721434116
- Kim, H., Dickey, L., Stone, C., Jafek, J. L., Lane, T. E., & Tantin, D. (2019). T cell-selective deletion of Oct1 protects animals from autoimmune neuroinflammation while maintaining neurotropic pathogen response. *J Neuroinflammation*, 16(1), 133. doi:10.1186/s12974-019-1523-3
- Patel, A. B., Franzini, A., Leroy, E., Kim, S. J., Pomicter, A. D., Genet, L., Deininger, M. W. (2019). JAK2 ex13InDel drives oncogenic transformation and is associated with chronic eosinophilic leukemia and polycythemia vera. *Blood*, 134(26), 2388-2398. doi:10.1182/blood.2019001385
- Patel, A. B., Pomicter, A. D., Yan, D., Eiring, A. M., Antelope, O., Schumacher, J. A., Deininger, M. W. (2020). Dasatinib overcomes stroma-based resistance to the FLT3 inhibitor quizartinib using multiple mechanisms. *Leukemia*. doi:10.1038/s41375-020-0858-1
- Snook, J. P., Soedel, A. J., Ekiz, H. A., O'Connell, R. M., & Williams, M. A. (2020). Inhibition of SHP-1 Expands the Repertoire of Antitumor T Cells Available to Respond to Immune Checkpoint Blockade. *Cancer Immunol Res*, 8(4), 506-517. doi:10.1158/2326-6066.CIR-19-0690

9. Than, H., Pomicter, A. D., Yan, D., Beaver, L. P., Eiring, A. M., Heaton, W. L., Deininger, M. W. (2020). Coordinated inhibition of nuclear export and Bcr-Abl1 selectively targets chronic myeloid leukemia stem cells. *Leukemia*, *34*(6), 1679-1683. doi:10.1038/s41375-020-0708-1
10. Yan, D., Pomicter, A. D., Tantravahi, S., Mason, C. C., Senina, A. V., Ahmann, J. M., Deininger, M. W. (2019). Nuclear-Cytoplasmic Transport Is a Therapeutic Target in Myelofibrosis. *Clin Cancer Res*, *25*(7), 2323-2335. doi:10.1158/1078-0432.CCR-18-0959

Genomics Facility

Overview

The Genomics Facility offers a variety of genetic analysis services including full service genotyping, from PCR setup through analysis, and assistance to researchers performing genotyping projects. The facility has commercial and custom sets of fluorescently labeled microsatellite markers that can be used for whole genome linkage studies and fine mapping projects. Researchers can select genes or regions of interest and the facility designs and optimizes the PCR primers, performs the initial PCR, runs the sequencing reactions, and analyzes the data using SoftGenetics Mutation Surveyor software.

Services

Fragment Analysis

- Full service genotyping from PCR setup through analysis
- Capillary Runs
- Microsatellite Instability
- Loss of Heterozygosity
- Multiplex Ligation Dependent Amplification

SNP Genotyping

- Taqman SNP Genotyping
- Illumina Whole-Genome Genotyping and Copy Number Variation Analysis
- Methylation Analysis
- Open Array Genotyping

Real Time PCR

- Gene Expression

Equipment

- One AB 7900HT system
- Illumina iScan
- Quantstudio 12k Flex Real-Time PCR System

Personnel

- Derek Warner, Director
- Michael Klein, Manager

2020 Annual Update

New Equipment

- The Genomics Facility did not acquire new equipment in FY20

New Services

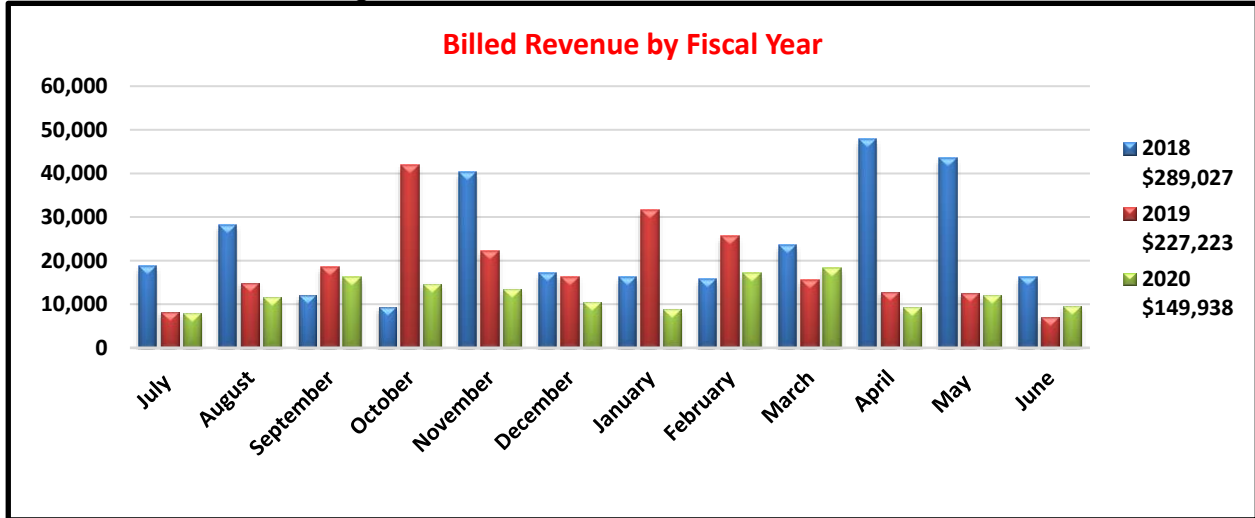
- The Genomics Facility did not implement additional services in FY20

Revenue/Expenses

FY20 Expenses: Total \$217,610

FY20 Revenue: Total \$149,938

- VP of Health Sciences Support: 0
- FY20 Revenue generated from services: \$149,938



* Legend displays total annual billed revenue by year.

Advisory Board Committee

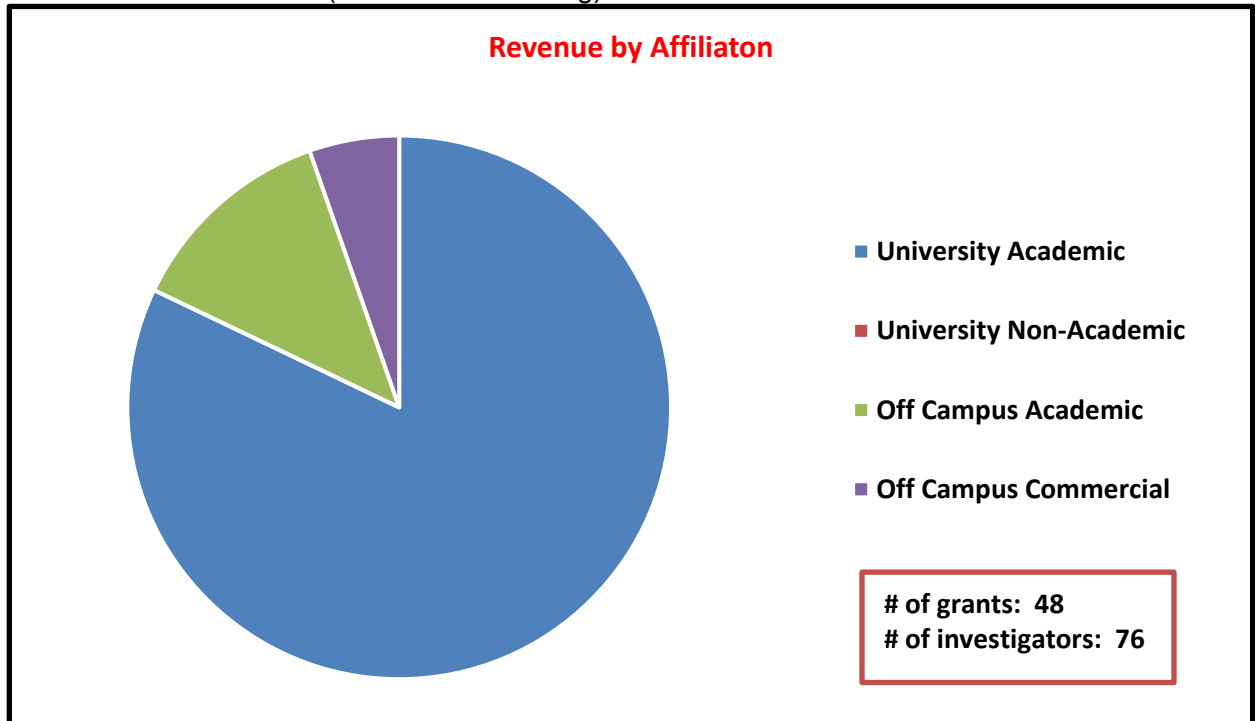
Last meeting date: January 15, 2020

- Gerald Krueger, Professor, Dermatology
- Deborah Neklason, Research Associate Professor, Huntsman Cancer Institute
- Nicola Camp, Professor, Department of Medicine/Human Genetics

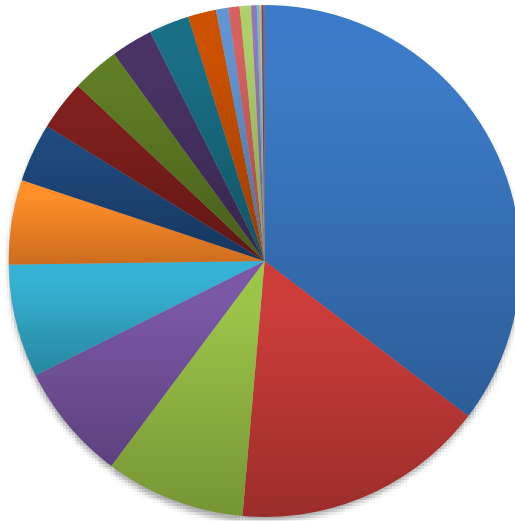
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Internal Medicine
- Neurology
- Psychiatry
- Human Genetics
- Surgery
- Health
- Pediatrics
- Obstetrics & Gynecology
- Orthopaedics
- Molecular Medicine
- Pharmacy
- Dermatology
- Neurobiology & Anatomy
- College of Science
- CVRTI
- Oncological Sciences
- Dentistry
- College of Engineering
- Pathology
- Core Research Facilities

Top Users

1	Welt, Corrine	Department, NIH
2	Penovich, Wanda	Department
3	Erickson, Geoff	Department
4	Columbia University Irving	Off Campus Academic
5	Weiss, Bob	University of Massachusetts
6	Jenkins, Tim	BYU
7	Carrell, Douglas	Department
8	Salimetrics, LLC	Commercial
9	Tristani-Firouzi, Martin	NIH, American Heart Association
10	Neklason, Deborah	NIH

Publications

1. Agrawal, R., Durupt, G., Verma, D., Montgomery, M., Vieira-de Abreu, A., Taylor, C., Fisher, S. J. (2019). MicroRNA-7a overexpression in VMH restores the sympathoadrenal response to hypoglycemia. *JCI Insight*, 4(20). doi:10.1172/jci.insight.130521
2. Bhatlekar, S., Manne, B. K., Basak, I., Edelstein, L. C., Tugolukova, E., Stoller, M. L., Bray, P. F. (2020). miR-125a-5p Regulates Megakaryocyte Proplatelet Formation Via the Actin Bundling Protein L-Plastin. *Blood*. doi:10.1182/blood.2020005230
3. Chaurasia, B., Tippetts, T. S., Mayoral Monibas, R., Liu, J., Li, Y., Wang, L., Summers, S. A. (2019). Targeting a ceramide double bond improves insulin resistance and hepatic steatosis. *Science*, 365(6451), 386-392. doi:10.1126/science.aav3722
4. Cho, C. E., Aardema, N. D. J., Bunnell, M. L., Larson, D. P., Aguilar, S. S., Bergeson, J. R., Lefevre, M. (2020). Effect of Choline Forms and Gut Microbiota Composition on Trimethylamine-N-Oxide Response in Healthy Men. *Nutrients*, 12(8). doi:10.3390/nu12082220
5. Docherty, A. R., Shabalin, A. A., DiBlasi, E., Monson, E., Mullins, N., Adkins, D. E., Coon, H. (2019). Genome-wide association study of suicide death and polygenic prediction of clinical antecedents. *bioRxiv*, 234674. doi:10.1101/234674
6. Gandelman, M., Dansithong, W., Figueroa, K. P., Paul, S., Scoles, D. R., & Pulst, S. M. (2020). Stufen 1 amplifies proapoptotic activation of the unfolded protein response. *Cell Death Differ*. doi:10.1038/s41418-020-0553-9
7. Jenkins, T. G., James, E. R., Aston, K. I., Salas-Huetos, A., Pastuszak, A. W., Smith, K. R., Carrell, D. T. (2019). Age-associated sperm DNA methylation patterns do not directly persist trans-generationally. *Epigenetics Chromatin*, 12(1), 74. doi:10.1186/s13072-019-0323-4
8. Johnson, J. M., Verkerke, A. R. P., Maschek, J. A., Ferrara, P. J., Lin, C. T., Kew, K. A., Funai, K. (2020). Alternative splicing of UCP1 by non-cell-autonomous action of PEMT. *Mol Metab*, 31, 55-66. doi:10.1016/j.molmet.2019.10.007
9. Krah, N. M., Narayanan, S. M., Yugawa, D. E., Straley, J. A., Wright, C. V. E., MacDonald, R. J., & Murtaugh, L. C. (2019). Prevention and Reversion of Pancreatic Tumorigenesis through a Differentiation-Based Mechanism. *Dev Cell*, 50(6), 744-754 e744. doi:10.1016/j.devcel.2019.07.012
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11. Verma, D., Church, T. M., & Swaminathan, S. (2020). Epstein-Barr virus co-opts TFIIH component XPB to specifically activate essential viral lytic promoters. *Proc Natl Acad Sci U S A*, 117(23), 13044-13055. doi:10.1073/pnas.2000625117
12. Wilcox, T. M., McKelvey, K. S., Young, M. K., Engkjer, C., Lance, R. F., Lahr, A., Schwartz, M. K. Parallel, targeted analysis of environmental samples via high-throughput quantitative PCR. *Environmental DNA*, n/a(n/a). doi:10.1002/edn3.80
13. Zhang, T., Trauger, S. A., Vidoudez, C., Doane, K. P., Pluimer, B. R., & Peterson, R. T. (2019). Parallel Reaction Monitoring reveals structure-specific ceramide alterations in the zebrafish. *Sci Rep*, 9(1), 19939. doi:10.1038/s41598-019-56466-z

Machine Shop

Overview

The Machine Shop Facility is equipped with a full complement of lathes, drills, mills, welders, grinders, and CNC Lathe and Milling systems, staffed by experienced CNC machinists and engineers capable of turning an idea into reality. The Shop Staff provide consultation to assist with the design process for products ranging from precise surgical instruments to large-scale testing equipment. They also fabricate as well as repair devices and parts made from carbon-steel, stainless steel, brass, copper, plastics, and other materials depending upon the requirements of design specifications. We provide microscope parts, stages and assemblies, surgery tool modifications, replications, alterations and reverse engineering.

Services

- Device Design/Engineering from basic concept to finished product
- Manufacturability consulting
- CNC and Manual 3 axis Milling machines 2D and 3D machining
- CNC and manual Lathes
- Laser cutting and engraving services, 3D printing
- Silver Soldering, Brazing
- MIG, TIG, Welding of steel, aluminum, and other types of fabrication
- Anodizing, powder coating and laser cutting project assistance.
- Repair and Maintenance of surgery specialty equipment
- Fast surgery tool replication/modifications
- Onsite assessments, pickup, delivery of equipment and repairs

Equipment

- Two CNC Mills
- Two Traditional Mills
- Four Manual Lathes
- Grinders
- MIG, TIG, Gas, Arc, and Spot welders
- Wood Working Equipment
- Band & Table Saws
- Sharpening Equipment
- Polishing Equipment

Personnel

- Shawn Colby, Machinist, Director
- Dustin Layton, Machinist, Surgery Tool Repair Specialist
- Kim Slusser, Machinist. Retired, June 2020.
-

2020 Annual Update

New Equipment

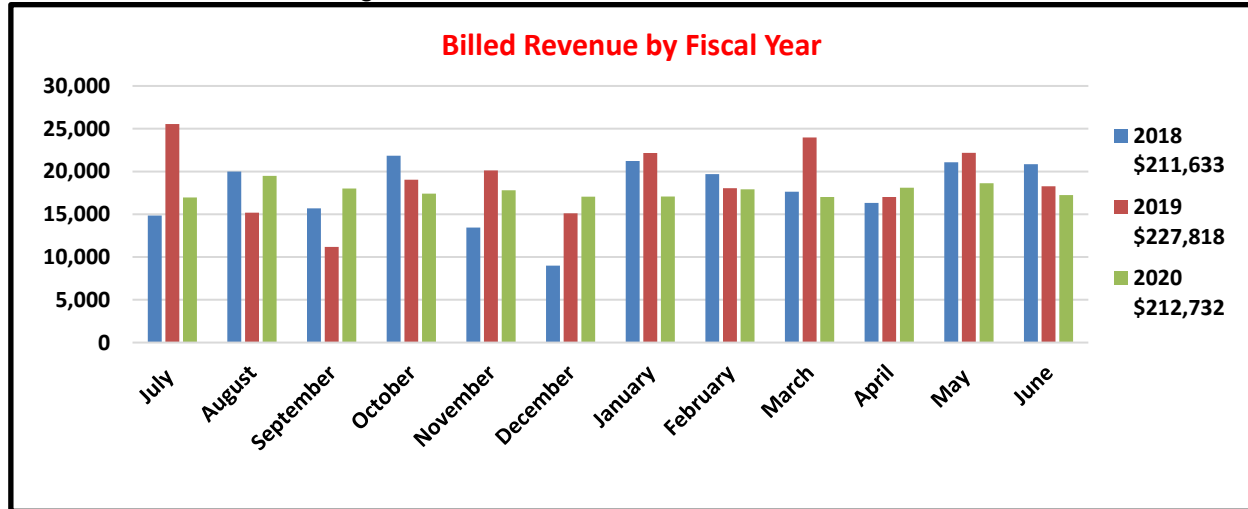
- New 3 axis Tree CNC Vertical Mill with Fanuc Controller

Revenue/Expenses

FY20 Expenses: Total \$284,318

FY20 Revenue: Total \$262,732

- VP of Health Sciences Support: \$50,000
- FY20 Revenue generated from services: \$212,732



* Legend displays total annual revenue by year generated.

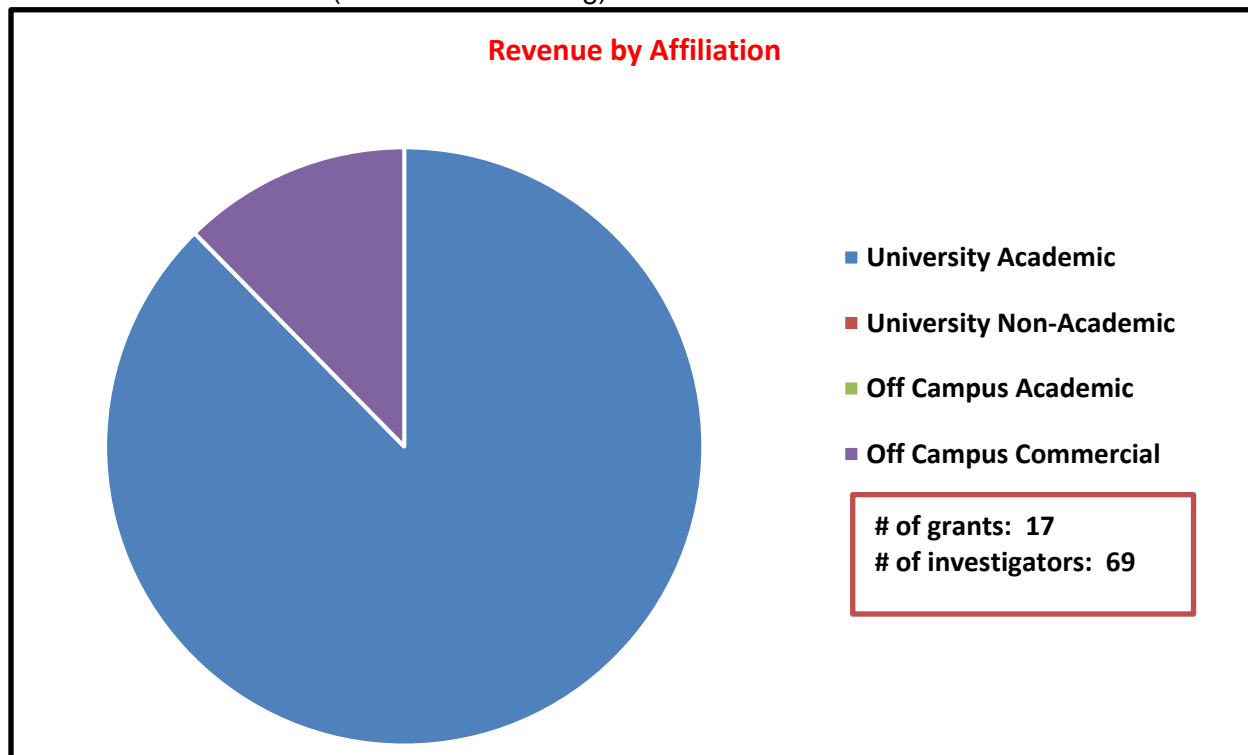
Advisory Board Committee

- Perry Renshaw, Professor, Psychiatry
- Michelle Ford, Materials Management Facilitator, Facilities Engineering
- Kyle Thomson, Researcher, Add Program

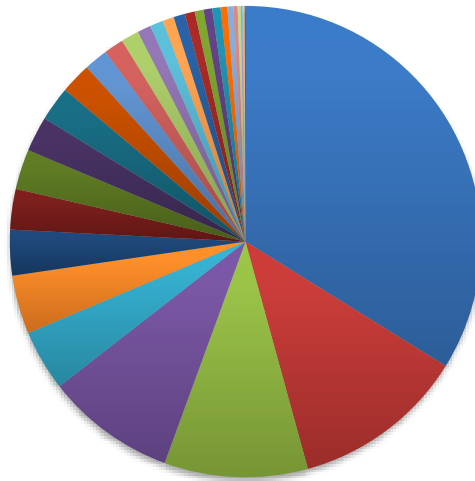
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- | | |
|------------------------------|--------------------------------------|
| ■ Operating Room Hospital | ■ Sterile Processing |
| ■ College of Engineering | ■ Perioperative Services |
| ■ Radiation Oncology | ■ Pharmacy |
| ■ Surgical Services Hospital | ■ Pathology |
| ■ Internal Medicine | ■ Core Research Facilities |
| ■ Surgery | ■ Ophthalmology & Visual Sciences |
| ■ Neurobiology & Anatomy | ■ Health |
| ■ Surgical Department HCI | ■ University Pharmacy |
| ■ Emergency Department | ■ Human Genetics |
| ■ Psychiatry | ■ Radiology & Imaging Sciences |
| ■ Materials Management | ■ Neurosurgery |
| ■ Neurology | ■ Physical Medicine & Rehabilitation |
| ■ Orthopaedics | ■ Mines & Earth Sciences |
| ■ Facilities & Engineering | ■ Dentistry |
| ■ Molecular Medicine | ■ Biochemistry |
| ■ Oncological Sciences | |

Top Users

1	Klev, Brent	Department
2	Sullivan, Christopher	Department
3	Ford, Michelle	Department
4	Hiatt, Catherine	Department
5	Peacock, Darren	Department
6	ProMedica	Commercial
7	Wilcox, Karen	Department, NIH
8	Meisner, Steve	Department
9	Henderson, Joey	Department
10	Evavold, Brian	Department, NIH

Publications

No publications acknowledged this facility in FY20.

Mass Spectrometry & Proteomics

Overview

The Mass Spectrometry & Proteomics Facility is geared toward supporting proteomics research as well as providing basic mass spectrometry (MS) support for a broad range of research and sample types, such as polymers, natural products, small synthetic molecules, peptides, large intact proteins, and nucleic acids. The facility is equipped with several high-performance mass spectrometers, including a Thermo QExactive HF with nano-LC and nano-ESI ionization, and a state-of-the-art MALDI/ToF/ToF instrument (UltrafleXtreme; Bruker Daltonics) with tissue-imaging capabilities. LC/MS/MS instruments in the lab are equipped with both nano-LC and microflow -LC for ultimate sensitivity and chromatographic performance. The mission of this facility is to provide the highest quality mass spectrometry analyses for protein and other biomolecule investigations.

Services

A range of proteomics, general and tissue-imaging MS services are available. The following services are provided to investigators:

Proteomics Services:

- Protein ID from SDS Gel
- Protein ID from Solution
- Protein ID from Complex Isolates in Solution and IP Pull-down Experiments
- Identification of Protein Modifications/Post-translational Modifications
- Intact Protein MW Analysis
- Peptide Screening with LC-MS/MS and accurate mass de novo sequencing
- “Top-Down” and “Bottom-Up” Proteomics
- Protein Quantification Analysis using TMT and SILAC labelling
- Custom Database Searching
- Protein Accurate mass measurement

General MS Services

- ESI/MS
- ESI/MS/MS
- Nucleic Acids
- LC/MS
- LC/MS/MS
- MALDI/ToF/ToF
- Special Project/Method Development

Tissue-Imaging MS Services

- Cryostat Tissue Sectioning and MALDI Plate Setup
- Tissue Section Preparation and Setup
- MALDI/ToF Imaging of Tissue Sections
- Software Data Processing and Image Generation
- Software Data Processing and Image Generation-by User

Equipment

Mass Spectrometers

- Thermo QExactive HF
- Bruker UltrafleXtreme
- Bruker Maxis II HD for high mass accuracy intact protein analysis.

HPLC Systems

- Two Eksigent 1D nanoLC systems
- One Eksigent 2D-Ultra system
- One Shimadzu 10AD system
- One Leica CM1950 cryostat system

Personnel

- James Cox, Ph.D., Director
- Sandra Osburn, Ph.D., Research Associate

Advisory Board Committee

- Darrell Davis, Professor, Medicinal Chemistry
- Wes Sundquist, Professor, Biochemistry
- Michael Kay, Professor, Biochemistry

2020 Annual Update

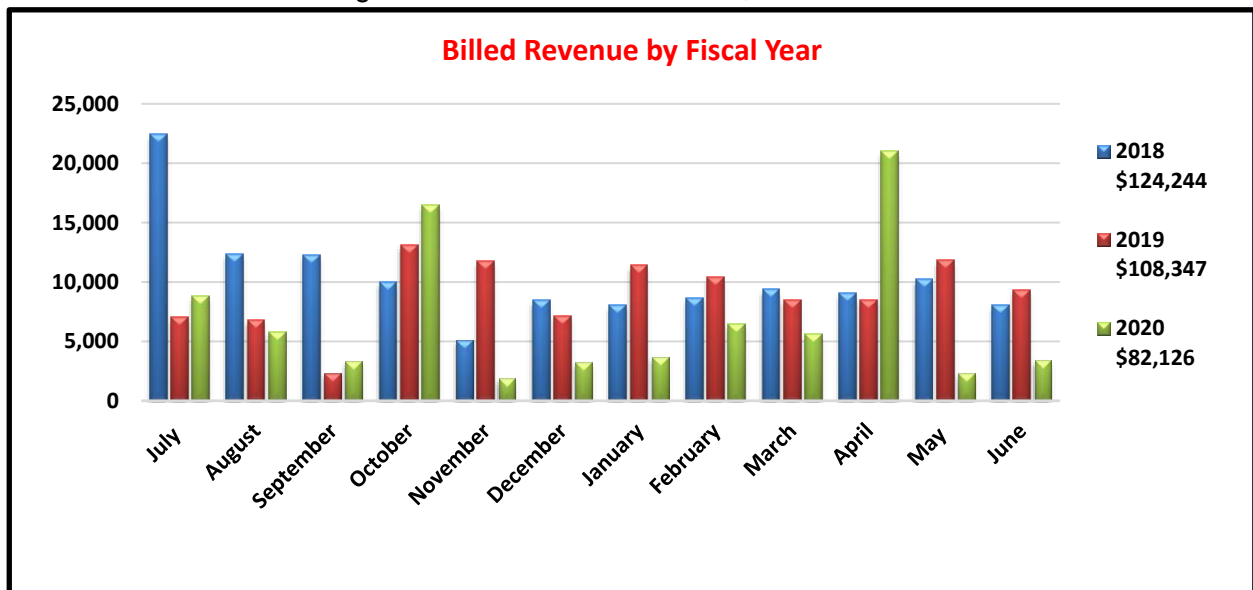
Revenue/Expenses

FY20 Total Expenses: \$734,611

FY20 Equipment Expense: \$461,500

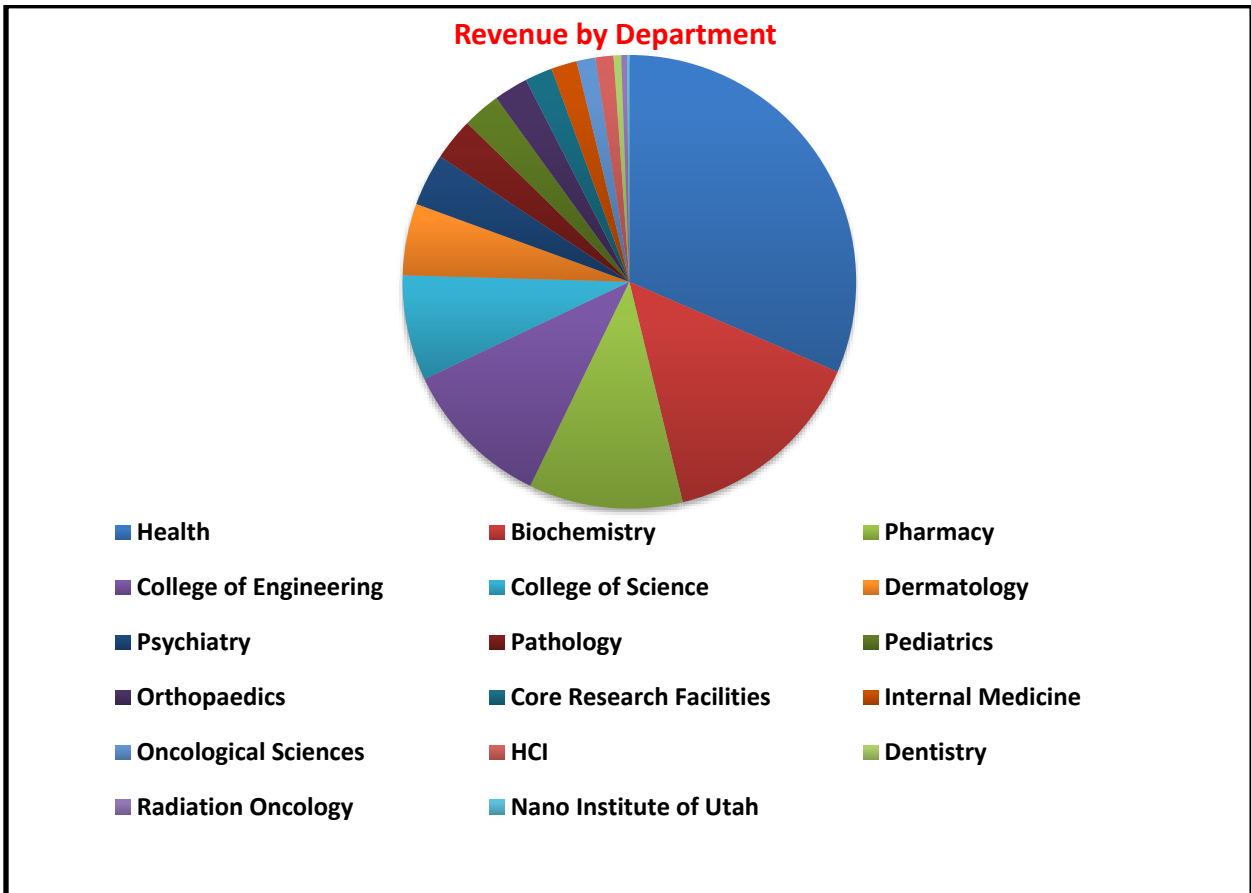
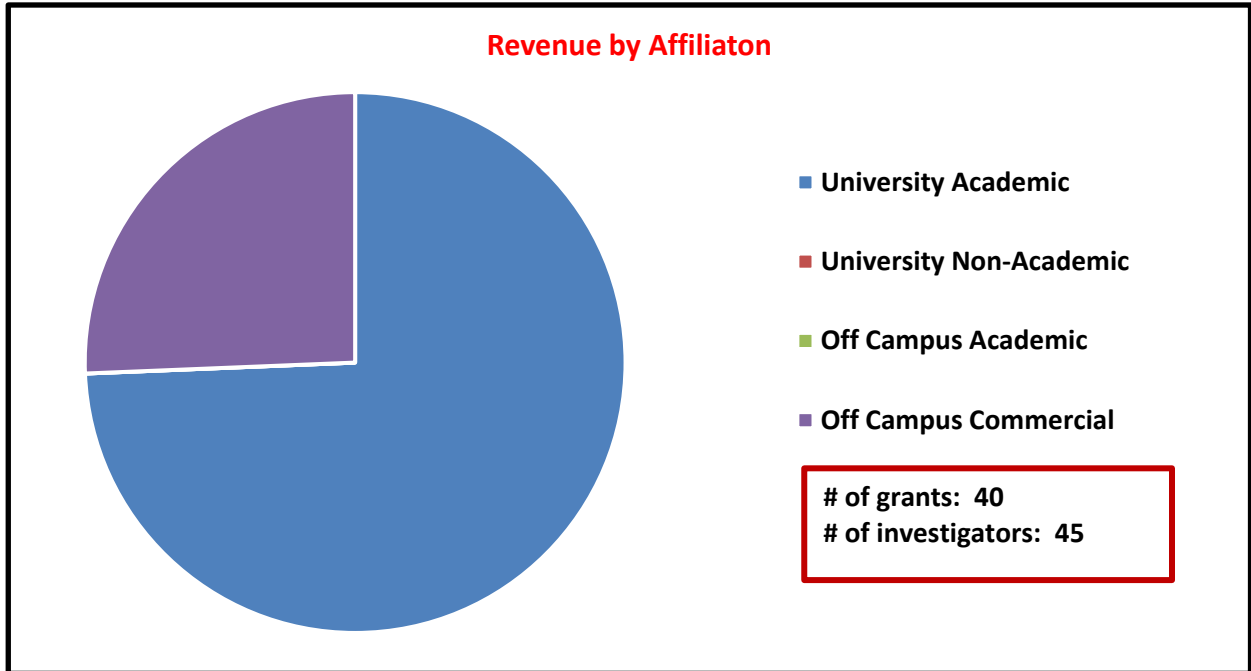
FY20 Revenue: Total \$688,626

- VP of Health Sciences Support: \$145,000
- VP of Research RIF Equipment Funds: \$115,501
- VP of Health Sciences DMCR & Depts. Support: \$345,999 (for equipment purchase)
- FY20 Revenue generated from services: \$82,126



* Legend displays total annual revenue by year earned.

**FY20 Scientific Impact
Research Support**
Revenue Generated (see charts following):



Top Users

1	Summers, Scott	American Diabetes Association
2	Tolero Pharmaceuticals	Commercial
3	Yu, Michael	NIH
4	Olivera, Baldomero	Department, NIH, US Army Medical Research
5	Sundquist, Wesley	Department, NIH
6	Echelon Biosciences	Commercial
7	Feng, Bingjian	Pfizer
8	Vaporsens	Commercial
9	Schmidt, Eric	NIH, US Army Medical Research
10	Jones, Kevin	Department, NIH, University of British Columbia

Publications

1. Han, H., Schubert, H. L., McCullough, J., Monroe, N., Purdy, M. D., Yeager, M., Hill, C. P. (2020). Structure of spastin bound to a glutamate-rich peptide implies a hand-over-hand mechanism of substrate translocation. *J Biol Chem*, 295(2), 435-443. doi:10.1074/jbc.AC119.009890
2. Hemmis, C. W., Heard, S. C., & Hill, C. P. (2019). Phosphorylation of Tyr-950 in the proteasome scaffolding protein RPN2 modulates its interaction with the ubiquitin receptor RPN13. *J Biol Chem*, 294(25), 9659-9665. doi:10.1074/jbc.AC119.008881
3. Kessler, J. L., Li, Y., Fornetti, J., Welm, A. L., & Yu, S. M. (2020). Enrichment of Collagen Fragments Using Dimeric Collagen Hybridizing Peptide for Urinary Collagenomics. *J Proteome Res*. doi:10.1021/acs.jproteome.0c00055
4. Xiong, X., Blakely, A., Karra, P., VandenBerg, M. A., Ghabash, G., Whitby, F., Chou, D. H. (2020). Novel four-disulfide insulin analog with high aggregation stability and potency. *Chem Sci*, 11(1), 195-200. doi:10.1039/c9sc04555d

Metabolic Phenotyping

Overview

The Metabolic Phenotyping Core (MPC) is an important University-sponsored resource that performs several standardized and high quality metabolic and physiologic tests for phenotypic characterization of mouse models developed by UofU investigators. This is an invaluable resource as it supports research on human diseases such as diabetes, cardiovascular disorders and cancer. The phenotyping tests include determination of whole body glucose metabolism and insulin sensitivity of animals by glucose and insulin tolerance tests and glucose clamps, assessment of whole animal energy expenditure using the Columbus Instrument's CLAMS/Oxymax system, determination of body composition by Bruker Minispec NMR and determination of circulating hormones, growth factors and cytokine concentrations using the Luminex xMAP multiplex systems (MAGPIX and Luminex 200), measurement of analyte (metabolites, ions, gases, enzymes) concentration in the body fluids such as serum, plasma, urine and cerebrospinal fluid using Vitros 350 chemistry analyzer. In addition, MPC performs tests to map the metabolic phenotype of different cell types and tissues using Agilent-Seahorse XF24 and XF⁹⁶ analyzers. The MPC also helps the scientists to optimize phenotyping tests. The overall goal of MPC is to expedite biomedical research efforts by providing academic and non-academic researchers access to advanced metabolic phenotyping tests at reasonable price.

Services

- Mitochondrial Bioenergetics Agilent-Seahorse XF⁹⁶ extracellular flux analyzers
- Cellular energy metabolism using Agilent-Seahorse XF24 and XF⁹⁶ extracellular flux analyzers
- Assessment of energy balance in mice using CLAMS Metabolic chambers
- Body Composition (lean mass, fat mass and water content) using Bruker Minispec NMR
- High throughput biomarker screening and quantification using Luminex technology
- Multiplexed protein analyte (hormone, growth factors, cytokines, adipokines, myokines and signaling molecules) quantification using MagPix and Luminex-200
- Multiplexed high throughput quantification of metabolites in body fluids such as serum, plasma, urine and cerebrospinal fluid using Vitros 350 chemistry analyzer
- Whole body glucose metabolism and insulin sensitivity- Glucose and insulin tolerance tests
- Isolation of Pancreatic islets
- Beta cell mass, cell proliferation and cell death
- Chronic exposure of mice to cold/warm temperature
- Radiometric enzyme assays- glycogen synthase and phosphorylase activities in metabolic tissues

Equipment

- Seahorse Flux Analyzer XF24
- Seahorse Flux Analyzer XF⁹⁶
- Eight Columbus Instruments metabolic chambers equipped with temperature-controlled enclosure.
- Eight Columbus Instruments CLAMS metabolic chambers equipped with running wheels and with the capability to measure core body temperature and heart rate.
- Bruker Minispec NMR
- Luminex MAGPIX
- Luminex 200 System

- Ortho Clinical Vitros 350 chemistry analyzer
- Powers Scientific rodent incubators

Personnel

- Anil Laxman, Ph.D., Director

2020 Annual Update**Equipment**

MPC has submitted grant proposals to internal and external funding sources to expand the data acquisition and analysis capability of its Seahorse XF[®]96 system and to acquire a 16 chamber Promethion-Core indirect calorimetry system. Since the Bruker Minispec NMR system has received the End of Service notice from Bruker Systems, MPC will submit an internal grant proposal to replace it with a state-of-the-art minispec LF90II Body Composition Rat and Mice Analyzer. This is a horizontal 6.2 MHz TD-NMR system on cart for body composition analysis (BCA) of rodents, like rats and mice (maximum weight 700g). Measurement is conducted with the animal fully awake adopting animal care. No need to anesthetize animal. The following are the key features: high repeatability and reproducibility, short measurement time, easy-to-use front-end software, easy-to-follow and extendable calibration software tools (auto-optimization), determination of fat, lean, free water etc. in mice and rats, also can be used for tissue samples and organs.

Services

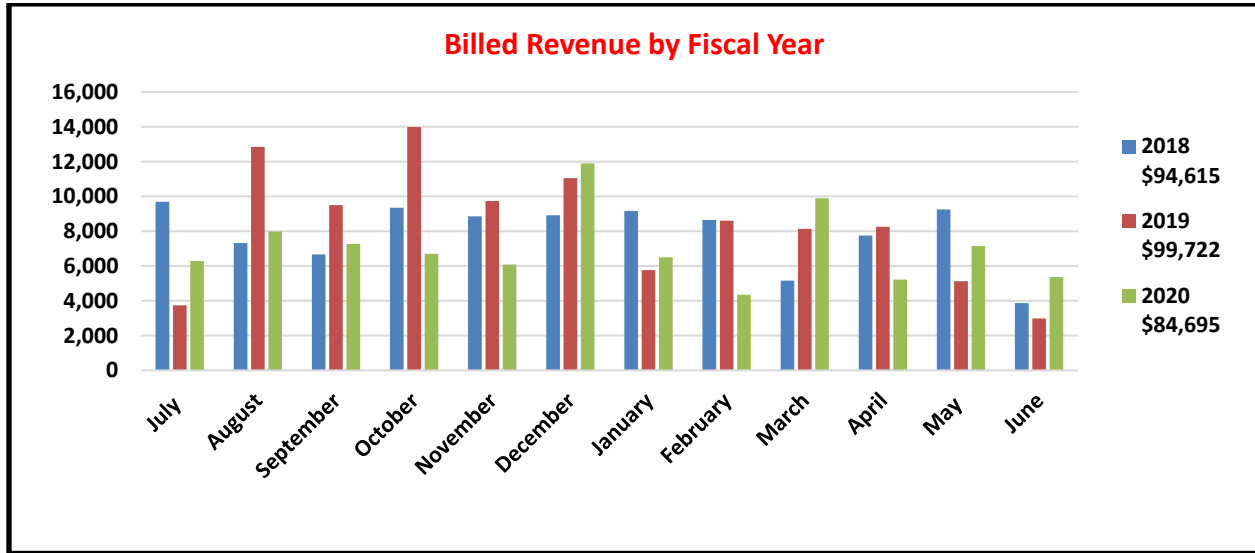
The Vitros 350 system purchased at the end of 2018-2019 fiscal year has been validated to measure metabolite concentration in body fluids (serum, plasma, urine and cerebrospinal fluid) from small animals such as mouse and rat. The Vitros MicroSlide technology used in this analyzer requires a small (5-11ul) amount of sample per test. Ortho Clinical currently offers Vitros MicroSlide assays for 40 different analytes. The Vitros 350 analyzer can perform up to 40 colorimetric tests/hour. MPC currently performs multiplex assay panels on Vitros 350 system, which include diabetes-Obesity panel (glucose, lactate, triglyceride, LDH, creatinine, Cholesterol, dHDL, LDL); Cardiovascular disease panel (Cholesterol, triglyceride, direct HDL and derived LDL, CO₂, Na⁺, Cl⁻, K⁺); Nephrology panel (Creatinine, Uric acid, BUN, glucose, total protein, CO₂, Na⁺, Cl⁻, K⁺, ammonia, albumin); Liver function panel (AST, ALT, albumin, bilirubin); Hematology Panel (Iron, Total Iron-Binding Capacity, bilirubin, Total Bilirubin).

Revenue/Expenses

FY20 Expenses: Total \$155,255

FY20 Revenue: Total \$154,695

- VP of Health Sciences Support: \$70,000
- FY20 revenue generated from services: \$84,695



* Legend displays total annual revenue by year earned.

Advisory Board Committee

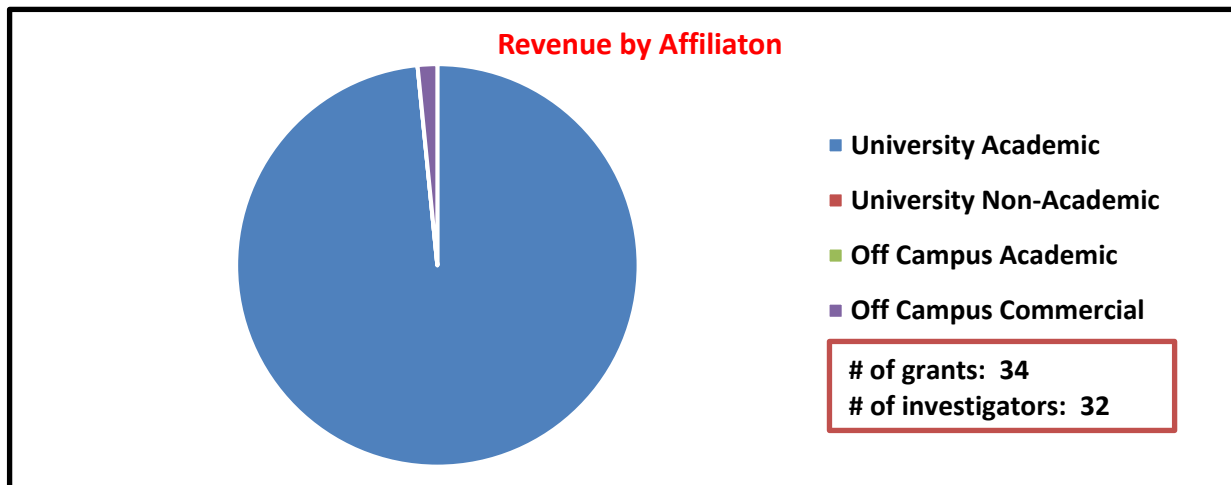
Last meeting date: March 8, 2019

- Jared Rutter, Professor, Biochemistry
- Scott Summers, Professor, Nutrition and Integrative Physiology
- William Holland, Assistant Professor, Nutrition and Integrative Physiology
- Katsuhiko Funai, Assistant Professor, Physical Therapy and Athletic Training
- John Phillips, Professor, Director of University of Utah HSC cores
- James Cox, Assistant Professor, Associate Director of University of Utah HSC cores

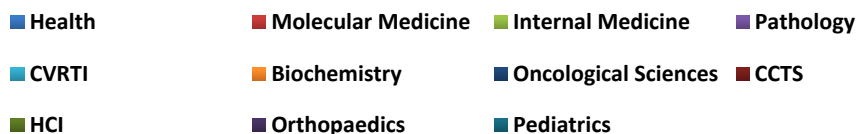
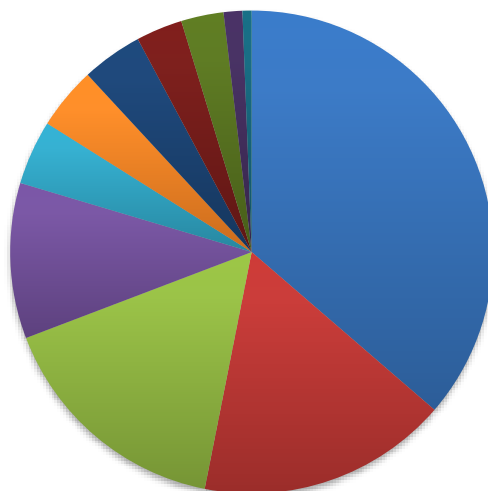
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



Top Users

1	Summers, Scott	NIH, American Diabetes Assoc., Juvenile Diabetes
2	Schlegel, Amnon	Department, NIH
3	Funai, Katsuhiko	NIH, Department
4	Boudina, Sihem	Department
5	Symons, John	NIH
6	Deiningner, Michael	Department, V FTD for Cancer Research, Alex's Lemonade Stand Foundation
7	Chan, Owen	Juvenile Diabetes Research Foundation
8	O'Connell, Ryan	Department, NIH
9	Franklin, Sarah	Nora Eccles Treadwell Foundation
10	Ward, Diane	Department, NIH

Letter of Support for grant applications:

1. Conan Kinsey's K08 grant application to the NIH entitled "Resistance Mechanisms to Combined Trametinib and 4-aminoquinolones in the Inhibition of Pancreatic Cancer."
2. Junco Warren's NIH R01 grant application to the National Institute of Health entitled "Perm1 is a Novel Regulator of Cardiac Energetics and Function."
3. Owen Chan's R01 grant application to the National Institute of Health entitled "Mechanism of Counterregulatory Failure."

Publications

1. Chaurasia, B., Tippetts, T. S., Mayoral Monibas, R., Liu, J., Li, Y., Wang, L., Summers, S. A. (2019). Targeting a ceramide double bond improves insulin resistance and hepatic steatosis. *Science*, 365(6451), 386-392. doi:10.1126/science.aav3722

2. Johnson, J. M., Verkerke, A. R. P., Maschek, J. A., Ferrara, P. J., Lin, C. T., Kew, K. A., Funai, K. (2020). Alternative splicing of UCP1 by non-cell-autonomous action of PEMT. *Mol Metab*, 31, 55-66. doi:10.1016/j.molmet.2019.10.007
3. Pearson, S., Loft, A., Rajbhandari, P., Simcox, J., Lee, S., Tontonoz, P., Villanueva, C. J. (2019). Loss of TLE3 promotes the mitochondrial program in beige adipocytes and improves glucose metabolism. *Genes Dev*, 33(13-14), 747-762. doi:10.1101/gad.321059.118
4. Petersen, C., Bell, R., Klag, K. A., Lee, S. H., Soto, R., Ghazaryan, A., Round, J. L. (2019). T cell-mediated regulation of the microbiota protects against obesity. *Science*, 365(6451). doi:10.1126/science.aat9351
5. Ramstead, A. G., Wallace, J. A., Lee, S. H., Bauer, K. M., Tang, W. W., Ekiz, H. A., O'Connell, R. M. (2020). Mitochondrial Pyruvate Carrier 1 Promotes Peripheral T Cell Homeostasis through Metabolic Regulation of Thymic Development. *Cell Rep*, 30(9), 2889-2899 e2886. doi:10.1016/j.celrep.2020.02.042
6. Runtsch, M. C., Nelson, M. C., Lee, S. H., Voth, W., Alexander, M., Hu, R., O'Connell, R. M. (2019). Anti-inflammatory microRNA-146a protects mice from diet-induced metabolic disease. *PLoS Genet*, 15(2), e1007970. doi:10.1371/journal.pgen.1007970

Metabolomics Facility

Overview

The Metabolomics Core at the University of Utah is a recognized leader in the field of global metabolomics, lipidomics and metabolic tracer analysis (MTA). It was established 15 years ago with a mission to perform comprehensive global metabolomics and lipidomics analyses. Over the years the Metabolomics Core has developed methods to analyze the metabolome and lipidome of a variety of biological systems and samples. The Metabolomics Core is highly equipped with state of the art instrumentation and expert staff. The Metabolomics Core provides both non-targeted analysis for biomarker discovery as well as targeted quantitation of metabolites for discovery validation. New, highly capable instrumentation has been acquired over the past several years to enhance our capabilities to perform these studies. No one method is fully capable of completely profiling the metabolome. To maximize the number of metabolites observed, the facility is equipped with three chemical analysis platforms, GC-MS, LC-MS, and NMR.

Services

The primary mission of the facility is the metabolomics/lipidomics profiling of biological samples including serum, urine, tissues, *Drosophila*, *C. elegans*, yeast, and bacteria. The following metabolites can be analyzed from many biochemical pathways:

- Amino acids
- TCA cycle intermediates
- Organic acids including lactic acid and pyruvate
- Carbohydrates
- Nucleotides
- Lipids including sterols
- Di and tri peptides including glutathione
- Full lipid profiling by LC-MS
- Stable isotope label flux analysis by GC-MS

The facility processes every sample using two distinct but overlapping procedures, a targeted analysis and a non-targeted analysis. The targeted analysis is used to search every chromatogram for known metabolites. The non-targeted analysis uses data mining software to detect chromatographic peaks that are altered in two different conditions. This procedure is done with Principle Components Analysis (PCA) and Partial Least Squares-Discriminate Analysis (PLS-DA).

Equipment

Chemical Analysis Platforms

- Agilent 5977B gas chromatograph-quadrupole mass spectrometer (GC-MS) for metabolic tracer analysis.
- Agilent 5973 gas chromatograph-quadrupole mass spectrometer (GC-MS) for fatty acid analysis.
- Agilent 7200 gas chromatograph-quadrupole time of flight mass spectrometer (GC-QTOF-MS) for discovery metabolomics.
- Agilent 6530 Ultra Pressure Liquid Chromatograph-Quadrupole Time of Flight Mass-Spectrometer (UPLC-QToF-MS) for discovery lipidomics.

- Agilent 6545 Ultra Pressure Liquid Chromatograph-Quadrupole Time of Flight Mass-Spectrometer (UPLC-QTOF-MS) for discovery metabolomics.
- Agilent 6490 Triple quadrupole UPLC-MS for the targeted quantification of metabolites, lipids and peptides
- Sciex 6500 QTRAP Triple quadrupole UPLC-MS for the targeted quantification of metabolites, lipids and peptides
- Thermo QExactive Plus UPLC-MS for isotope tracer analysis.

Personnel

- James Cox, PhD, Director
- Alan Maschek, PhD, Research Associate
- Leon Catrow, PhD, Research Associate
- Tyler Van Ry, BS, Technician

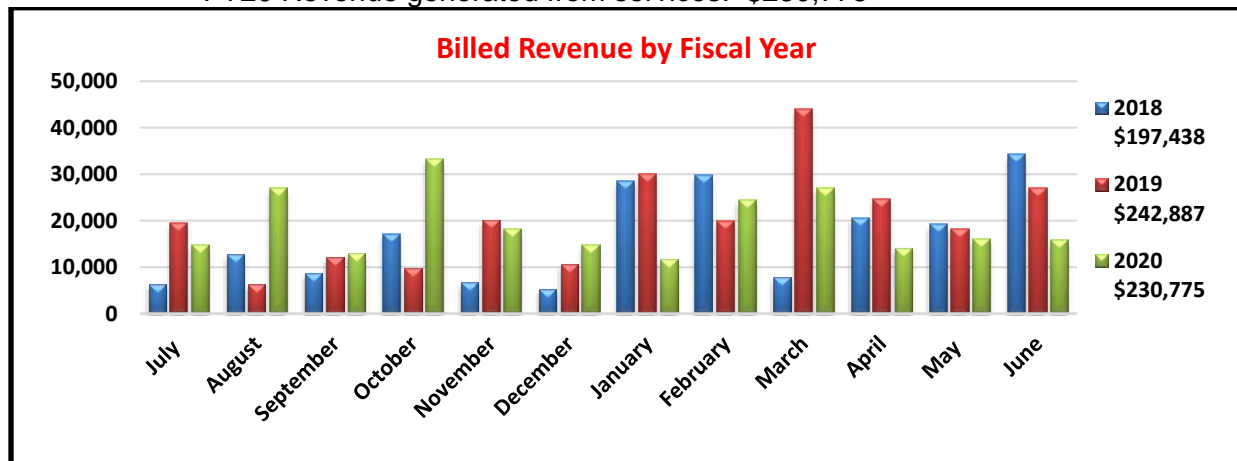
2020 Annual Update

Revenue/Expenses

FY20 Expenses: Total \$524,334

FY20 Revenue: Total \$470,775

- VP of Health Sciences Support: \$240,000
- FY20 Revenue generated from services: \$230,775



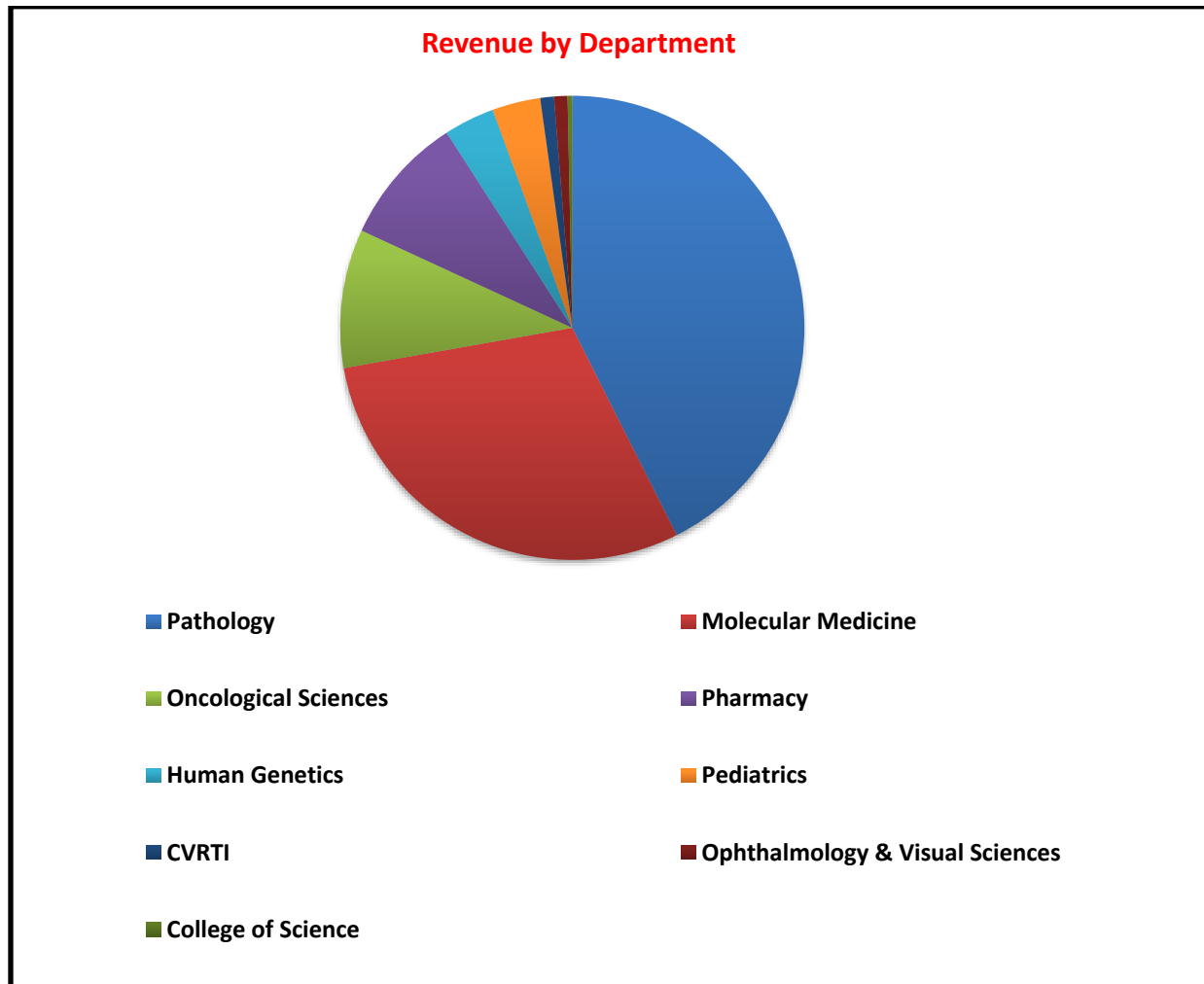
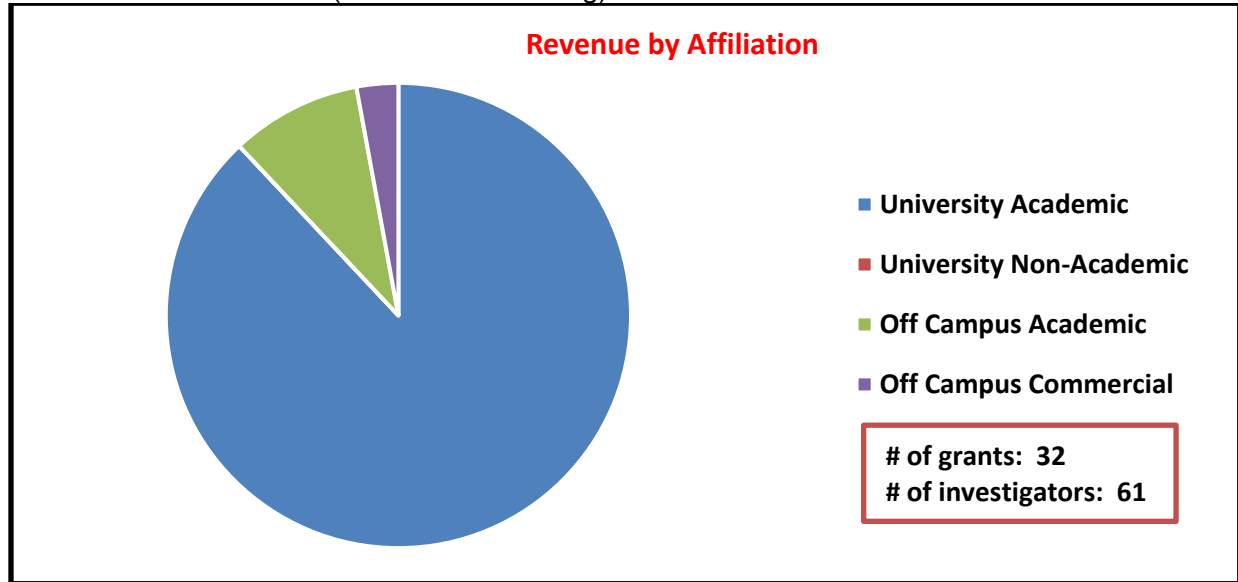
* Legend displays total annual revenue by year earned.

Advisory Board Committee

Last meeting date: November 25, 2019

- Greg Ducker, PhD, Assistant Professor, Department of Biochemistry
- Keke Fairfax, PhD, Assistant Professor, Department of Pathology
- William Holland, PhD, Assistant Professor, Department of Nutrition & Integrative Physiology
- Katsu Funai, PhD, Associate Professor, Molecular Medicine
- Jared Rutter, PhD, Professor, Department of Biochemistry

**FY20 Scientific Impact
Research Support
Revenue Generated (see charts following):**



Top Users

1	Rutter, Jared	Department, Global FTD for Peroxisomal Disorders
2	Summers, Scott	NIH, American Diabetes Association, Juvenile Diabetes Research Foundation
3	Phillips, John	NIH, Department
4	Fairfax, Keke	NIH, Department
5	Holland, William	NIH, Department
6	Weyrich, Andy	University of Utah
7	Chawla, Ajay	University of California- San Francisco
8	NIDDK- Liver Disease Branch	NIH
9	Funai, Katsuhiko	NIH
10	Regional Ctr Biotechnology India	Off Campus Educational

Publications

- Badolia, R., Ramadurai, D. K. A., Abel, E. D., Ferrin, P., Taleb, I., Shankar, T. S., Drakos, S. G. (2020). The Role of Nonglycolytic Glucose Metabolism in Myocardial Recovery Upon Mechanical Unloading and Circulatory Support in Chronic Heart Failure. *Circulation*, 142(3), 259-274. doi:10.1161/CIRCULATIONAHA.119.044452
- Beebe, K., Robins, M. M., Hernandez, E. J., Lam, G., Horner, M. A., & Thummel, C. S. (2020). Drosophila estrogen-related receptor directs a transcriptional switch that supports adult glycolysis and lipogenesis. *Genes Dev*, 34(9-10), 701-714. doi:10.1101/gad.335281.119
- Bensard, C. L., Wisidagama, D. R., Olson, K. A., Berg, J. A., Krah, N. M., Schell, J. C., Rutter, J. (2020). Regulation of Tumor Initiation by the Mitochondrial Pyruvate Carrier. *Cell Metab*, 31(2), 284-300 e287. doi:10.1016/j.cmet.2019.11.002
- Chalermwat, C., Thosapornvichai, T., Wongkittichote, P., Phillips, J. D., Cox, J. E., Jensen, A. N., Jensen, L. T. (2019). Overexpression of the peroxin Pex34p suppresses impaired acetate utilization in yeast lacking the mitochondrial aspartate/glutamate carrier Agc1p. *FEMS Yeast Res*, 19(8). doi:10.1093/femsyr/foz078
- Chaurasia, B., Tippetts, T. S., Mayoral Monibas, R., Liu, J., Li, Y., Wang, L., . . . Summers, S. A. (2019). Targeting a ceramide double bond improves insulin resistance and hepatic steatosis. *Science*, 365(6451), 386-392. doi:10.1126/science.aav3722
- Heden, T. D., Johnson, J. M., Ferrara, P. J., Eshima, H., Verkerke, A. R. P., Wentzler, E. J., Funai, K. (2019). Mitochondrial PE potentiates respiratory enzymes to amplify skeletal muscle aerobic capacity. *Sci Adv*, 5(9), eaax8352. doi:10.1126/sciadv.aax8352
- Heo, J. M., Harper, N. J., Paulo, J. A., Li, M., Xu, Q., Coughlin, M., Harper, J. W. (2019). Integrated proteogenetic analysis reveals the landscape of a mitochondrial-autophagosome synapse during PARK2-dependent mitophagy. *Sci Adv*, 5(11), eaay4624. doi:10.1126/sciadv.aay4624
- Hughes, C. E., Coody, T. K., Jeong, M. Y., Berg, J. A., Winge, D. R., & Hughes, A. L. (2020). Cysteine Toxicity Drives Age-Related Mitochondrial Decline by Altering Iron Homeostasis. *Cell*, 180(2), 296-310 e218. doi:10.1016/j.cell.2019.12.035
- Johnson, J. M., Verkerke, A. R. P., Maschek, J. A., Ferrara, P. J., Lin, C. T., Kew, K. A., Funai, K. (2020). Alternative splicing of UCP1 by non-cell-autonomous action of PEMT. *Mol Metab*, 31, 55-66. doi:10.1016/j.molmet.2019.10.007
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20. Weinheimer, C., Wang, H., Comstock, J. M., Singh, P., Wang, Z., Locklear, B. A., Joss-Moore, L. A. (2020). Maternal Tobacco Smoke Exposure Causes Sex-Divergent Changes in Placental Lipid Metabolism in the Rat. *Reprod Sci*, 27(2), 631-643. doi:10.1007/s43032-019-00065-w
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Mutation Generation & Detection Facility

Overview

The Mutation Generation & Detection (MGD) Core Facility supports researchers by securing, developing, and optimizing the latest DNA nuclease technologies, reagents, and protocols for targeted genome modification. Currently, the MGD core specializes in providing customized CRISPR reagents for gene editing in multiple model systems, including but not limited to *D. rerio*, *D. melanogaster*, *C. elegans*, *S. cerevisiae*, *M. musculus* and mammalian cell lines. Beyond reagent production, the MGD Core has established partnerships with the Mouse Transgenic Facility, the Centralized Zebrafish Resource Center and the Drug Discovery Core to create engineered mouse models, zebrafish models and cell lines respectively. The MGD Cores also provides custom genotyping services including high resolution melt analysis (HRMA), CRISPR validation services, homology directed repair donor template synthesis and targeted sequencing services. To date the MGD Core has helped further the research of over 100 different laboratories around the world by providing more than 500 unique reagents. The MGD Core is also a member of the Utah Center for Iron and Heme Disorders.

Main Services

- **CRISPR Services**
 - CRISPR sgRNA RNA production
 - High fidelity Cas9 protein
 - Custom CRISPR plasmid design and construction
- **High Resolution Melt Analysis**
 - BioFire LightScanner Access Fee
 - HRMA PCR plates (10 pack)
 - HRMA PCR sealing film (10 pack)
 - BioFire LightScanner MasterMix 100 rxns
 - BioFire LightScanner MasterMix 500 rxns
 - Mineral Oil (500ml bottle)
 - HRMA Training
 - Help with optimization and analysis of HRMA assays
 - Custom Mutation Detection upon request
- **TALEN Services**
 - TALEN plasmid pair design and construction
 - 2X TALEN plasmid pair design and construction (same gene)
 - 0.5X TALEN effector plasmid design and construction

Additional Services

- Mouse Transgenic Injection (partnership with Mouse Transgenic Facility)
- Blastocyst Validation of CRISPR reagents (partnership with Mouse Transgenic Facility)
- Generation of modified cell lines (partnership with Drug Discovery Core)
- Short ssDNA donor design and production
- Long ssDNA design and production

- dsDNA donor design and production
- Custom RFLP genotyping of mutant and transgenic mice
- Custom HRMA genotyping
- Sequence verification of genome edits
- Production of transgenic *D. rerio* using CRISPR reagents
- Production of CRISPR and donor constructs for generating transgenic *D. melanogaster*

Equipment

- BioFire LightScanner
- 3X Eppendorf Mastercycler ProS
- Eppendorf Centrifuge 5430
- 2X Eppendorf 5424 Microcentrifuges
- 27" Apple iMac Desktop with QWC Mercury Elite-AI Pro External Hard drive
- Illumina Eco
- Innova 43 bacterial Shaker
- Innova 42 bacterial Shaker
- Frigidaire -20°C Freezer
- Lonza 4D Nucleofector system:
 - 4D-Nucleofector Core Unit
 - 4D-Nucleofector X Unit
 - 4D-Nucleofector Y Unit
 - 4D-Nucleofector 96-well Shuttle
- CCI Biological Safety Cabinet
- NapCo Model 6300 CO2 Incubator
- ThermoFisher TSX600 -80C Freezer
- Sorvall RT 6300 Centrifuge
- ASUS ZenBook 3 Deluxe Laptop

Personnel

- Crystal Davey, Ph.D., Director
- Lindsay Mortensen, Lab Technician

New Services

In FY20, the MGD Core and the Drug Discovery Core established a collaboration to generate genetically modified cell lines.

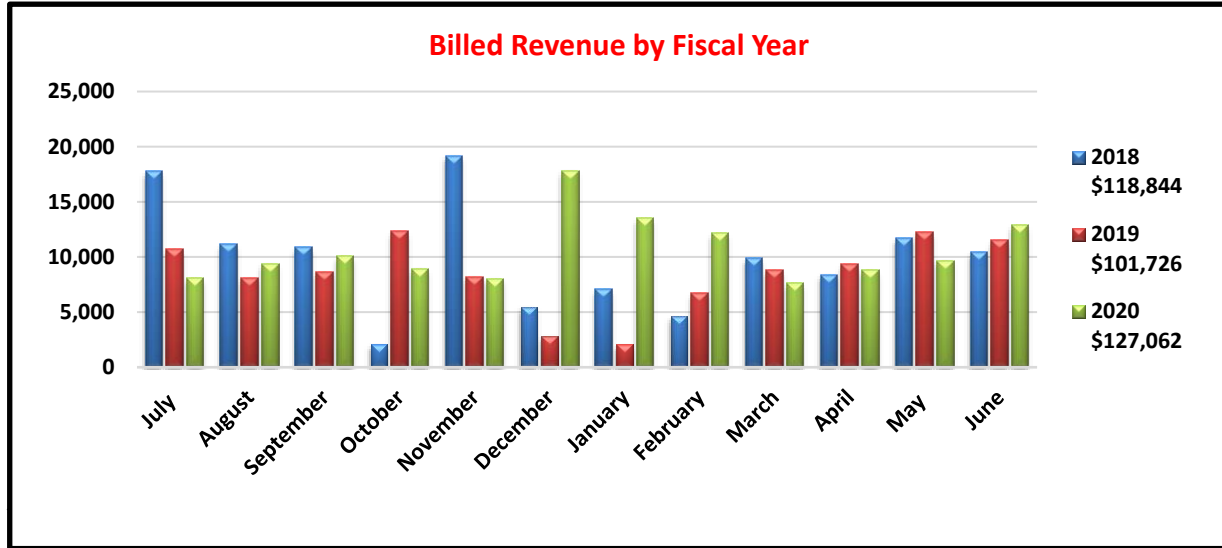
- Production of required CRISPR reagents
- Validation of sgRNA target cell line
- Cell line genotyping

Revenue/Expenses

FY20 Expenses: Total \$223,969

FY20 Revenue: Total \$157,062

- VP of Health Sciences Support: \$30,000
- FY20 Revenue generated from services: \$127,062



Advisory Board Committee

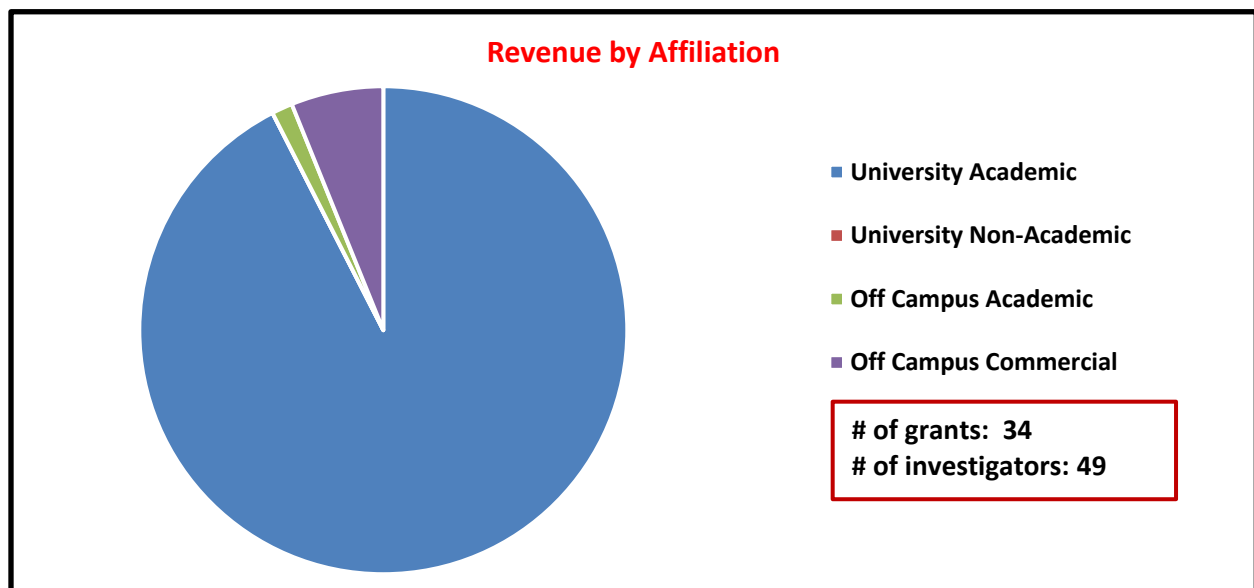
Last meeting date: January 31, 2020

- David Grunwald, Department of Human Genetics (Senior Faculty Advisor)
- Dana Carroll, Department of Biochemistry
- Ryan O’Connell, Department of Pathology
- Lewis Charles Murtaugh, Department of Human Genetics

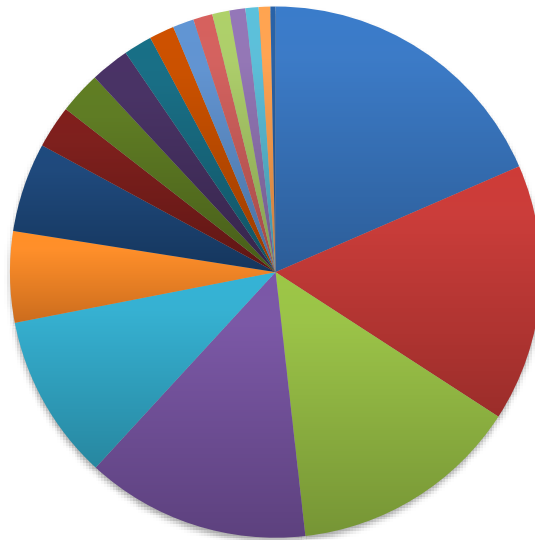
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Neurobiology & Anatomy
- Pediatrics
- Oncological Sciences
- Human Genetics
- Ophthalmology & Visual Sciences
- CVRTI
- CCTS
- Biochemistry
- HCI
- Dentistry
- Orthopaedics
- Health
- College of Engineering
- Internal Medicine
- Pharmacy
- Surgery
- Pathology
- Molecular Medicine
- Core Research Facilities

Top Users

1	Rutter, Jared	Department, Calico Life Sciences
2	Gregg, Christopher	NIH, Department
3	Bonkowsky, Josh	Department, NIH
4	Phillips, John	NIH, Icahn School of Medicine
5	Evason, Kimberly	NIH, Department
6	Stewart, Rodney	Department, NIH
7	Reilly, Christopher	NIH
8	Tavtigian, Sean	Department
9	Max Planck Research Unit	Off Campus Academic
10	Park, Sungjin	Department, NIH

Collaboration and Support of Other HSC and University Facilities:

- **Center for Iron and Heme Disorders**
The MGD is one of three Cores that are part of the Utah Center for Iron and Heme Disorders (CIHD). The CIHD provides 10% of the MGD Core Director's salary requirements and covers 48% of the MGD Core's full time Laboratory Technician salary requirements.
- **DNA Sequencing Facility**
The MGD Core spent \$3,154 with the DNA Sequencing Core in FY20.
- **DNA Peptide Facility**
The MGD Core spent \$6,124 with the DNA/Peptide Synthesis Core in FY20.
- **Drug Discovery Facility**
During FY20 the MGD Core's partnership with the Drug Discovery Facility to produce genetically modified cell lines brought in 3 different projects totaling \$8,400 in chargebacks for that facility.
- **Mouse Transgenic Facility**
During FY20 the MGD Core's partnership with the Mouse Transgenic Facility to produce transgenic mouse models brought in 23 different projects to the Mouse Transgenic Facility totaling \$120,282 in chargebacks for that facility.

Total chargeback impact of the MGD Core on other University Core Research facilities is \$137,960.

Non-billable Invoice Hours

One of the central purposes of the MGD Facility is to be a resource of education for researchers on the University of Utah campus. The MGD Core achieves this aim in official ways such as seminars given directly to different departments on campus. However, the central avenue of education by the MGD Core is informal one-on-one, in person communication with researchers. In the past, the MGD Core has tracked these interactions, but due to the number and randomness of these interactions in FY'16, the MGD Core stopped tracking them. Based on previous numbers the MGD Core estimates that it spends around 250-300 hours per year in direct interaction with researchers.

Publications

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2. Edwards, J. J., Rouillard, A. D., Fernandez, N. F., Wang, Z., Lachmann, A., Shankaran, S. S., Gelb, B. D. (2020). Systems Analysis Implicates WAVE2 Complex in the Pathogenesis of Developmental Left-Sided Obstructive Heart Defects. *JACC Basic Transl Sci*, 5(4), 376-386. doi:10.1016/j.jacbts.2020.01.012
3. Keefe, M. D., Soderholm, H. E., Shih, H.-Y., Stevenson, T. J., Glaittli, K. A., Bowles, D. M., Bonkowsky, J. L. (2020). Vanishing White Matter Disease Expression of Truncated EIF2B5 Activates Induced Stress Response. *bioRxiv*, 2020.2005.2005.078295. doi:10.1101/2020.05.05.078295
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5. Lamichhane, B. S., Bisgrove, B. W., Su, Y.-C., Demarest, B. L., & Yost, H. J. (2020). Syndecan 2 regulates hematopoietic lineages and infection resolution in zebrafish. *bioRxiv*, 2020.2005.2004.076786. doi:10.1101/2020.05.04.076786
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7. Ramstead, A. G., Wallace, J. A., Lee, S. H., Bauer, K. M., Tang, W. W., Ekiz, H. A., O'Connell, R. M. (2020). Mitochondrial Pyruvate Carrier 1 Promotes Peripheral T Cell Homeostasis through Metabolic Regulation of Thymic Development. *Cell Rep*, 30(9), 2889-2899 e2886. doi:10.1016/j.celrep.2020.02.042
8. Ruf-Zamojski, F., Zhang, Z., Zamojski, M., Smith, G. R., Mendelev, N., Liu, H., Sealfon, S. C. (2020). Single nucleus multi-omics regulatory atlas of the murine pituitary. *bioRxiv*, 2020.2006.2006.138024. doi:10.1101/2020.06.06.138024

9. Santos, M., Anderson, C. P., Neschen, S., Zumbrennen-Bullough, K. B., Romney, S. J., Kahle-Stephan, M., Leibold, E. A. (2020). Irf2 regulates insulin production through iron-mediated Cdkal1-catalyzed tRNA modification. *Nat Commun*, 11(1), 296. doi:10.1038/s41467-019-14004-5
10. Serrano, M. L. A., Demarest, B. L., Tone-Pah-Hote, T., Tristani-Firouzi, M., & Yost, H. J. (2019). Inhibition of Notch signaling rescues cardiovascular development in Kabuki Syndrome. *PLoS Biol*, 17(9), e3000087. doi:10.1371/journal.pbio.3000087
11. Stein, M., Barnea-Zohar, M., Shalev, M., Arman, E., Brenner, O., Winograd-Katz, S., Elson, A. (2020). Massive osteopetrosis caused by non-functional osteoclasts in R51Q SNX10 mutant mice. *Bone*, 136, 115360. doi:10.1016/j.bone.2020.115360
12. Struckman, H. L., Baine, S., Thomas, J., Mezache, L., Mykytyn, K., Gyorke, S., Veeraraghavan, R. (2020). Super-Resolution Imaging Using a Novel High-Fidelity Antibody Reveals Close Association of the Neuronal Sodium Channel NaV1.6 with Ryanodine Receptors in Cardiac Muscle. *Microsc Microanal*, 26(1), 157-165. doi:10.1017/S1431927619015289

Letters of Support

Written and provided to faculty for support of grant applications:

1. LOS for Dr. Yvette Yien's NIDDK-Collaborative Pilot and Feasibility Proposal, August, 2019
2. LOS for Dr. Sihem Boudina's CCTS Intra-Institutional Pilot Grant, October, 2019
3. LOS for Dr. Alexander Pastuszak's proposal to generate a conditional Nell1 mouse model, October, 2019
4. LOS for Dr. Micah Drummond's proposal to generate a conditional Igf1 mouse model, November, 2019
5. LOS for Dr. Oleg Yarishkin's proposal: "The role of ion channel PIEZO1 in the trabecular meshwork mechanotransduction." November, 2019
6. LOS for Dr. Diane Ward's grant: "Mitochondria oxidants and regulation Yfh1/Fxn protein levels." January, 2020
7. LOS for Dr. Dean Tantin's proposal to generate a targeted SNP in mouse ES cells, January, 2020
8. LOS for Dr. Shihai Jia's proposal to generate a conditional Pax9 mouse model, January, 2020
9. LOS for Dr. Megan E. Williams's R21 proposal: "Localizing Synaptic Proteins In Vivo." February, 2020
10. LOS for Dr. Chris Gregg's proposal to make targeted genome edits in neuroblastoma cells, February, 2020
11. LOS for Dr. Sungjin Park's RO1 proposal: "The molecular mechanisms underlying morphogenesis of the tectorial membrane." June, 2020

Nuclear Magnetic Resonance Core Facility

Overview

This core provides NMR services for the research community at the University of Utah, other Utah academic institutions, and local for-profit companies. Access is available to several high field NMR spectrometers (Varian 400, 500, 600 and 900 MHz instruments; see Equipment below) located on the University of Utah Health Sciences Campus and the University of Colorado Anschutz Medical Campus. The 600 and 900 are equipped with high sensitivity cryogenic HCN probes ideal for protein and natural products research while the 400 and 500 are primarily used for small molecule and natural products research. Data collection at the Colorado 900 is performed using a secure network portal. Routine data processing and analysis is now mostly done on personal computers. More advanced processing and analysis is executed using a central server and multiple Linux workstations in the Structural Biology Computing Center (SBCC), Department of Biochemistry.

Our staff have substantial experience characterizing small molecules, natural products, nucleic acids, carbohydrates and solving protein structures using NMR spectroscopy. Our business model stresses user data collection and analysis and thus we provide practical NMR training for individuals and groups on an as needed basis and occasionally teach formal NMR spectroscopy courses.

Services

- NMR data collection and analysis
- NMR training for individuals and groups
- Formal courses in NMR spectroscopy

Equipment

- Varian Mercury 400 MHz NMR (University of Utah, Skaggs Hall)
- Varian Inova 500 MHz NMR (University of Utah, BPRB)
- Varian Inova 600 MHz NMR with HCN cryogenic probe (University of Utah, BPRB)
- DD2 900 MHz NMR with HCN cryogenic probe (University of Colorado-Denver)

Personnel

- Jack Skalicky, Ph.D., NMR Core Director and Res. Associate Professor of Biochemistry
- Dennis Edwards, RF Technician; 35+ years of NMR hardware repair

2020 Annual Update

New Equipment

- The Closed Cycle Chiller (CCC) cold head was replaced in FY 2018 (this service is required every 2-3 years for optimal operation of the 600 cryoprobe)
- Facilities added a new cooling loop in BPRB. This upgrade now provides reliable cooling of the CCC helium compressor.

New Services

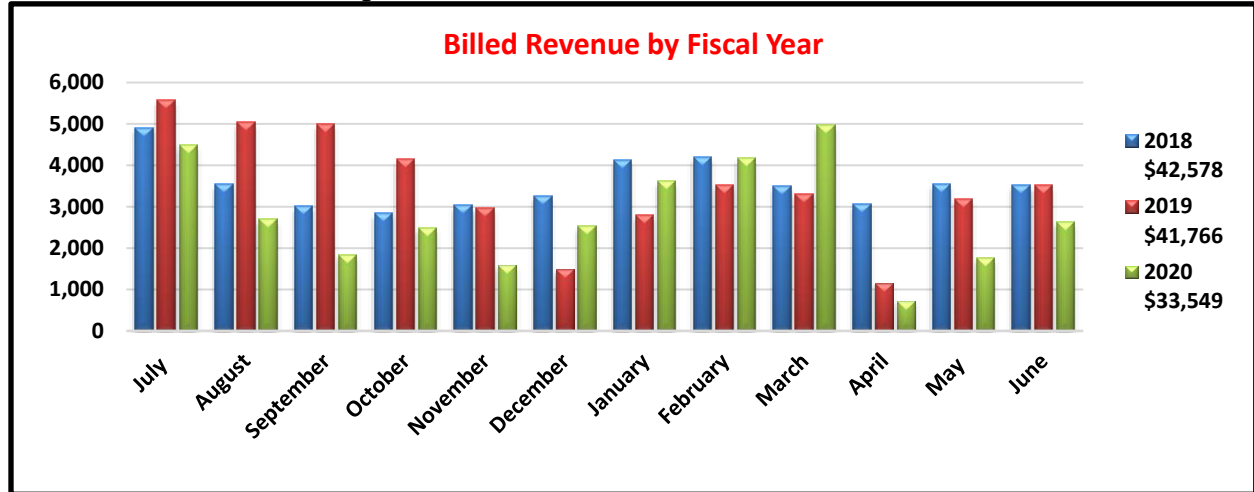
- The NMR Facility did not implement additional services in FY20

Revenues/Expenses

FY20 Expenses: Total \$115,566

FY20 Revenue: Total \$113,549

- VP of Health Sciences Support: \$80,000
- FY20 Revenue generated from services: \$33,549



* Legend displays total annual revenue by year earned.

Advisory Board Committee

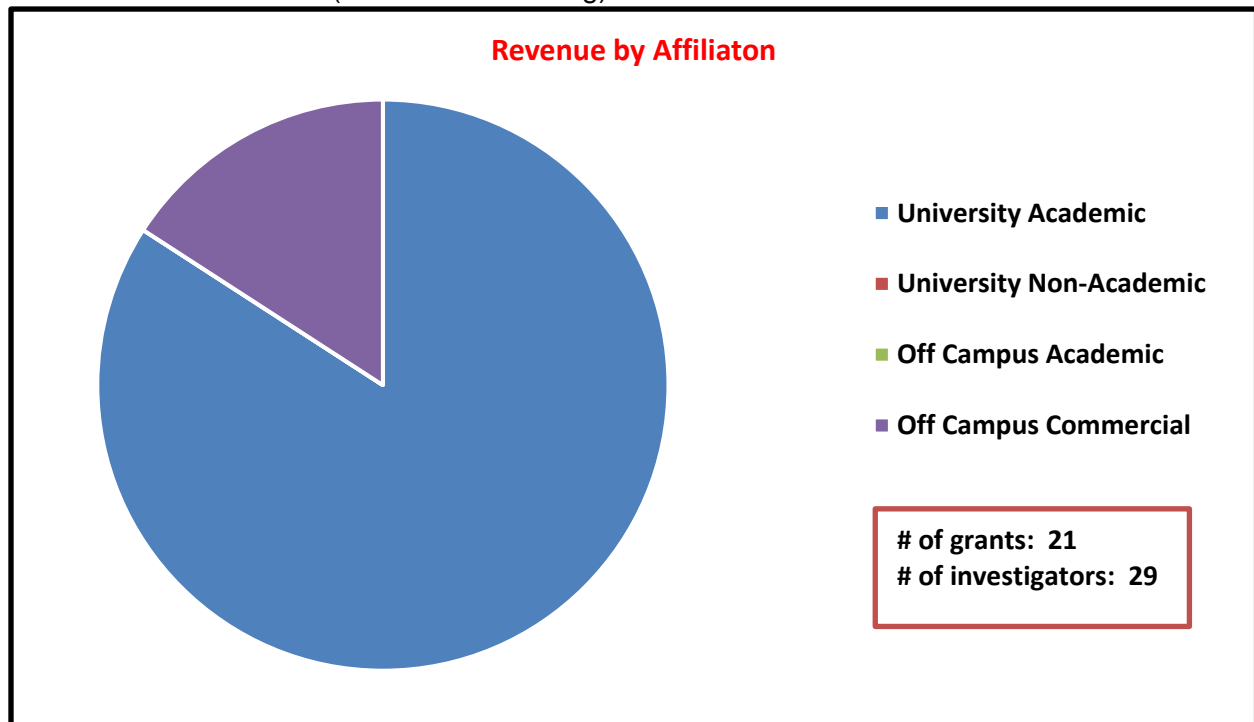
Last updates: June/July 2017.

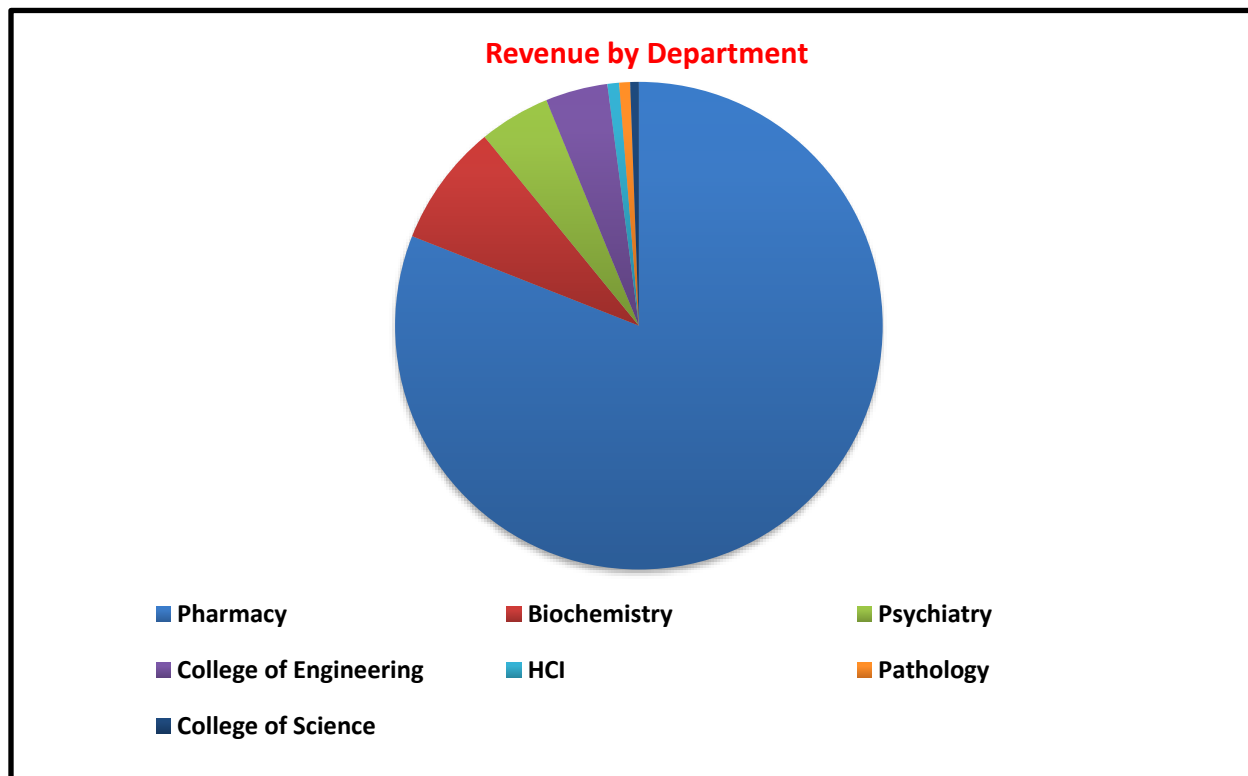
- Darrell Davis, Eric Schmidt and Jaclyn Winter, Department of Medicinal Chemistry
- Wesley Sundquist, Department of Biochemistry
- Jessica Kramer, Department of Bioengineering

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Schmidt, Eric	NIH, US Army Medical Research
2	Franzini, Raphael	Department
3	Vaporsens, Inc.	Commercial
4	Winter, Jaclyn	Department, Gordon & Betty Moore Foundation
5	Echelon Biosciences	Commercial
6	Chou, Hung-Chieh	NIH, US Army Medical Research, Juvenile Diabetes Research Foundation
7	Haygood, Margo	Department
8	Barrios, Amy	Department
9	McIntosh, Michael	NIH
10	Kramer, Jessica	Department, NSF

Publications

- Lacerna, N. M., 2nd, Miller, B. W., Lim, A. L., Tun, J. O., Robes, J. M. D., Cleofas, M. J. B., Concepcion, G. P. (2019). Mindapyrroles A-C, Pyoluteorin Analogues from a Shipworm-Associated Bacterium. *J Nat Prod*, 82(4), 1024-1028. doi:10.1021/acs.jnatprod.8b00979
- Larson, E. C., Lim, A. L., Pond, C. D., Craft, M., Cavuzic, M., Waldrop, G. L., Barrows, L. R. (2020). Pyrrolocin C and equisetin inhibit bacterial acetyl-CoA carboxylase. *PLoS One*, 15(5), e0233485. doi:10.1371/journal.pone.0233485
- Lin, Z., Kakule, T. B., Reilly, C. A., Beyhan, S., & Schmidt, E. W. (2019). Secondary Metabolites of Onygenales Fungi Exemplified by *Aioliomyces pyridodomos*. *J Nat Prod*, 82(6), 1616-1626. doi:10.1021/acs.jnatprod.9b00121
- Malaker, S. A., Pedram, K., Ferracane, M. J., Bensing, B. A., Krishnan, V., Pett, C., Bertozzi, C. R. (2019). The mucin-selective protease StcE enables molecular and functional analysis of human cancer-associated mucins. *Proc Natl Acad Sci U S A*, 116(15), 7278-7287. doi:10.1073/pnas.1813020116

5. Miller, B. W., Torres, J. P., Tun, J. O., Flores, M. S., Forteza, I., Rosenberg, G., Concepcion, G. P. (2020). Synergistic anti-methicillin-resistant *Staphylococcus aureus* (MRSA) activity and absolute stereochemistry of 7,8-dideoxygriseorhodin C. *J Antibiot (Tokyo)*, *73*(5), 290-298. doi:10.1038/s41429-019-0275-8
6. Torres, J. P., Lin, Z., Winter, J. M., Krug, P. J., & Schmidt, E. W. (2020). Animal biosynthesis of complex polyketides in a photosynthetic partnership. *Nat Commun*, *11*(1), 2882. doi:10.1038/s41467-020-16376-5
7. Tu, J., Svatunek, D., Parvez, S., Eckvahl, H. J., Xu, M., Peterson, R. T., Franzini, R. M. (2020). Isonitrile-responsive and bioorthogonally removable tetrazine protecting groups. *Chem Sci*, *11*(1), 169-179. doi:10.1039/c9sc04649f
8. Tu, J., Svatunek, D., Parvez, S., Liu, A. C., Levandowski, B. J., Eckvahl, H. J., Franzini, R. M. (2019). Stable, Reactive, and Orthogonal Tetrazines: Dispersion Forces Promote the Cycloaddition with Isonitriles. *Angew Chem Int Ed Engl*, *58*(27), 9043-9048. doi:10.1002/anie.201903877

Preclinical Imaging Facility

Overview

The Preclinical (formerly Small Animal) Imaging Facility extends the benefits of modern diagnostic medical imaging technologies to the studies of anatomy and physiology in small animals. The facility features state-of-the-art MRI, CT, PET and SPECT scanners. All instruments are equipped with supporting and monitoring hardware that allows a wide variety of imaging experiments, including longitudinal studies, to be performed on live animals and specimens. Imaging scientists, full-time imaging personnel, and animal support technicians are available for technical consultation and experimental assistance.

Services

The Preclinical Imaging Facility has a variety of modalities to choose from such as MRI, CT, PET and SPECT. Examples of scanning capabilities include the following:

7 Tesla small animal MRI system

- Diffusion-weighted and diffusion tensor imaging
- Relaxometry (T1, T2, T2*) mapping
- Perfusion MRI
- Functional and awake-state functional MRI
- MR angiography
- Cardiac MRI
- NMR spectroscopy (localized and non-localized)
- Chemical shift imaging
- Parallel imaging techniques

CT/PET/SPECT Scanners

- Automatic transition between modes and seamless coordination of CT, SPECT, and PET data
- System can be configured as an ultra-high resolution preclinical CT scanner; a high-resolution, high-sensitivity preclinical SPECT scanner; or as a dual modality preclinical SPECT/CT scanner
- The Inveon 2-Head SPECT Module is designed to efficiently detect gamma rays ranging in energy from 30 keV to 250 keV, the SPECT system is ideal for use with most single photon-emitting radionuclides
- Includes two Inveon Research Workplace workstations for multimodality image review, fusion, and analysis which CT, PET, SPECT, and MR data in DICOM and Siemens Inveon CT, PET, and SPECT formats, as well as raw data import

Equipment

- 7 Tesla Bruker BioSpec MRI Scanner
- Siemens Inveon CT/PET/SPECT System

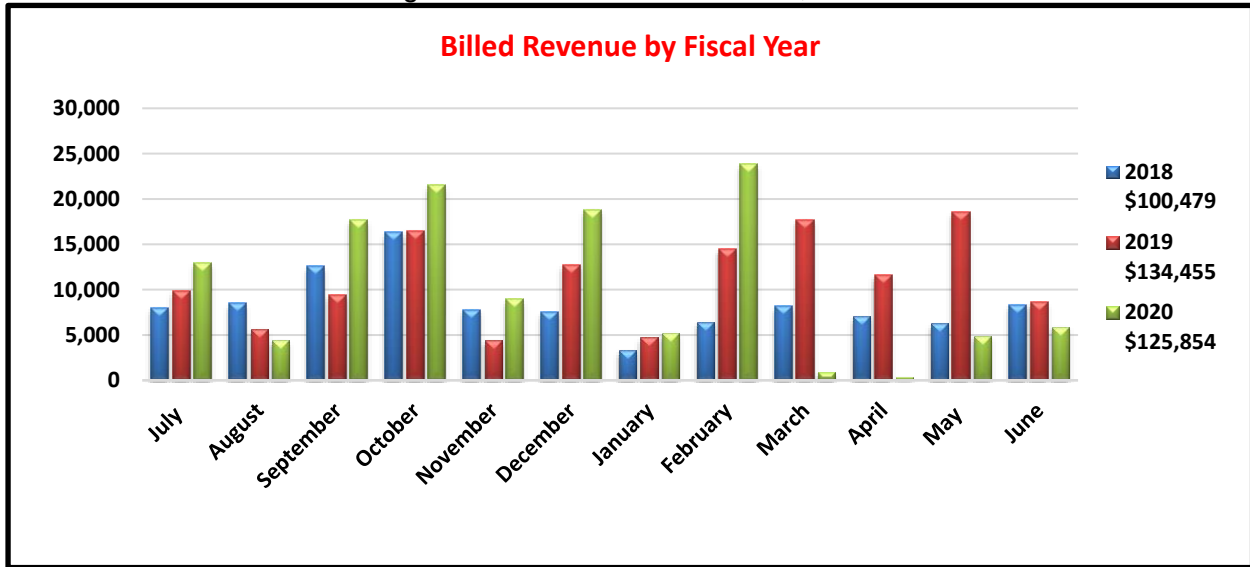
Personnel

- Edward Hsu, Ph.D., Director
- Samer Merchant, M.S., Manager
- Tyler Thompson, Research Assistant
- Samuel Colby, Research Assistant

**2020 Annual Update
Revenue/Expenses**

FY20 Expenses: Total \$296,214
FY20 Revenue: Total \$250,854

- VP of Health Sciences Support: \$50,000
- VP of Research Support: \$75,000
- FY20 Revenue generated from services: \$125,854



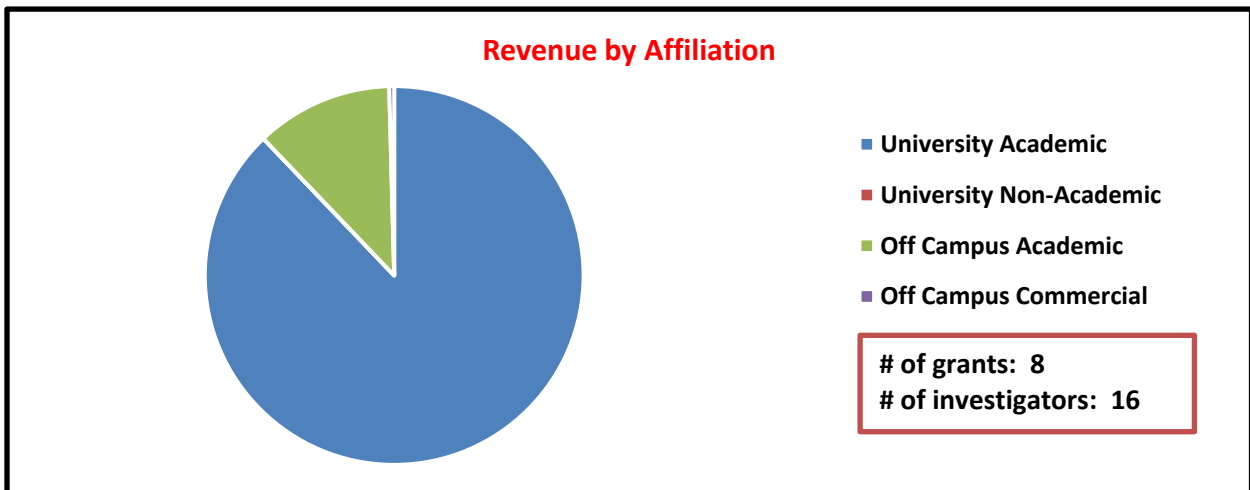
Advisory Board Committee

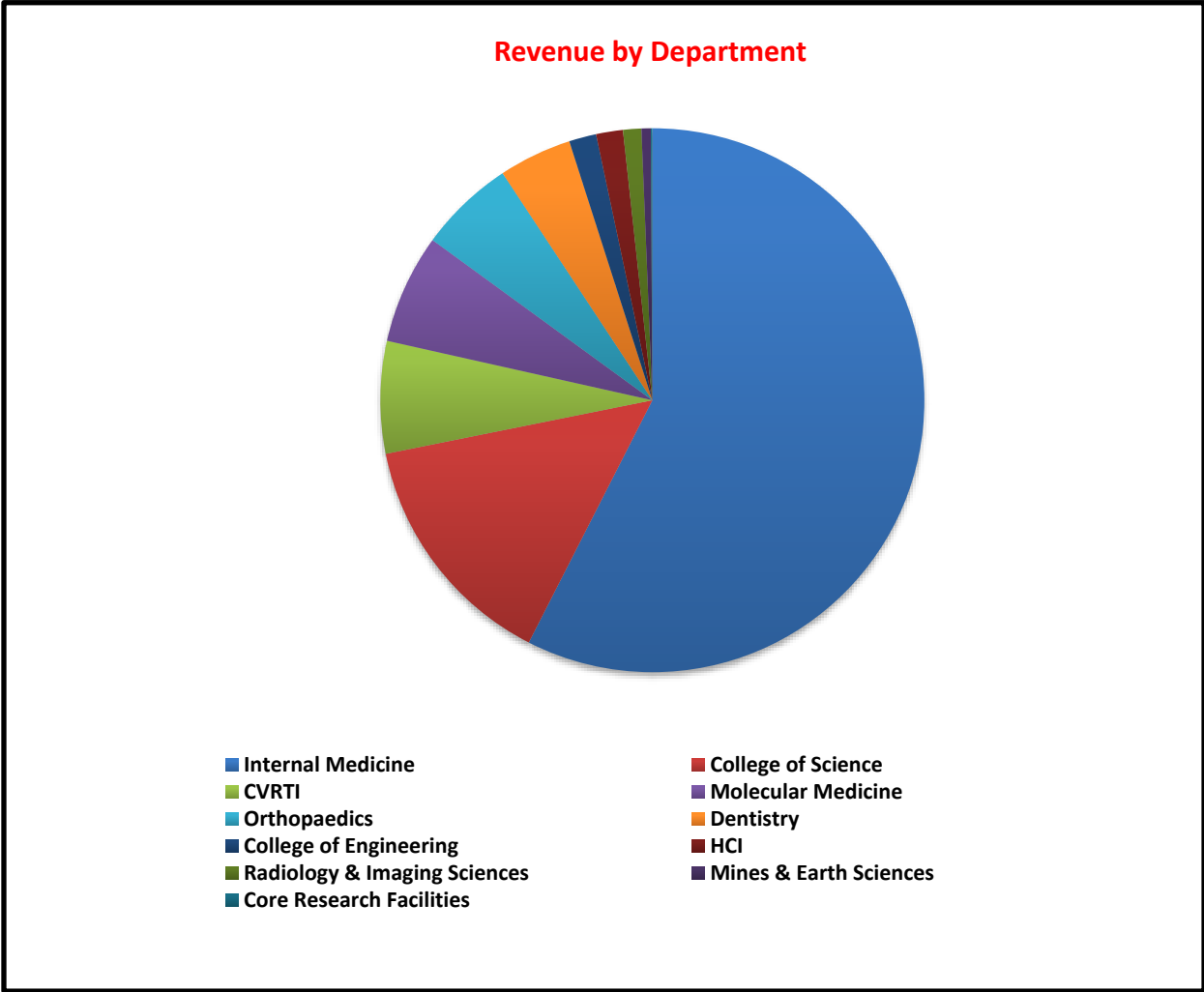
Last meeting date: April 1, 2018

- Rob MacLeod, Professor, Bioengineering/SCI/CVRTI
- John Phillips, Professor, Hematology
- Jack Taylor, Interim Director, Office of Comparative Medicine
- Edward DiBella, Professor, Radiology
- Donna Cross, Associate Professor, Radiology

**FY20 Scientific Impact
Research Support**

Revenue Generated (see charts following):





Top Users

1	Donato, Anthony	NIH
2	Shapiro, Michael	NIH
3	University of Texas-Austin	Off Campus Educational
4	Ranjan, Ravi	NIH
5	MacLeod, Rob	Nora Eccles Treadwell Foundation
6	Whitehead, Kevin	Department
7	Jones, Kevin	NIH
8	Jia, Shihai	University of Utah Research Foundation
9	University of Cambridge	Off Campus Educational
10	Holmen, Sheri	Department

Publications

- Li, D. S., Avazmohammadi, R., Merchant, S. S., Kawamura, T., Hsu, E. W., Gorman, J. H., 3rd, Sacks, M. S. (2020). Insights into the passive mechanical behavior of left ventricular myocardium using a robust constitutive model based on full 3D kinematics. *J Mech Behav Biomed Mater*, 103, 103508. doi:10.1016/j.jmbbm.2019.103508

Small Animal Ultrasound Facility

Overview

The Small Animal Ultrasound Facility has two state-of-the-art VisualSonics 2100 ultrasound machines capable of imaging mice, rats, and other animal models with excellent spatial and temporal resolution. The facility has probes that cover the spectrum from 9-70 MHz (standard human clinical ultrasound covers the spectrum from 2.5-12 MHz). These machines are capable of real-time 2D imaging as well as a full spectrum of Doppler techniques (pulsed-wave, color, tissue, power). One of the two machines is also capable of 3D imaging and contrast imaging (both targeted and non-targeted). Software is available for advanced image analysis of cardiac mechanics with speckle tracking that allows analysis of strain and strain rate. These tools allow near histologic resolution imaging of live animals, and are well suited to challenging applications such as the resolving the rapid heart rates of mice, or the microscopic size and function of early and mid-gestation embryos, and everything in between. The facility has long been an extremely important tool in the practice of clinical medicine because it offers real-time imaging providing understanding of anatomy and physiology, is non-invasive, and can be repeated serially.

Services

The facility has the capability for anesthesia and monitoring of mice and rats, and will support training laboratory personnel in the design of protocols and the use of the equipment for acquiring images. An off-line image analysis station is also available for later review and analysis of studies.

- Ultrasound imaging access
- Training in use of equipment
- Experiment design and assistance with protocol optimization
- Off-line image review and analysis

Equipment

- Two VisualSonics 2100 ultrasound machines
- Off-line image analysis station and network storage for backing-up data files

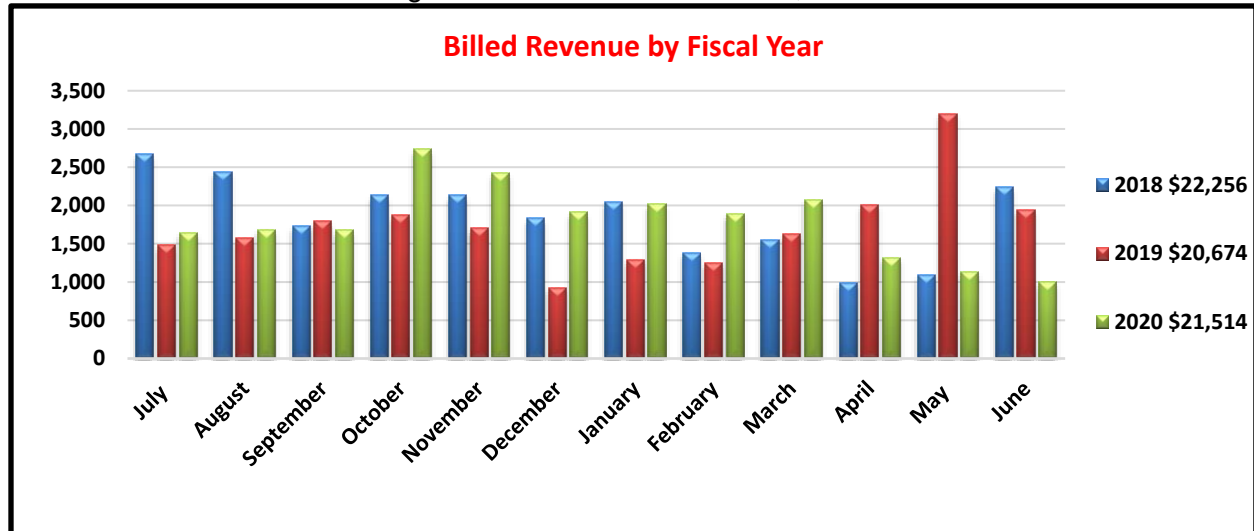
Personnel

- Kevin Whitehead, M.D., Director
- Kandis Carter, Laboratory Technician
- Tiehua Chen, Laboratory Technician

**2020 Annual Update
Revenue/Expenses**

FY20 Expenses: Total \$25,345
FY20 Revenue: Total \$31,514

- VP of Health Sciences Support: \$10,000
- FY20 Revenue generated from services: \$21,514



* Legend displays total annual revenue by year earned.

Advisory Board Committee

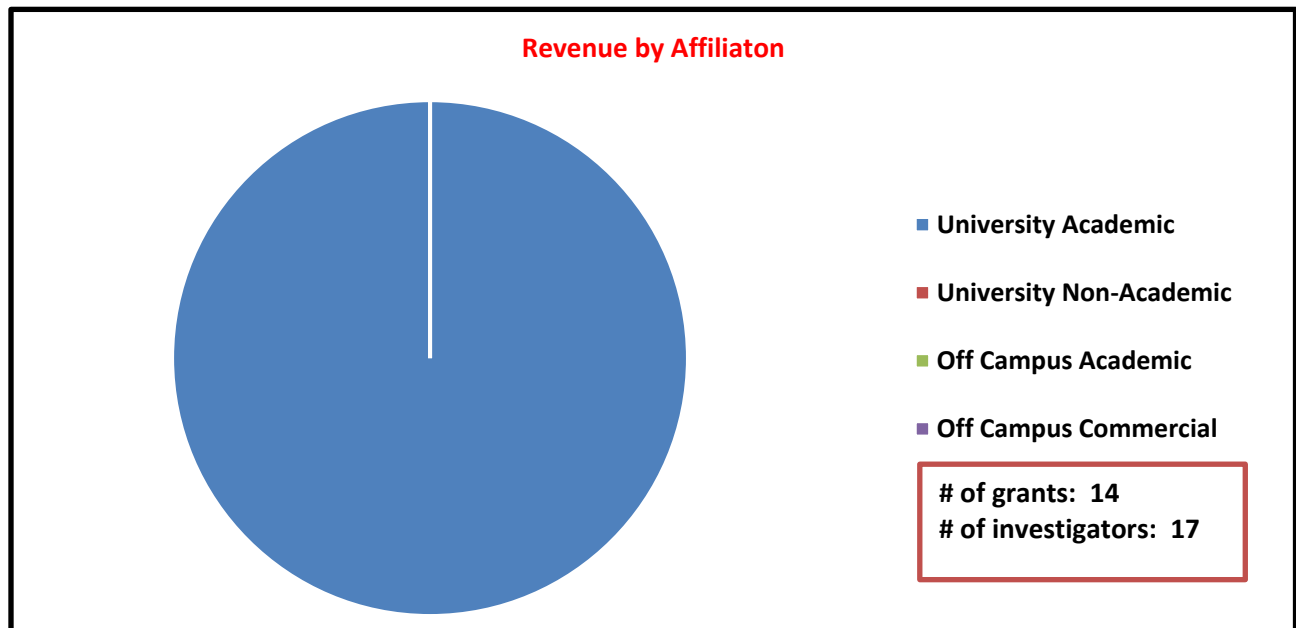
Last meeting date: April 15, 2013.

- Andy Weyrich, PhD, Associate Dean for Basic and Translational Sciences
- Craig Selzman, MD, Professor, Cardiothoracic Surgery
- Brent Wilson, MD, PhD, Professor, Cardiology

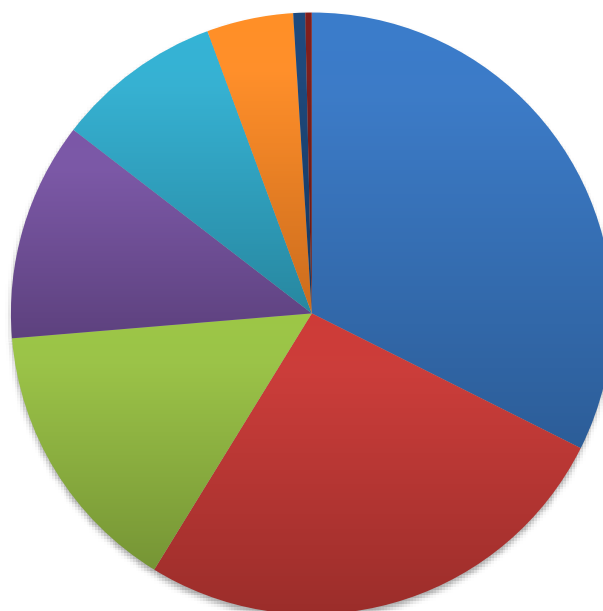
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



Top Users

1	Drakos, Stavros	NIH, Eccles Treadwell FTD
2	Franklin, Sarah	NIH, Eccles Treadwell FTD
3	McKellar, Stephen	Department
4	Zelzman, Craig	Department
5	Pon Velayutham, Anandh	NIH
6	Boudina, Sihem	Department
7	Rutter, Jared	Department, Brigham & Women's Hospital
8	Holland, William	NIH
9	Ramkumar, Nirupama	Department
10	Yost, Joseph	Department

Publications

1. Pires, K. M., Torres, N. S., Buffolo, M., Gunville, R., Schaaf, C., Davis, K., Boudina, S. (2019). Suppression of Cardiac Autophagy by Hyperinsulinemia in Insulin Receptor-Deficient Hearts Is Mediated by Insulin-Like Growth Factor Receptor Signaling. *Antioxid Redox Signal*, 31(6), 444-457. doi:10.1089/ars.2018.7640
2. Shanmugam, G., Wang, D., Gounder, S. S., Fernandes, J., Litovsky, S. H., Whitehead, K., Rajasekaran, N. S. (2020). Reductive Stress Causes Pathological Cardiac Remodeling and Diastolic Dysfunction. *Antioxid Redox Signal*, 32(18), 1293-1312. doi:10.1089/ars.2019.7808

Transgenic & Gene Targeting

Overview

The goal of the Transgenic & Gene Targeting Core (TGTC) is to provide state of the art service and assistance in the field of mouse transgenesis and gene targeting. Our aim is to provide excellent services to the scientific community in a timely and cost efficient manner. The core develops technology, possesses high tech, precise equipment, provides consultation on project design and assists in the execution of research to maintain a position as a leader in the field of mouse genetic modification.

Our main service is to provide transgenic and gene targeted mice to researchers. CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) technology has allowed researchers, even those not adept at molecular biology, to obtain specific gene targeted mice for their research in a more direct manner than traditional methods. TGTC uses CRISPR technology to generate knockout, knockin, and conditionally targeted alleles in mice. This method allows for faster, more efficient and less expensive generation of mice with specific genetic mutations.

Other services include conventional gene targeting of ES (embryonic stem) cells followed by injection of targeted cells to produce germline chimeras, and production of traditional transgenic mice where the transgene is randomly inserted into the genome. In addition, TGTC has expertise in mouse-related procedures including embryo and sperm cryopreservation, in vitro fertilization (IVF), intracytoplasmic sperm injection (ICSI), karyotyping of ES cells, rederivation of mice from frozen embryos, and derivation of primary ES cells. Our facility consists of two cell culture hoods and incubators, three microinjection stations for both pronuclear and blastocyst injections, three surgery areas, and a mouse room for housing and breeding the necessary animals. The TGTC staff have a vast array of experience in the gene targeting and transgenic mouse field. Our lab works closely with University of Utah regulatory groups and is in compliance with strict IACUC and USDA guidelines.

Services

- Mouse generation of targeted mutations using CRISPR/Cas technology to create specific genetic mutations including knockout, knockin, and conditional knockout
 - CRISPR mouse generation via microinjection of reagents
 - CRISPR mouse generation via ZEN (zygote electroporation of nucleases)
 - CRISPR mouse generation via GONAD (genome editing via oviductal nucleic acids delivery)
- In vivo validation of CRISPR reagents
- Blastocyst injection of targeted ES embryonic stem cells
- Pronuclear injection of DNA to produce transgenic mice
- Gene targeting of ES embryonic stem cells
- Primary ES cell generation
- Sperm cryopreservation
- Embryo cryopreservation
- IVF, in vitro fertilization
- Rederivation of mouse lines via embryo transfer
- Ovary transfer
- Import/export sperm and/or embryos

- Karyotyping of ES embryonic stem cells
- Sperm and embryo long-term storage

Equipment

- Nikon Eclipse Ti2 microinjection station, with fluorescence, CO₂, heating/cooling stage
- Leica Dmi8 microinjection stations (2)
- Eppendorf Transferman NK2 micromanipulators
- Eppendorf Femtojet microinjectors
- Eppendorf Peizo drills
- Leica S9i stereomicroscopes (2)
- Olympus SZX16 dissection microscopes (2), one with fluorescence option
- Nikon Eclipse TS100 inverted microscopes
- Zeiss Stemi508 stereomicroscope
- Sutter P-97 pipette puller
- Narashige MF-900 microforges
- TMC vibration isolation tables (3)
- ESCO, Forma, New Brunswick CO₂ incubators
- MINC IVF incubator
- Brinkman benchtop autoclave
- ESCO cell culture hood
- Forma cell culture hood
- BioRad Gene Pulser Xcell electroporator
- NepaGene21 Electroporator system, with concave electrodes for in vivo GONAD, and with glass slide electrode for ZEN
- Thermo Cryomed controlled rate embryo freezer
- Thermo TSX Series -80°C freezer
- Centrifuges, microfuges

Personnel

- Susan Tamowski, Director
- Wenhua Li, Senior Lab Specialist
- He Lan, Senior Lab Specialist
- Nick Black, Lab Specialist

2020 Annual Update

New Services

- 2-step CRISPR/Cas microinjections and ZEN to improve efficiency of obtaining floxed alleles in mouse embryos
- 2-cell microinjection and ZEN of CRISPR reagents to overcome lethality of knockouts and to increase efficiency of large donors
- TILD-CRISPR (targeted integration with linearized dsDNA-CRISPR) to increase targeting efficiency by using large double stranded donor with 800bp homology arms

Goals

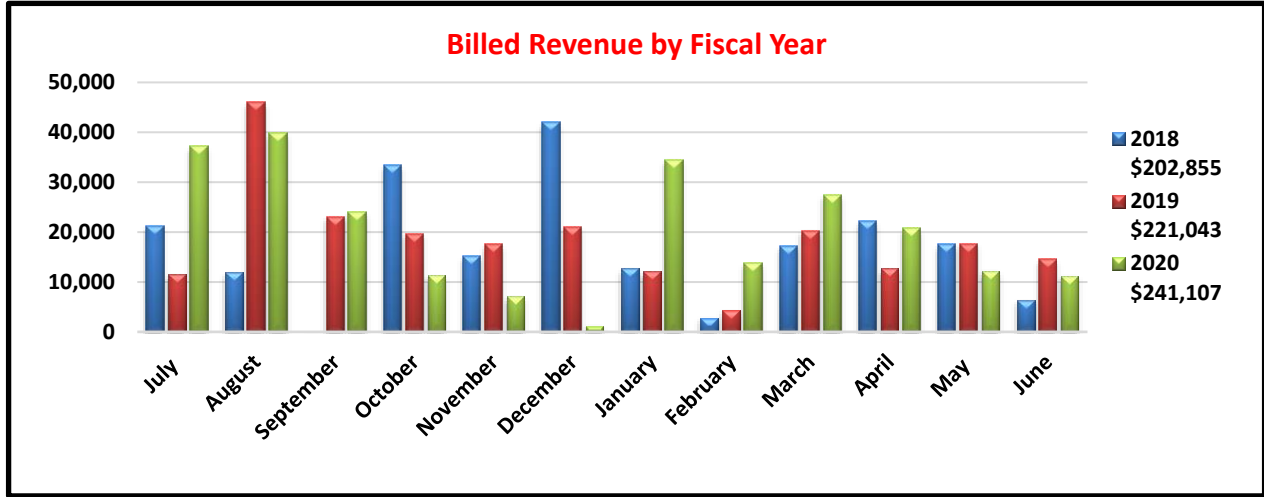
- Our Core strives to keep abreast of and to optimize new techniques to obtain requested mice in the most efficient manner bearing in mind the 3R's of animal research.

Revenue/Expenses

FY20 Expenses: Total \$620,206

FY20 Revenue: Total \$675,710

- VP of Health Sciences Support: \$434,603
- FY20 Revenue generated from services: \$241,107



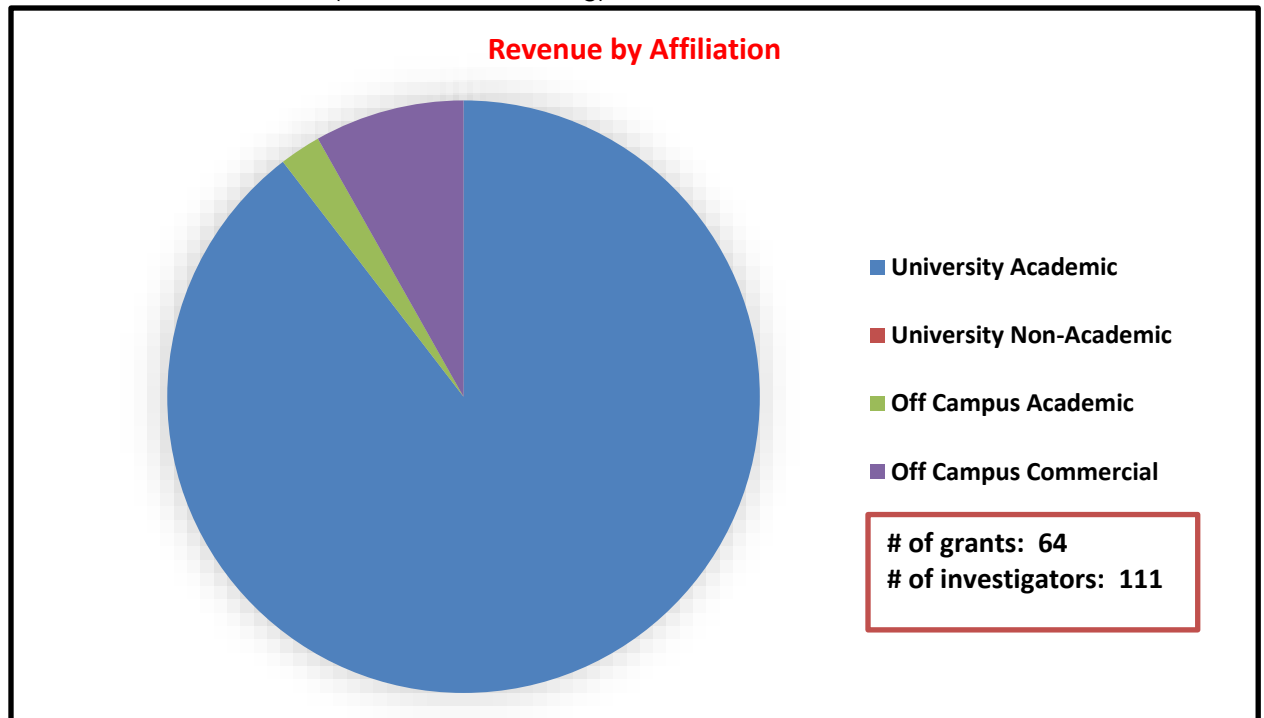
Advisory Board Committee

- Charlie Murtaugh, PhD, Co-Director, Professor, Human Genetics
- Suzi Mansour, PhD, Professor, Human Genetics
- Dean Tantin, PhD, Professor, Pathology
- Kevin B. Jones, MD, Professor, Huntsman Cancer Institute

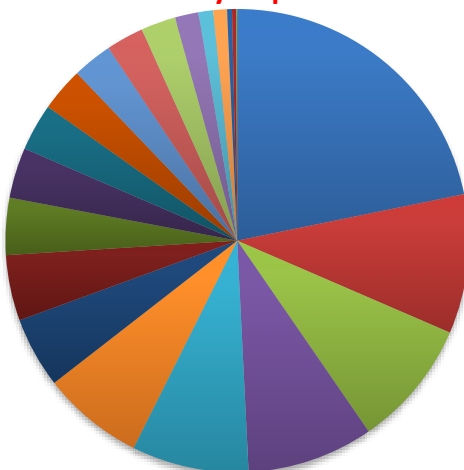
FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- | | |
|--------------------------------------|------------------------|
| ■ Neurobiology & Anatomy | ■ Internal Medicine |
| ■ Pathology | ■ Molecular Medicine |
| ■ Ophthalmology & Visual Sciences | ■ Oncological Sciences |
| ■ Orthopaedics | ■ Pharmacy |
| ■ Pediatrics | ■ CVRTI |
| ■ Human Genetics | ■ HCI |
| ■ Nutrition & Integrative Physiology | ■ Biochemistry |
| ■ Dentistry | ■ College of Health |
| ■ Dermatology | ■ Anesthesiology |
| ■ Neurology | ■ Psychiatry |
| ■ Neurosurgery | ■ Radiation Oncology |

Top Users

1	Gregg, Christopher	NIH, Department
2	Science Exchange	Commercial
3	Jones, Kevin	NIH
4	Reilly, Christopher	NIH
5	Tavtigian, Sean	Department
6	Yang, Jun	NIH
7	Hartnett, Mary	Department
8	Snyder, Eric	NIH
9	Warren, Junco	NIH
10	Butterfield, Russell	NIH

Letters of Support for grant applications:

1. Dr. Sungjin Park's R01 grant application to include generation of a knock-in mouse using CRISPR technology for a project investigating the molecular mechanism for the tectorial membrane formation. September 2019
2. Dr. Rajeshwary Ghosh's College of Health Seed Grant Application to generate a KFERQ-*Renilla* Luciferase knock-in mouse to study Chaperone Mediated Autophagy in the heart. October 2019

3. Dr. Mick Juryneć's Arthritis National Research Foundation proposal to generate a conditional *Ripk2* mouse to introduce the human *RIPK2* OA-associated disease allele into the mouse using CRISPR technology. January 2020
4. Dr. Dean Tantin's NIH R01 grant proposal to use CRISPR techniques to introduce specific point mutations into the *Pou5f1* gene in mouse embryonic stem (ES) cells. January 2020
5. Dr. Sean Shadle's NRSA F32 proposal to create a *Kdm4d* knockout mouse using CRISPR techniques. April 2020

Utah Center for Genetic Discovery

Overview

The UCGD Core helps investigate the genetic basis for human disease by providing whole exome and genome sequence analyses for research and clinical projects. We specialize in variant calling and disease-gene discovery research. Services offered include alignment and variant calling (including structural variant calling) for NGS datasets, variant interpretation, joint genotyping, disease gene discovery in cohorts and families, and ad hoc research analyses as dictated by the project. In total, the UCGD has available 2340 CPU cores and 3.25 PB of disc storage, plus access to additional shared resources. Total capacity for variant calling is approximately ~200,000 genomes annually via a combination of in-house and cloud-based processing. The UCGD Core has cloud computing expertise for massively scalable data access, processing and sharing, and maintains a web-based data portal for data access and collaborative analysis.

Services

- Alignment and variant calling to identify small nucleotide variants (SNVs), small insertions/deletions (INDELs), and structural variants using our automated, high capacity variant calling pipeline.
- Prioritization and interpretation of variants using a filtering and/or statistical methods.
- Disease gene discovery in cohorts and families.

Personnel

- Mary Anne Karren, Director
- Barry Moore, Project Director
- Shawn Rynearson, Software Developer
- Carson Holt, Software Developer
- Bushra Gorski, Research Analyst
- Steven Boyden, Director of Research and Science
- Ad hoc analysts from Yandell, Quinlan, and Marth laboratories including Javier Hernandez, Matt Velinder, Tom Nicholas, Andrew Farrell, Brent Pedersen

2020 Annual Update

Grant Support – UCGD Core supported the following grant submissions in FY20:

- Bridging the Gap between Genomics and Clinical Outcomes in CHD (**U01**). Tristani-Firouzi, Yandell, Yost. **Awarded.**
- Cardiovascular Development Data Resource Center (**UM1**). MPIs: Yost, Marth, Tristani-Firouzi. **Awarded.**
- A Novel role for NFATC1 in modulating cardiac excitability (**R01**). PI: Tristani-Firouzi. **Awarded.**
- A diagnostic analysis system to enable community-wide adoption of longitudinal genomic medicine (**U24**). MPIs: Marth, Tristani-Firouzi, Brunelli.
- Center for somatic mosaicism (**RM1**). MPIs: Marth, Murtaugh, Quinlan, Tristani-Firouzi, Yost.
- Utah/Rady Mendelian Genomics Research Center (**U01**). MPIs: Quinlan, Marth, Yandell, Tristani-Firouzi, Brunelli, Botto, Bonkowsky, Hobbs, Nadault.
- Validation and Identification of Genetic Variants in Peyronie's and Dupuytren's

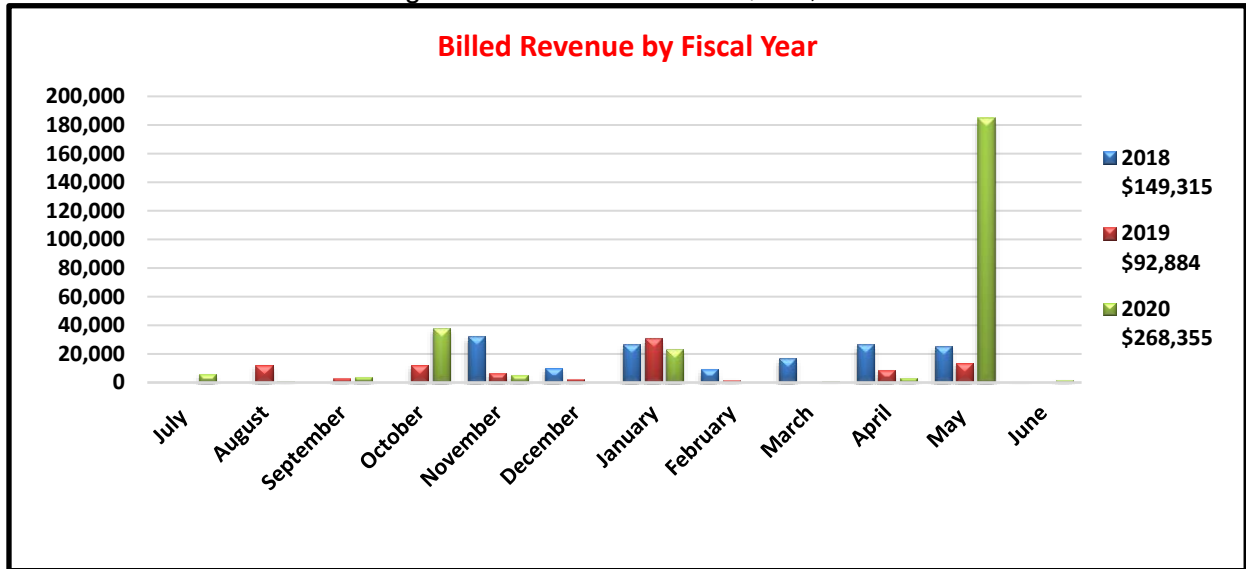
- Disease that Predispose to Fibrosis and Inflammation **(R01)**. PI: Pastuszak
- Erectile Dysfunction Genetics and the Environment (EDGE): A Systems Biology Approach to ED **(R01)**. PI: Hotaling
- A solution to expand the implementation of rapid next-generation sequencing in critically ill infants **(R01)**. PI: Brunelli
- A comprehensive de novo mutation discovery tool **(R01)**. PI: Marth

Revenue/Expenses

FY20 Expenses: Total \$1,092,300

FY20 Revenue: Total \$1,402,153

- VP of Health Sciences Support: \$1,133,798
- Gift Account: \$ 0
- FY20 Revenue generated from services: \$268,355

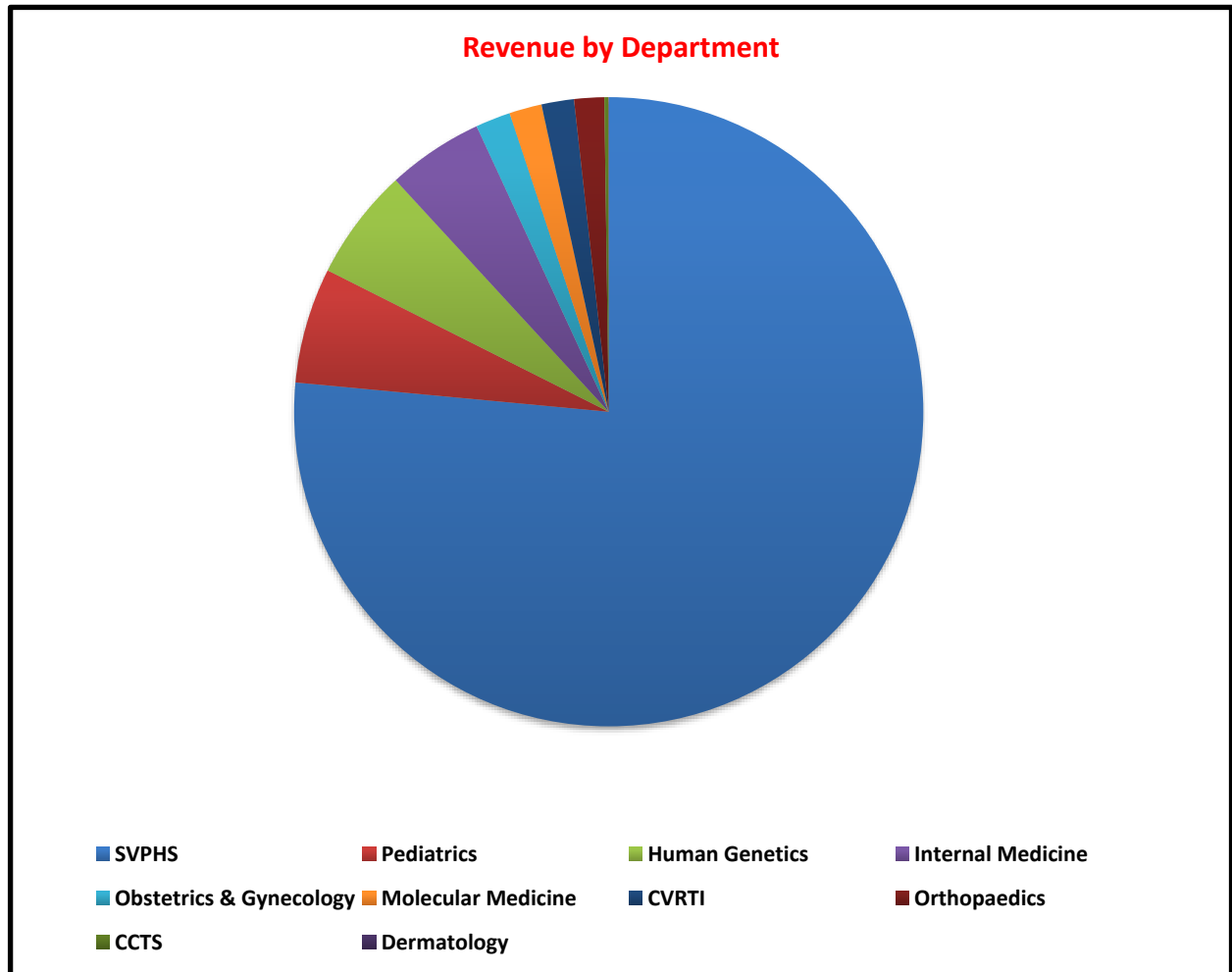
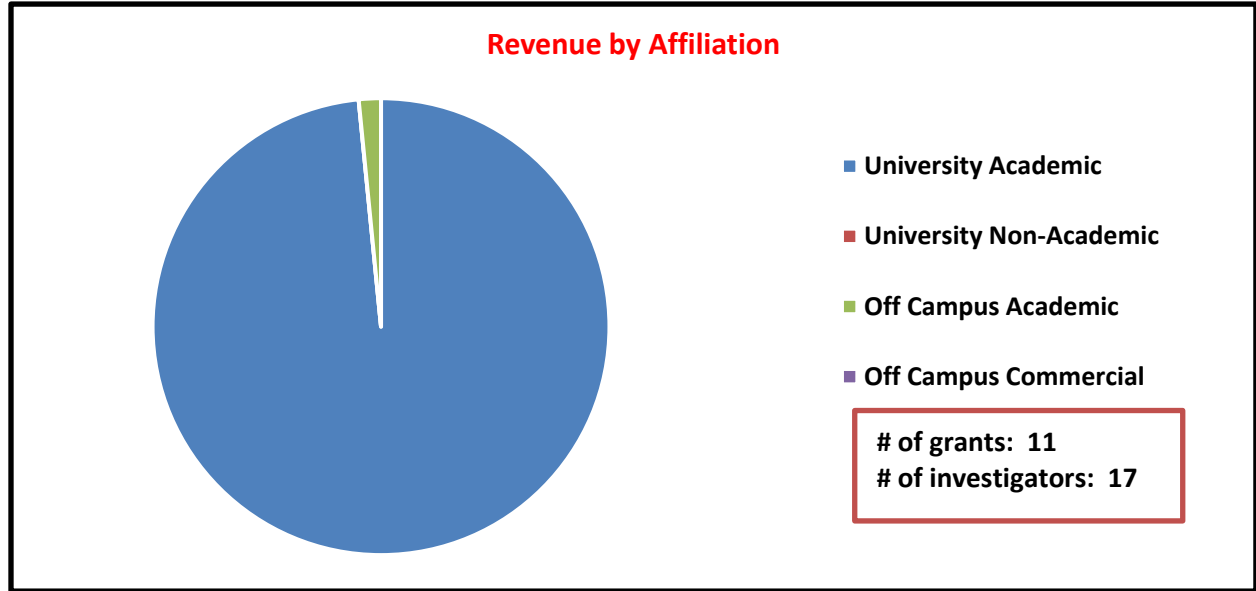


* Legend displays total annual revenue by year earned.

Advisory Board Committee

- Mark Yandell, PhD, Professor of Human Genetics
- Gabor Marth, DSc, Professor of Human Genetics
- Aaron Quinlan, PhD, Associate Professor of Human Genetics
- Joseph Yost, PhD, Professor and Vice Chairman for Basic Science Research, Department of Pediatrics

**FY20 Scientific Impact
Research Support
Revenue Generated (see charts following):**



Top Users

1	Dere, Will	Department
2	Tristani-Firouzi, Martin	NIH
3	Phillips, John	NIH
4	Varner, Michael	NIH
5	Welt, Corrine	NIH
6	Juryneec, Mick	Skaggs Foundation for Research
7	Bonkowsky, Josh	Department
8	Botto, Lorenzo	NIH, Department
9	University of Colorado	Off Camus Academic
10	Kanth, Priyanka	Department

Publications:

1. Cawthon, R. M., Meeks, H. D., Sasani, T. A., Smith, K. R., Kerber, R. A., O'Brien, E., Jorde, L. B. (2020). Germline mutation rates in young adults predict longevity and reproductive lifespan. *Sci Rep*, 10(1), 10001. doi:10.1038/s41598-020-66867-0
2. Richter, F., Morton, S. U., Kim, S. W., Kitaygorodsky, A., Wasson, L. K., Chen, K. M., Gelb, B. D. (2020). Genomic analyses implicate noncoding de novo variants in congenital heart disease. *Nat Genet*, 52(8), 769-777. doi:10.1038/s41588-020-0652-z
3. Sasani, T. A., Pedersen, B. S., Gao, Z., Baird, L., Przeworski, M., Jorde, L. B., & Quinlan, A. R. (2019). Large, three-generation human families reveal post-zygotic mosaicism and variability in germline mutation accumulation. *Elife*, 8. doi:10.7554/eLife.46922
4. Watkins, W. S., Hernandez, E. J., Wesolowski, S., Bisgrove, B. W., Sunderland, R. T., Lin, E., Tristani-Firouzi, M. (2019). De novo and recessive forms of congenital heart disease have distinct genetic and phenotypic landscapes. *Nat Commun*, 10(1), 4722. doi:10.1038/s41467-019-12582-y

Service Recharge Centers

Overview

The HSC Administration Office also manages Service/Recharge Centers. These Centers are not cores but follow most of the same guidelines as the HSC Cores. The Administration Office processes the billing, collections and ordering of supplies for these Centers. Each Center receives monthly reports showing revenue and expenses and has access to the internal tracking system which shows in real time what their account balances are. The Administration Office charges a fee of 5% on revenue collected from billed services. These Centers are listed on the HSC Cores website under Service/Recharge Centers. If it is determined at a later time that a Center would benefit from becoming a Core, then all guidelines must be followed.

Service/Recharge Centers are primarily created to provide services to the University Community but can also provide services to external customers. The administration of these facilities is performed by the home department. Only recharge activity for these groups is managed by the Administrative Office, this is partly due to the efficient billing system that has been developed in collaboration with our IT support group managed by Mr. Rick Haycock.

Genetic Science Learning Center

Overview

The GSLC specializes in translating complex science and health concepts for those who are not experts in a particular field. They produce award-winning educational materials and programs that make science and health easy for everyone to understand.

Uniqueness

The GSLC brings together in one team synergistic expertise in design and production of educational materials and programs as well as research and evaluation on the efficacy of both. It's team is unique among groups at US academic institutions that produce science and health education materials in that it includes expertise in science and health writing, science research, instructional and educational material design, multimedia animation and interactivity, graphic design, video production, video game and app development, original music composition and audio engineering, course and workshop design, and research and evaluation of educational materials and programs; other groups outsource some of these functions.

The GSLC produces the most highly-used online life science education resource in the world. Each year its Learn.Genetics and Teach.Genetics websites are visited by over 16 million individuals who view over 60 million pages and come from every country. These sites provide an unparalleled, international dissemination mechanism for educational materials developed through collaborative projects with faculty. The GSLC has received numerous awards for the educational materials it produces. Among others, these include the inaugural award of the *Science* Prize for Online Resources in Education from *Science Magazine* and AAAS.

The GSLC has over 21 years of experience in producing educational materials and programs for patients, the lay public, students at the K-12 and higher education levels, and K-12 teachers. They successfully collaborate with faculty and others in producing materials and programs and in conducting evaluations for both large and small projects.

Services

The GSLC offers the following services:

Design and Production of Educational Materials

- Design and production of educational materials for:
 - Research studies
 - Clinical trials recruitment
 - Patients and families
 - K-12 students and teachers
 - Higher education students
 - Diverse audiences, including tailoring for cultural and language differences
- Science and health writing
- Instructional design
- Multimedia animation and interactivity
- 2D and 3D animation
- Graphic design for online and print-based materials

- Video production, including script writing, production and scheduling, videography, editing, and post-production
- Original music composition/scoring and audio engineering for video and multimedia materials
- Video game development
- App design and development
- Website design and development

Designing and Holding Educational Programs

- Online courses in Canvas for University credit
- In-person courses and workshops, with or without University credit
- Classroom programs for K-12 students
- Programs for the lay public
- Facilitating connections with K-12 teachers, schools and districts

Conducting Research and Evaluation Studies

- Evaluation of educational materials and programs
- Quantitative, qualitative and mixed-methods designs
- Small and medium-scale randomized controlled trials
- Development of valid knowledge assessment (test) items
- Focus groups and key informant or participant interviews
- Survey design

Cross-Cutting Services

- Dissemination of educational materials via conference presentations and manuscripts
- Writing education sections of grant proposals
- Planning Broader Impacts activities for NSF grant proposals

An initial consultation is provided in order to define a project's scope and budget. For grant proposals, text describing the GSLC and its contributions to the project, a budget and justification are provided. Once a project is agreed to and/or funded, a project lead is assigned, who serves as the primary GSLC contact for the project.

Personnel

- Louisa A. Stark, PhD, Director
- Kevin Pompei, MEd, Administrative Director
- Dina Drits-Esser, PhD, Assistant Director for Research and Evaluation
- Kaile Akina-Scheiss, BFA, Graphic Artist
- Peter Anderson, BFA, Creative Director
- Kagan Breitenbach, BMu, Specialty Media Coordinator
- Rochelle Cassells, PhD, Research Associate
- Jonathan Conger, BS, Associate Software Engineer
- Kristin Fenker, PhD, Post-doctoral Fellow
- Elliot Francis, BS, Senior Software Engineer
- Jason Harris, AS, Web Software Developer
- Nathan Holland, BA, Animator
- Jonny Holmgren, AA, Graphic Artist
- Sheila Homburger, MS, Science Content Manager
- Ann Lambert, PhD, Research Associate
- John Maxwell Kelly, BFA, Multimedia Manager

- Molly Malone, BS, Senior Education Specialist
- Ryan Perkins, BFA, Art Director
- Julia Peterson, BFA, Graphic Artist
- Steve Reest, MLS, Program Assistant
- Harmony Starr, BS, Senior Media Production Manager
- Jen Taylor, BS, Education Specialist
- Brooklee Watters, AS, User Experience Developer

FY20 Annual Update

New Services

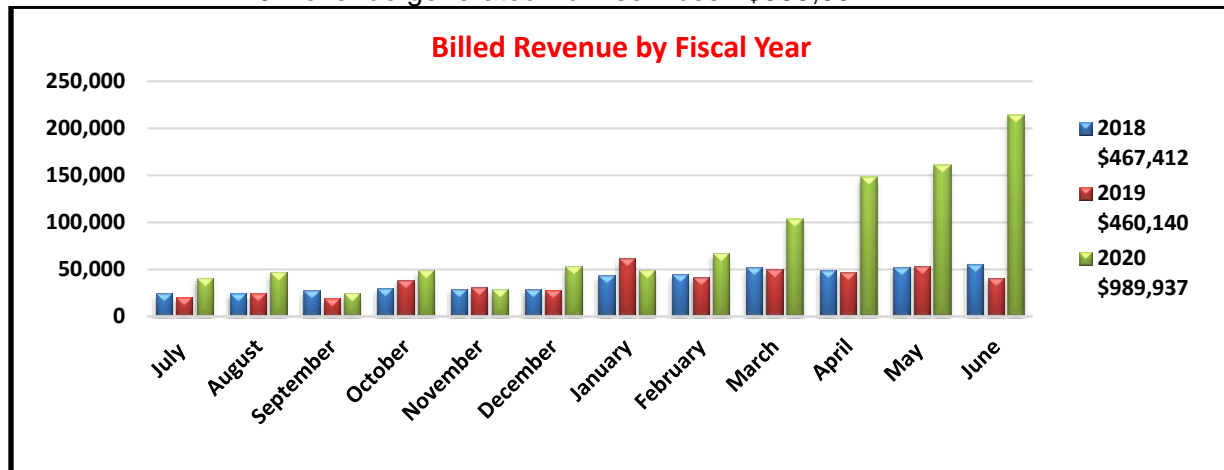
- Conference Planning
- Conference Coordination

Revenue/Expenses

FY20 Expenses: \$990,855

FY20 Revenue: \$989,937

- Other Revenue Sources: 0
- FY20 Revenue generated from services: \$989,937



* Legend displays total annual revenue by year earned.

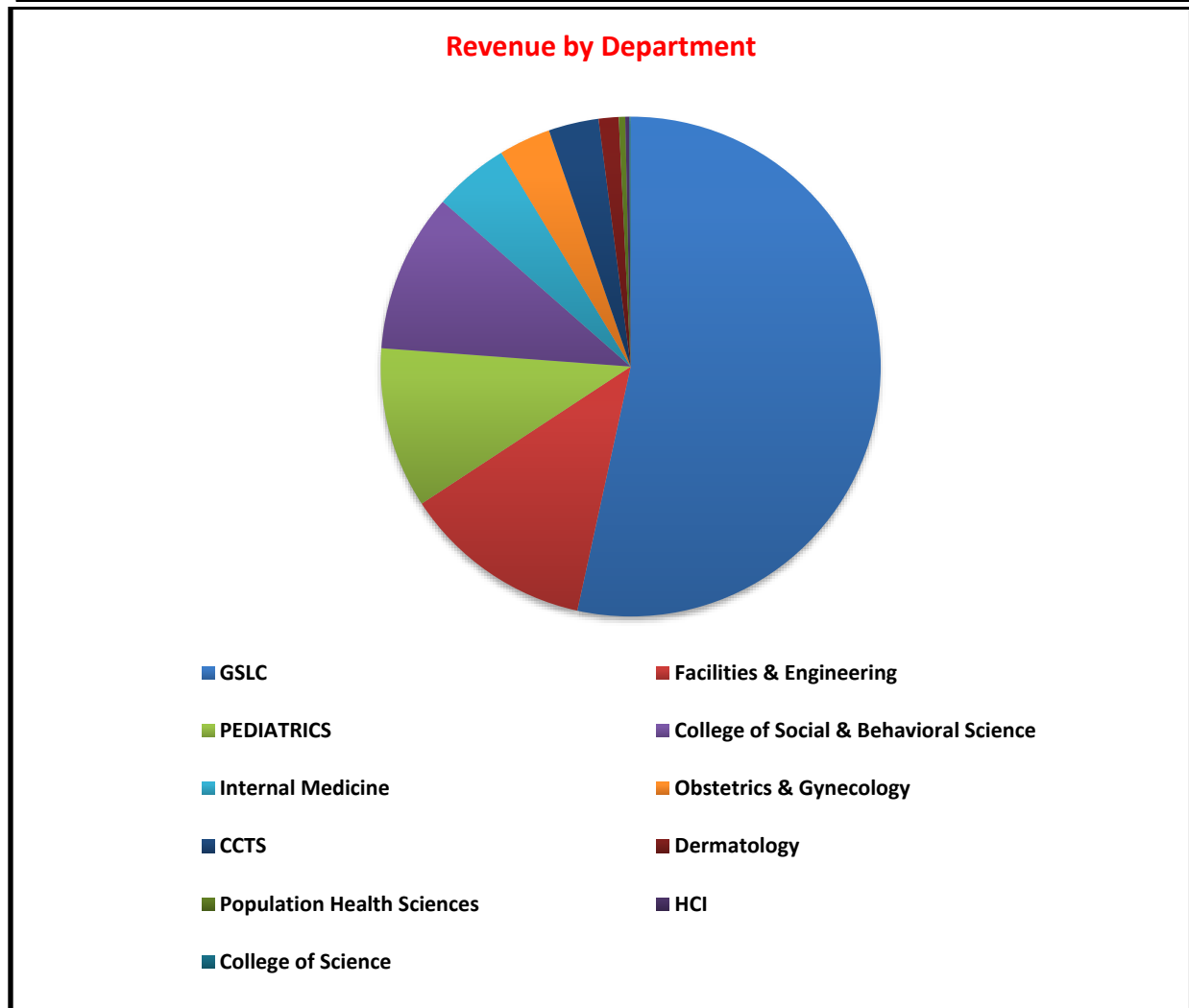
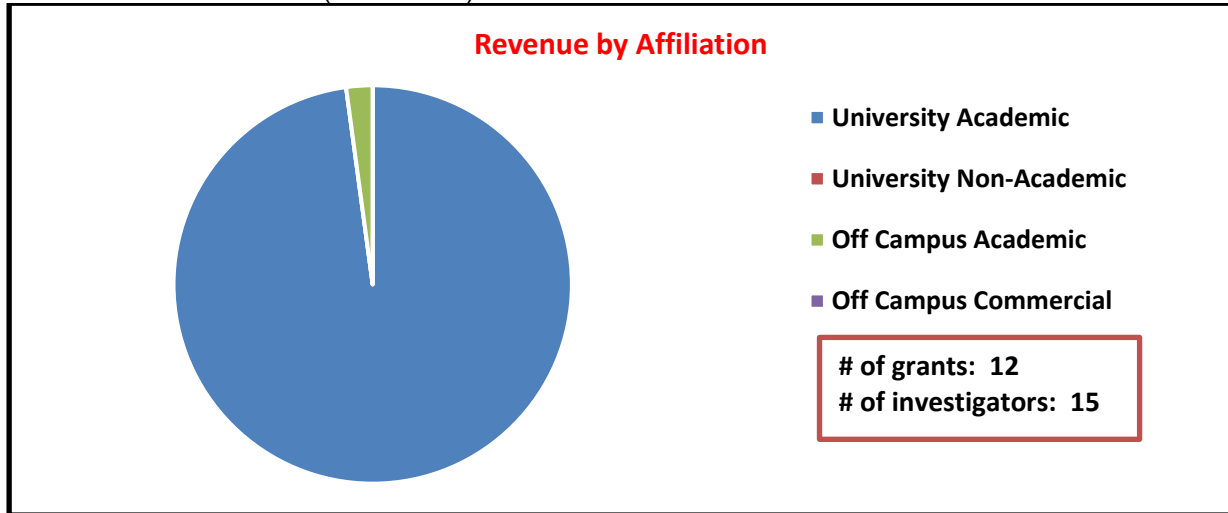
** Management by Core Administration.

Management Meeting

Last meeting date: April 10, 2019

- Louisa Stark, PhD, GSLC Director
- Kevin Pompei, MEd, Administrative Director
- John Phillips, PhD, HSC Core Research Facility, Director
- Brenda Smith, Director, Accounting and Finance, HSC Core Research Facility Operations
- Amy Tanner, Director, Research & Science, SVPHS Research Unit
- Natalie Johnson, Manager, Administration, Department of Human Genetics

**FY20 Scientific Impact
Research Support
Revenue Generated (see charts):**



Top Users

1	Stark, Louisa	NIH, NSF
2	Patterson , Brittany	Department
3	Utz, Rebecca	NIH
4	Keenan, Heather	NIH
5	Phillips, John	NIH
6	Krantz, Susan	Department
7	Egger, Marlene	NIH
8	University of Georgia	Off Campus Educational
9	Wu, Yelena	Department
10	Rothwell, Erin	NIH

Goals for FY21

The GSLC will continue to produce high-quality, award-winning educational materials, programs and evaluations. We will work to inform researchers and units across the University of Utah campus and elsewhere about our capabilities and our availability to collaborate on projects. In this way, we will seek to increase our visibility and expand our users.

Publications

1. Rothwell E, Johnson E, Wong B, Goldenberg A, Tarini BA, Riches N, Stark LA, Pries C, Langbo C, Langen E, Botkin J. (2020). Comparison of video, app and standard consent processes on decision-making for biospecimen research: A randomized controlled trial. *Journal of Empirical Research on Human Research Ethics* 2020 Apr 3; 1556264620913455. doi: 10.1177/1556264620913455
2. Homburger, S. A., Drits-Esser, D., Malone, M., Pompei, K., Breitenbach, K., Perkins, R. D., Stark, L. A. (2019). Development and pilot testing of a three-dimensional, phenomenon-based unit that integrates evolution and heredity. *Evolution: Education and Outreach*, 12(1), 13. doi:10.1186/s12052-019-0106-1

Educational Modules Published Online

1. Exploring Genetics through Genetic Disorders [Web]. Available: <https://teach.genetics.utah.edu/content/genetics/> and <https://learn.genetics.utah.edu/content/genetics/>
2. Flowering Plants & Their Pollinators [Web]. Available: <https://learn.genetics.utah.edu/content/flowers/>

Iron & Heme

Overview

The Iron and Heme Core provides analysis of biologically important metals, precursor porphyrins and heme. The core also measures activity of the enzymes responsible for heme biosynthesis. Analysis and quantification of heme and its precursors can be obtained for cell pellets, tissue, whole blood, urine, feces and other complex biological materials. Analysis of enzyme activity can be provided for cell pellets, tissue and blood. An Agilent 7900-ICP mass spectrometer is used to measure iron content (as well as other metals) in biological samples.

Uniqueness

The Iron and Heme Core provides a service, not available at most universities including experienced UPLC/HPLC analysis of heme and porphyrin and tetrapyrrole precursor (ALA and PBG) content, assays for activity of enzymes involved in heme biosynthesis. We receive and process samples and provide service for academic laboratories all over the United States. We are able to assay and measure each of the 8 heme biosynthetic intermediates from tissue and cell sources.

Services

The Iron and Heme Core's primary mission is to facilitate research into the role of heme, heme precursors and transition metals in both normal and disease states. The Iron and Heme core lab has extensive experience with the separation and identification of tetrapyrroles and with running and developing heme biosynthesis pathway enzyme assays. We specialize in iron analysis by ICP-MS and also test for other metals. We are offering the following services:

- Metal analysis by ICP-MS
- UPLC Analysis of Total Heme and protoporphyrin IX
- Spectral Analysis of Heme
- UPLC analysis of porphyrins
- Assays for the following Heme Biosynthetic Enzymes (ALAS, ALAD/PBGS, PBGD, U3S, UROD, COPOX, PPOX & FECH)

Equipment

Metal Analysis:

- Agilent 7900-ICP mass spectrometer
- Agilent SPS4 autosampler

Heme and Porphyrin analysis:

- Waters Acquity ultra performance liquid chromatography (UPLC) system, equipped with a reverse phase C18 column, a photodiode array detector and a fluorescence detector for reversed phase analytical work
- Agilent 8453 diode array spectrophotometer
- HPLC Waters 2795 Alliance HT separations module with a Waters 474 Scanning Fluorescence Detector and a Waters 2996 PDA Detector (photodiode array)

Personnel

- Hector Bergonia, Lab Specialist Tetrapyrrole Biochemistry
- Laurie Jackson, PhD, Core Director

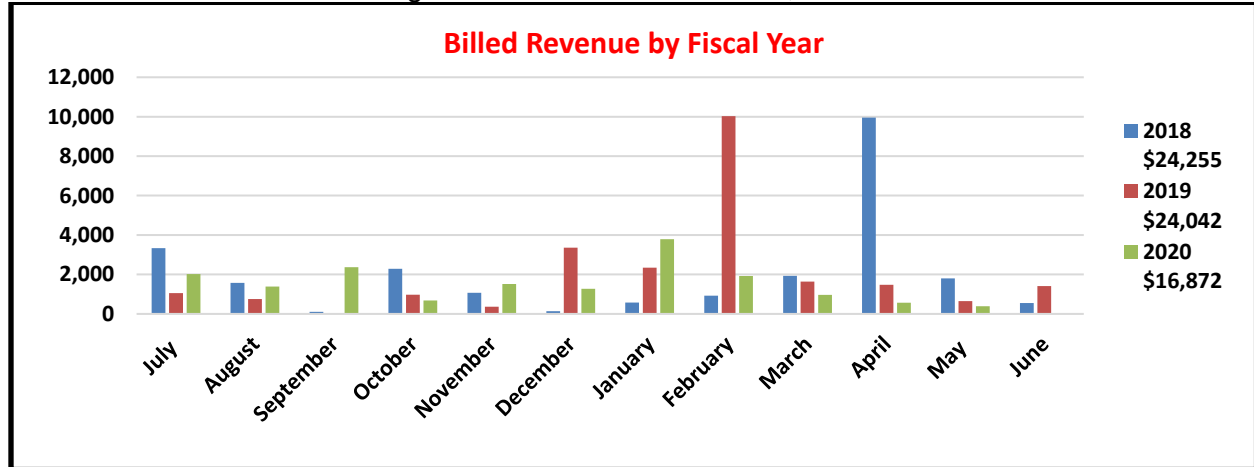
2020 Annual Update

Revenue/Expenses

FY20 Total Expenses: \$14,331

FY20 Total Revenue: \$16,872

- VP of Research Support: \$0
- FY20 Revenue generated from services: \$16,872



* Legend displays total annual revenue by year earned.

Advisory Board Committee (CIHD Operations Committee)

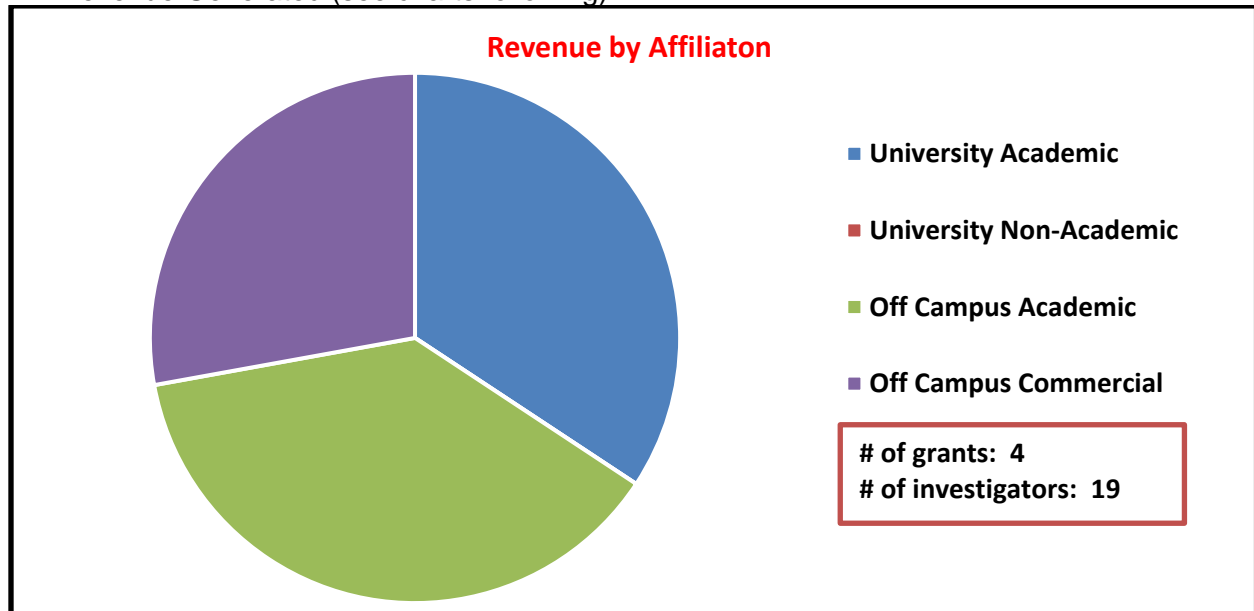
Last meeting date: October 4, 2017

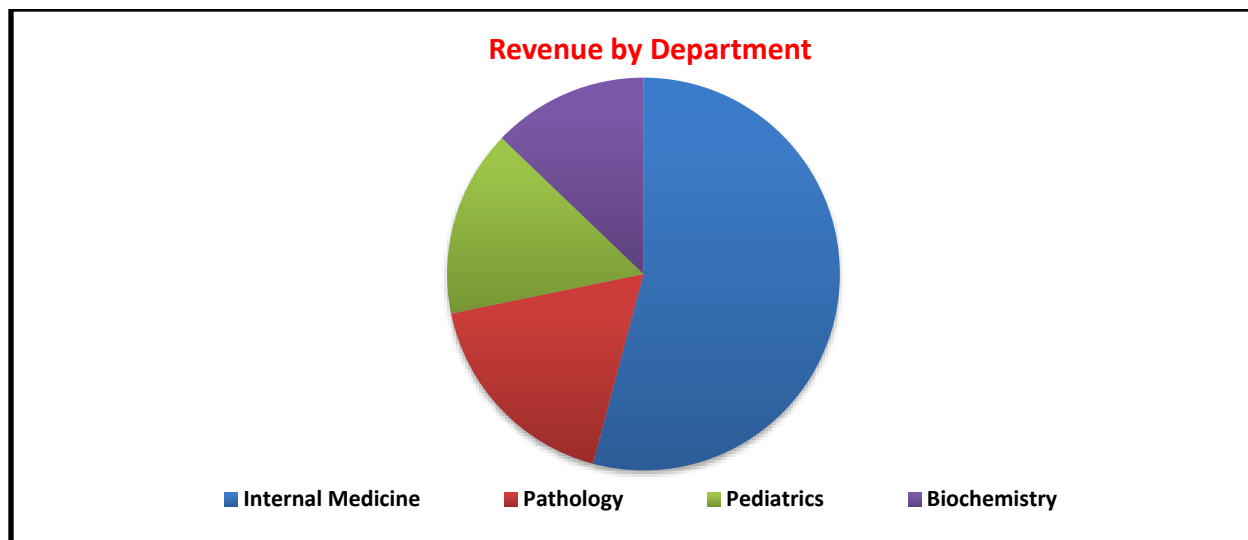
- John D. Phillips, PhD, Hematology
- James Cox, PhD, Biochemistry
- Diane M Ward, PhD, Pathology
- Dennis Winge, PhD, Hematology

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Koh, Mei	Kuda Therapeutics, LLC
2	Phillips, John	NIH
3	East Carolina University	Off Campus Academic
4	University Wisconsin-Madison	Off Campus Academic
5	Leibold, Elizabeth	Department, NIH
6	University of Wisconsin Madison	Off Campus Academic
7	IUSM-Glick Eye Institute	Commercial
8	Schiffman, Joshua	Department
9	Ward, Diane	NIH
10	Roh-Johnson, Minna	Department

Goals for FY2021

- Increase awareness of our services
- Expand capabilities of metal analysis portion of core

Publications

1. Dutta, R., Zhang, T. Y., Kohnke, T., Thomas, D., Linde, M., Gars, E., Majeti, R. (2020). Enasidenib drives human erythroid differentiation independently of isocitrate dehydrogenase 2. *J Clin Invest*, 130(4), 1843-1849. doi:10.1172/JCI133344
2. Frandsen, P. B., Bursell, M. G., Taylor, A. M., Wilson, S. B., Steeneck, A., & Stewart, R. J. (2019). Exploring the underwater silken architectures of caddisworms: comparative silkomics across two caddisfly suborders. *Philos Trans R Soc Lond B Biol Sci*, 374(1784), 20190206. doi:10.1098/rstb.2019.0206
3. Hughes, C. E., Coody, T. K., Jeong, M. Y., Berg, J. A., Winge, D. R., & Hughes, A. L. (2020). Cysteine Toxicity Drives Age-Related Mitochondrial Decline by Altering Iron Homeostasis. *Cell*, 180(2), 296-310 e218. doi:10.1016/j.cell.2019.12.035
4. Kusminski, C. M., Ghaben, A. L., Morley, T. S., Samms, R. J., Adams, A. C., An, Y., Scherer, P. E. (2020). A Novel Model of Diabetic Complications: Adipocyte Mitochondrial Dysfunction Triggers Massive beta-Cell Hyperplasia. *Diabetes*, 69(3), 313-330. doi:10.2337/db19-0327
5. Parker, A. C., Bergonia, H. A., Seals, N. L., Bacchanale, C. L., & Rocha, E. R. (2020). The uroS and yifB Genes Conserved among Tetrapyrrole Synthesizing-Deficient Bacteroidales Are Involved in Bacteroides fragilis Heme Assimilation and Survival in Experimental Intra-abdominal Infection and Intestinal Colonization. *Infect Immun*, 88(8). doi:10.1128/IAI.00103-20
6. Parker, C. J., Desnick, R. J., Bissel, M. D., Bloomer, J. R., Singal, A., Gouya, L., Phillips, J. D. (2019). Results of a pilot study of isoniazid in patients with erythropoietic protoporphyria. *Mol Genet Metab*, 128(3), 309-313. doi:10.1016/j.ymgme.2019.07.017
7. Pek, R. H., Yuan, X., Rietzschel, N., Zhang, J., Jackson, L., Nishibori, E., Hamza, I. (2019). Hemozoin produced by mammals confers heme tolerance. *Elife*, 8. doi:10.7554/eLife.49503

8. Rajan, M., Anderson, C. P., Rindler, P. M., Romney, S. J., Ferreira Dos Santos, M. C., Gertz, J., & Leibold, E. A. (2019). NHR-14 loss of function couples intestinal iron uptake with innate immunity in *C. elegans* through PQM-1 signaling. *Elife*, 8. doi:10.7554/eLife.44674
9. Santos, M., Anderson, C. P., Neschen, S., Zumbrennen-Bullough, K. B., Romney, S. J., Kahle-Stephan, M., Leibold, E. A. (2020). Irp2 regulates insulin production through iron-mediated Cdkal1-catalyzed tRNA modification. *Nat Commun*, 11(1), 296. doi:10.1038/s41467-019-14004-5
10. Schmidt, P. J., Hollowell, M. L., Fitzgerald, K., Butler, J. S., & Fleming, M. D. (2020). Mild iron deficiency does not ameliorate the phenotype of a murine erythropoietic protoporphyria model. *Am J Hematol*, 95(5), 492-496. doi:10.1002/ajh.25743

Materials Characterization Lab

Overview

The Materials Characterization Lab (MCL) is a user research facility managed by the Materials Science and Engineering (MSE) Department at the University of Utah. The lab offers clients access to a wide range of analytical instrumentation and services for a variety of biochemical, organic, inorganic, and environmental samples.

The MCL provides researchers with training on the care and operation of equipment used in materials characterization. In addition to providing training for new users, our staff is available to help users in the design of experiments and the interpretation of results.

The MCL maintains a ~1300 sq. ft. lab facility, including optical and metallographic microscopes, two scanning electron microscopes (SEM), an energy dispersive X-ray spectrometer (EDS), a Fourier transform infrared (FTIR) spectrometer, an ultraviolet-visible-near-infrared (UV-Vis-NIR) spectrophotometer, two X-ray diffractometers (XRD), a differential scanning calorimeter (DSC), a combination thermogravimetric analyzer and differential scanning calorimeter (DSC-TGA), a dilatometer, an Instron mechanical testing system, a BET surface area and pore size analyzer, a particle size analyzer (PSA) carbon and gold sputter coaters, a compression mounting press, and a grinding and polishing system.

Uniqueness

The MCL has an extensive history of successful collaborations with academia, government, and industry clients ranging from startups to multinational corporations in the aerospace, automotive, coatings, geochemical, medical, semiconductor, and other markets.

MSE faculty and staff serve as resources in the following areas of specialization: biofuel cells, ceramics, composites, computational electronic materials and polymers, electronic materials and assemblies, explosive sensing, nanomaterials, nanotechnology, and more.

The MCL has expertise in:

- Biomedical materials and devices
- Ceramics
- Composites
- Electronic materials
- Metals and metal oxides
- Polymers

The MCL provides the following:

- Cross-sectional analysis
- Materials analysis, comparison, and identification
- Microphotography suitable for advertising and training purposes
- Routine analysis for quality assurance and control

Services & Equipment

The MCL serves as a facility for Materials Science and Engineering undergraduate and graduate level courses that involve materials characterization.

The MCL staff also provide consultations and experiment design suggestions based on the needs of the user. The services offered by the MCL include materials characterization with the following techniques:

Optical Microscopy

- Olympus BH2 Series System Microscope
- Olympus Tokyo PME Inverted Stage / Metallographic Microscope
- Olympus VANOX Universal Research Microscope

Scanning Electron Microscopy

- Hitachi S-3000N Scanning Electron Microscope (SEM) with variable pressure modes and Secondary Electron (SE) and Backscatter Electron (BSE)
- Hitachi TM3030Plus Tabletop Microscope (SEM) with SE, BSE detectors, and Thermo Scientific Pathfinder SDD energy dispersive x-ray spectrometer (EDS).

Spectroscopy

- Varian 3100 Excalibur Series Fourier Transform Infrared Spectrometer (FTIR) with Attenuated Total Reflectance (ATR) and Transmission Accessories
- Perkin-Elmer LAMBDA 950 UV-Vis-NIR Spectrophotometer with 150 mm Integrating Sphere, 2D Detector Module, and Universal Reflectance (URA) Accessories

X-Ray Diffraction

- Philips PANalytical X'Pert X-Ray Diffractometer (XRD) with powder diffraction and thin film detectors.
- Bruker D2 Phaser X-Ray Diffractometer (XRD) with Phi axis rotation abilities.

Macroscopic & Physical Testing

- NETZSCH DSC 3500 Sirius Differential Scanning Calorimeter (DSC)
- TA Instruments SDT 650 thermogravimetric analyzer and differential scanning calorimeter (DSC-TGA) with autosampler
- Anter Corporation Work Horse IB Dilatometer
- Instron 5969 Dual Column Tabletop Testing System
- Micromeritics 3Flex BET Surface Area and Pore Size Analyzer
- Beckman Coulter LS230 particle size analyzer (PSA) with polarized light detectors
- Micromeritics FlowPrep 060 Sample Degas System
- Mettler AE100 Analytical Balance

Sample Preparation

- Cressington 108carbon/A Carbon Coater for Conductive Carbon Coatings
- Cressington 108auto Sputter Coater for Conductive Gold and other precious metal Coatings

Cross-Sectioning / Microsectioning

- Buehler SimpliMet II Mounting Press
- LECO Spectrum System 1000 with Oscillating Polishing Head and Six Sample Holder

Personnel

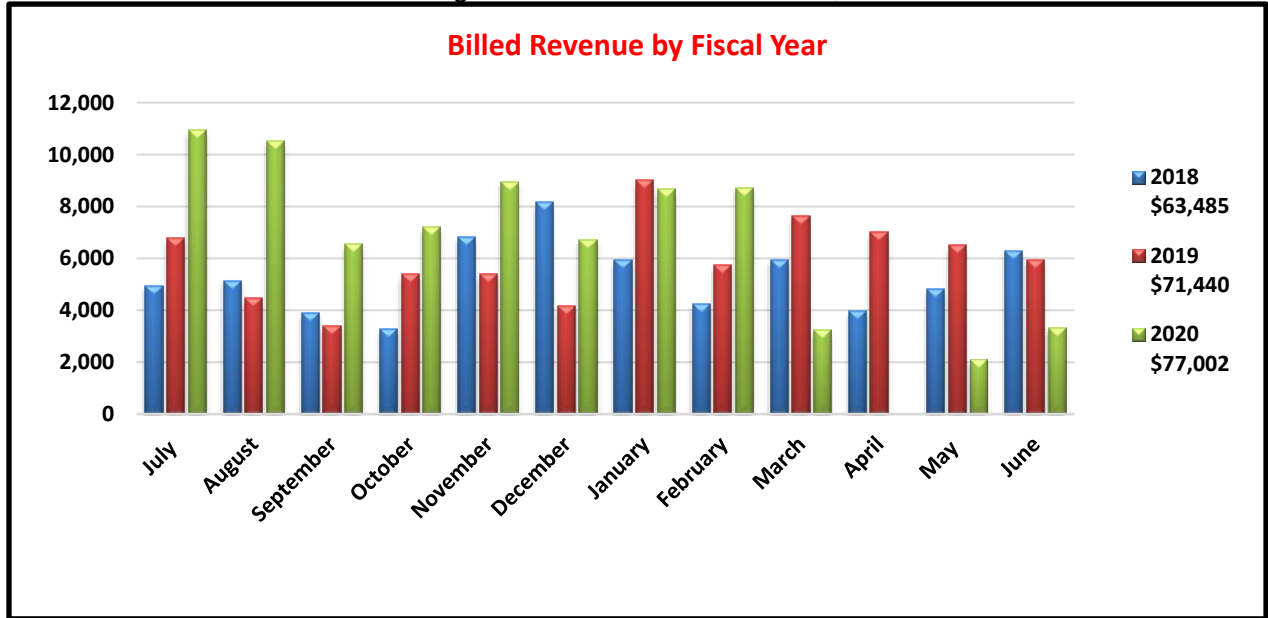
- Angela Nelson, Administrative Officer
- Kimberly Watts, Lab Manager

Revenue/Expenses

FY20 Expenses: Total \$88,520

FY20 Revenue: Total \$77,002

- VP of Research Support: \$ 0
- FY20 Revenue generated from services: \$77,002



* Legend displays total annual revenue by year earned.

Advisory Board Committee

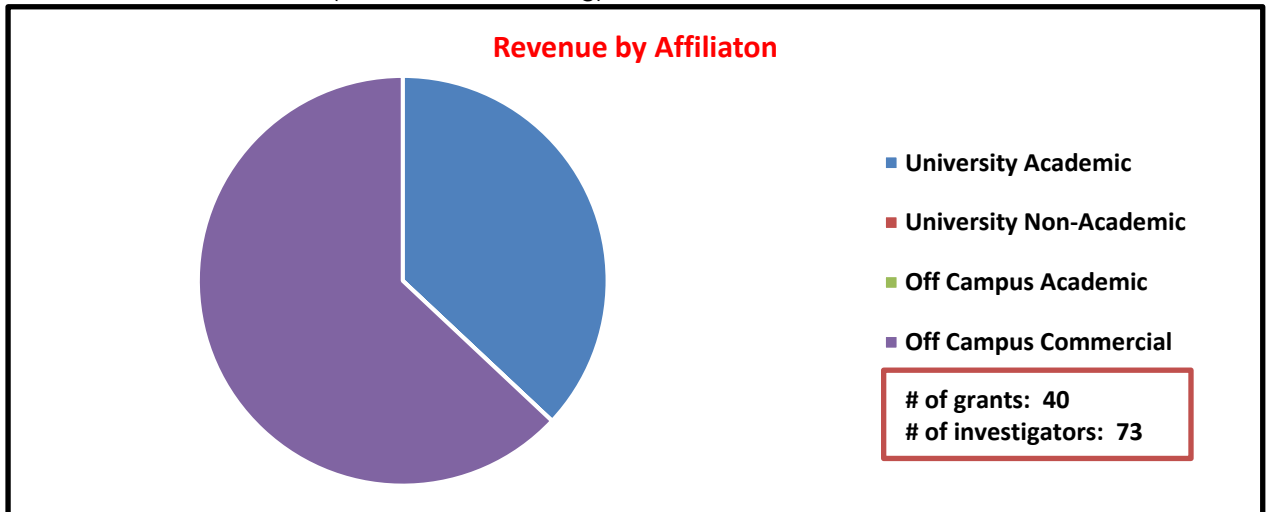
Last meeting date: July 30, 2018

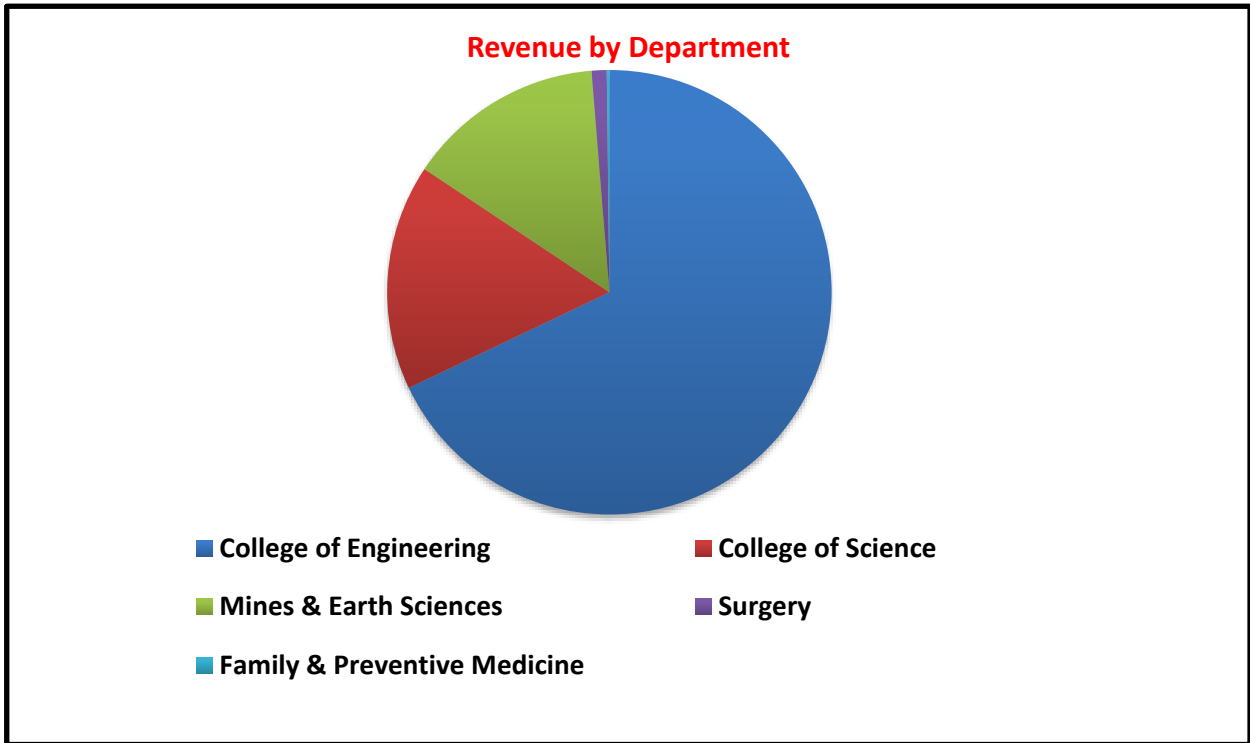
- Taylor Sparks, Ph.D., Associate Professor
- Mike Scarpulla, Ph.D., Associate Professor
- Dmitry Bedrov, Ph.D., Associate Professor

FY20 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	American Oxygen, LLC	Commercial
2	OxEon Energy	Commercial
3	Sparks, Taylor	NSF, DOE, Department
4	HiFunda, LLC	Commercial
5	Novus Research Group	Commercial
6	LeBohec, Stephan	University of Utah Research FTD
7	Butt, Darryl	Department
8	Utah Material Research	Commercial
9	Testing Engineers International	Commercial
10	SINTX Technologies	Commercial

Goals for FY20

- Create standard training videos and materials for interns and users
- Complete integration of new online analysis submission tracking to decrease delays in project management

Publications

1. Dai, J., & Whitty, K. (2018). Effects of Coal Ash on CuO as an Oxygen Carrier for Chemical Looping with Oxygen Uncoupling. *Energy & Fuels*, 32(11), 11656-11665. doi:10.1021/acs.energyfuels.8b02521
2. Dai, J., & Whitty, K. J. (2020). Impact of fuel-derived chlorine on CuO-based oxygen carriers for chemical looping with oxygen uncoupling. *Fuel*, 263, 116780. doi:https://doi.org/10.1016/j.fuel.2019.116780
3. Nizinski, C. A., Hanson, A. B., Fullmer, B. C., Mecham, N. J., Tasdizen, T., & McDonald, L. W. (2020). Effects of process history on the surface morphology of uranium ore concentrates extracted from ore. *Minerals Engineering*, 156, 106457. doi:https://doi.org/10.1016/j.mineng.2020.106457

National Center for Veterans Studies

Overview

The mission of the National Center for Veterans Studies (NCVS) at The University of Utah is to engage in research, education, outreach, and advocacy for improving the lives of military personnel, veterans, and their families. The NCVS conducts research primarily focused on suicide prevention and PTSD among service members and veterans, and provides evidence-based treatments to this community at no cost. NCVS staff also conduct training workshops and educational presentations for healthcare providers and the public.

Services

NCVS offers a range of services including **consulting, training, and psychological treatments.**

Main services that have been developed and used during FY2020 include:

- **Suicide prevention training workshops.** The NCVS provides a range of training workshops to licensed mental healthcare providers, certified peer specialists, and other members of the community. These workshops focus on translating the results of NCVS research into a range of settings in order to better prepare healthcare providers and communities to assist in prevention and intervention for high-risk individuals.
- **Psychological treatments for service members, veterans, and first responders.** The NCVS offers evidence-based treatments for the military, veteran, and first responder communities at no-cost. The NCVS has pioneered innovative treatment delivery methods shown to yield more rapid recovery from posttraumatic stress disorder (PTSD) and suicidal thinking. The primary treatments offered by the NCVS include cognitive processing therapy for PTSD and brief cognitive behavioral therapy for suicide prevention. Service members, veterans, and first responders interested in receiving these therapies can contact the NCVS to schedule an initial consultation at ncvs@utah.edu or 801-587-7978.

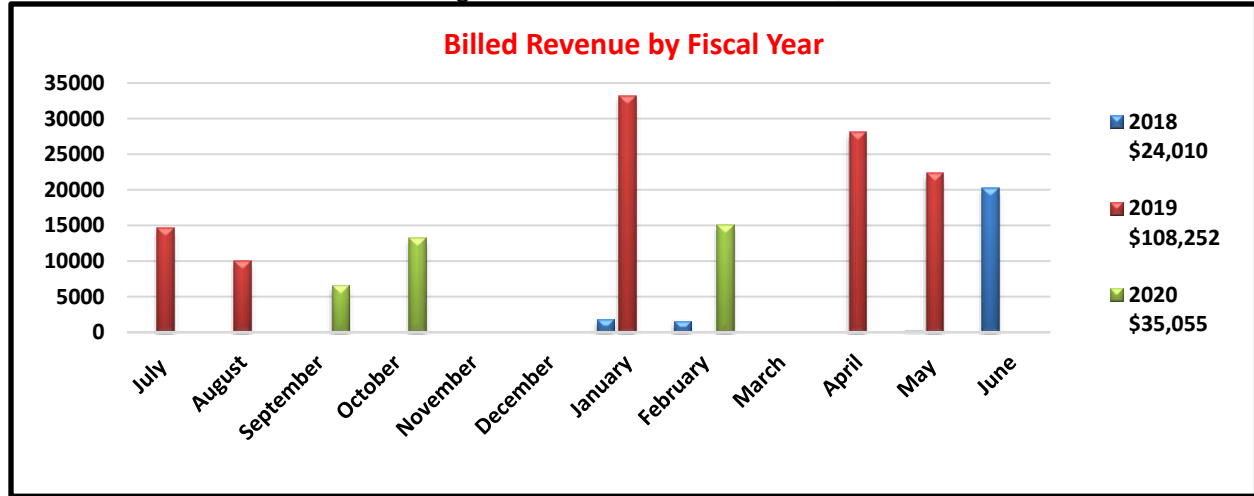
Personnel

- Craig Bryan, PsyD, ABPP, Executive Director
- AnnaBelle Bryan, MS, Director of Operations
- Feea Leifker, PhD, Director of Clinical Services
- David Rozek, PhD, Director of Training

**2020 Annual Update
Revenue/Expenses**

FY20 Expenses: Total \$111,043
FY20 Revenue: Total \$35,055

- VP of Research Support: \$ 0
- FY20 Revenue generated from services: \$35,055



*Legend displays total annual revenue by year earned. ** Managed by HSC Core Administration 2018.

Grant Support – The NCVS was supported by the following grants this year:

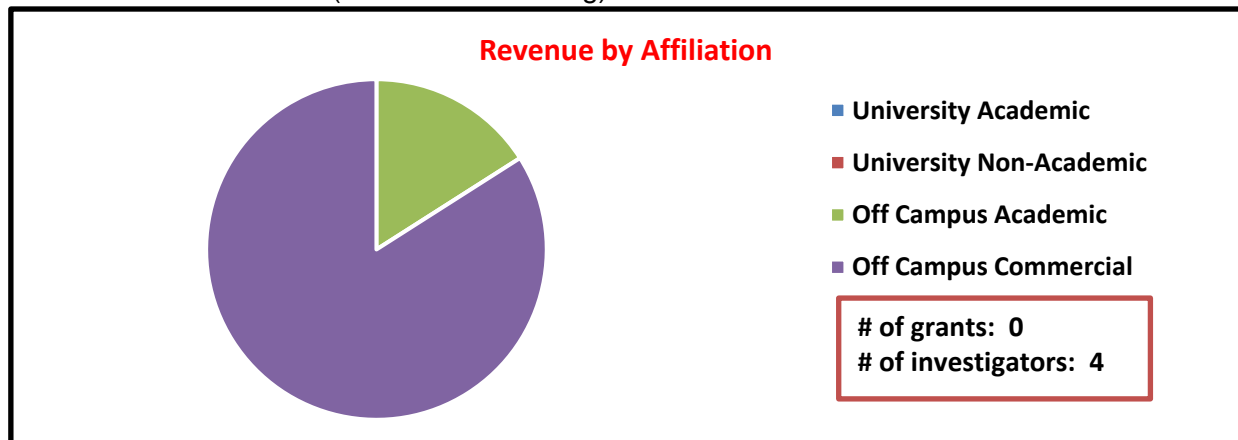
- Department of Defense – Peer to Peer Programs for Military Suicide Prevention
- The Boeing Company – Suicide & Trauma Reduction Initiative for VETerans (STRIVE)
- Department of Defense – Brief Cognitive Behavioral Therapy Replication Trial
- Department of Defense – Project Safe Guard (Prime: University of Southern Mississippi)

Advisory Board Committee

- N/A

**FY20 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Top Users

1	21 st Medical Group	Commercial
2	Navy Seal Foundation	Commercial
3	NRO	Commercial
4	University of Wisconsin	Off Campus Academic

Publications

- Albanese, B. J., Macatee, R. J., Stentz, L. A., Schmidt, N. B., & Bryan, C. J. (2019). Interactive effects of cumulative lifetime traumatic brain injuries and combat exposure on posttraumatic stress among deployed military personnel. *Cogn Behav Ther*, *48*(1), 77-88. doi:10.1080/16506073.2018.1478446
- Applegarth, D. M., Wood, D. S., Bryan, A. O., & Bryan, C. J. (2019). Examining Help-Seeking Among National Guard Service Members. *Military Behavioral Health*, *7*(2), 198-205. doi:10.1080/21635781.2018.1526143
- Ben Barnes, J., Presseau, C., Jordan, A. H., Kline, N. K., Young-McCaughan, S., Keane, T. M., the Consortium to Alleviate, P. (2019). Common Data Elements in the Assessment of Military-Related PTSD Research Applied in the Consortium to Alleviate PTSD. *Mil Med*, *184*(5-6), e218-e226. doi:10.1093/milmed/usy226
- Brown, L. A., McLean, C. P., Zang, Y., Zandberg, L., Mintz, J., Yarvis, J. S., consortium, S. S. (2019). Does prolonged exposure increase suicide risk? Results from an active duty military sample. *Behav Res Ther*, *118*, 87-93. doi:10.1016/j.brat.2019.04.003
- Bryan, C., & Harris, J. (2018). The Structure of Suicidal Beliefs: A Bifactor Analysis of the Suicide Cognitions Scale. *Cognitive Therapy and Research*, *43*, 335-344.
- Bryan, C. J. (2019). A Preliminary Validation Study of Two Ultra-Brief Measures of Suicide Risk: The Suicide and Perceived Burdensomeness Visual Analog Scales. *Suicide Life Threat Behav*, *49*(2), 343-352. doi:10.1111/sltb.12447
- Bryan, C. J., Rozek, D. C., Burch, T. S., Leeson, B., & Clemans, T. A. (2019). Therapeutic Alliance and Intervention Approach Among Acutely Suicidal Patients. *Psychiatry*, *82*(1), 80-82. doi:10.1080/00332747.2018.1485371
- Bryan, C. J., Wood, D., Applegarth, M., & Bryan, A. O. (2020). Subtypes of Mental Health Stigma and Barriers to Care Among National Guard Personnel: Results of a Latent Class Analysis. *Armed Forces & Society*, *46*(3), 424-437. doi:10.1177/0095327x19842220
- Fang, Q., McNaughton-Cassill, M., Bryan, C., Pirani, S., & Osman, A. (2019). Further evidence for score reliability and validity of the Anxiety Depression Distress Inventory-27 scale. *Military Psychology*, *31*(2), 160-168. doi:10.1080/08995605.2019.1578151
- Griffin, B. J., Purcell, N., Burkman, K., Litz, B. T., Bryan, C. J., Schmitz, M., Maguen, S. (2019). Moral Injury: An Integrative Review. *J Trauma Stress*, *32*(3), 350-362. doi:10.1002/jts.22362
- Kanzler, K. E., Pugh, J. A., McGeary, D. D., Hale, W. J., Mathias, C. W., Kilpela, L. S., McCracken, L. M. (2019). Mitigating the Effect of Pain Severity on Activity and Disability in Patients with Chronic Pain: The Crucial Context of Acceptance. *Pain Med*, *20*(8), 1509-1518. doi:10.1093/pm/pny197
- Kopacz, M. S., Adams, M. S., Searle, R., Koenig, H. G., & Bryan, C. J. (2019). A Preliminary Study Examining the Prevalence and Perceived Intensity of Morally Injurious Events in a Veterans Affairs Chaplaincy Spiritual Injury Support Group. *J Health Care Chaplain*, *25*(2), 76-88. doi:10.1080/08854726.2018.1538655
- Kopacz, M. S., Bryan, C. J., Bishop, T. M., & Ashrafioun, L. (2018). Alcohol and Suicide Risk: Examining the Role of Meaning-Making. *J Dual Diagn*, *14*(4), 220-227. doi:10.1080/15504263.2018.1513618
- Kopacz, M. S., Lockman, J., Lusk, J., Bryan, C. J., Park, C. L., Sheu, S. C., & Gibson, W. C. (2019). How meaningful is meaning-making? *New Ideas in Psychology*, *54*, 76-81. doi:https://doi.org/10.1016/j.newideapsych.2019.02.001
- Roberge, E. M., Bryan, C. J., Peterson, A., & Rudd, M. D. (2019). Variables associated with reductions in insomnia severity among acutely suicidal patients receiving brief cognitive behavioral therapy for suicide prevention. *J Affect Disord*, *252*, 230-236. doi:10.1016/j.jad.2019.04.045
- Rozek, D. C., Keane, C., Sippel, L. M., Stein, J. Y., Rollo-Carlson, C., & Bryan, C. J. (2019). Short-term effects of crisis response planning on optimism in a U.S. Army sample. *Early Intervention in Psychiatry*, *13*(3), 682-685. doi:10.1111/eip.12699

Nuclear Engineering

Overview

UNEP provides state-of-the-art laboratories and devices for alpha, beta, gamma and neutron radiation detection, irradiation of material samples to study various effects of all types of radiation, and neutron activation analysis techniques (nondestructive technique to find a sample elemental composition). UNEP maintains a 7,500 sq ft nuclear engineering and radiochemistry facility, including a fully operable 100 kW TRIGA Mark-1 nuclear reactor, 3 High Purity Germanium (HPGe) gamma detectors, liquid scintillation counting, and alpha spectrometry.

Uniqueness

The Utah Nuclear Engineering Facility is the only nuclear research reactor in the State of Utah, and one of the few in the Intermountain West area. We offer a number of unique, non-destructive testing techniques for analyzing isotopic and chemical composition of a wide variety of samples. UNEP has been at the forefront of establishing a safety culture and practices, already implemented at large scale commercial power plants, in a research reactor environment. UNEP also allows students from the University of Utah, as well as other local universities, to train for and obtain a Reactor Operator (RO) license from the Nuclear Regulatory Commission (NRC).

Services

The types of services offered by UNEP include material characterization by elemental and isotopic composition analysis, sample irradiation services, and radiation hardness testing of samples placed in high radiation environments. Example services are as follows:

- Neutron Activation Analysis (NAA)
- Sample Irradiation
- Electronics Hardness Testing
- Radioisotope Generation
- Passive Gamma Spectroscopy
- Alpha Spectroscopy
- Liquid Scintillation Counting
- Fission Track Analysis

Because of the uniqueness and lack of familiarity that often encompasses a research reactor an important aspect of our work is consulting with researchers and PIs at the early stages of their research in order to establish an efficient and cost effective plan with utilizing our TRIGA reactor and a wide variety of radiation detectors.

Equipment

Radiation Detectors:

- Canberra Alpha Analyst
- Canberra HPGe detectors
 - BEGe 3830
 - REGe 4020
 - GC 4020
- Beckman Liquid Scintillation Counter
- NaI and LaBr detectors
- TRIGA Research Reactor

Personnel

- Matthew Lund, Reactor Supervisor
- Amanda Foley, Senior Reactor Operator
- Steven Pappas, Senior Reactor Operator
- Donovan Feist, Lab Analyst

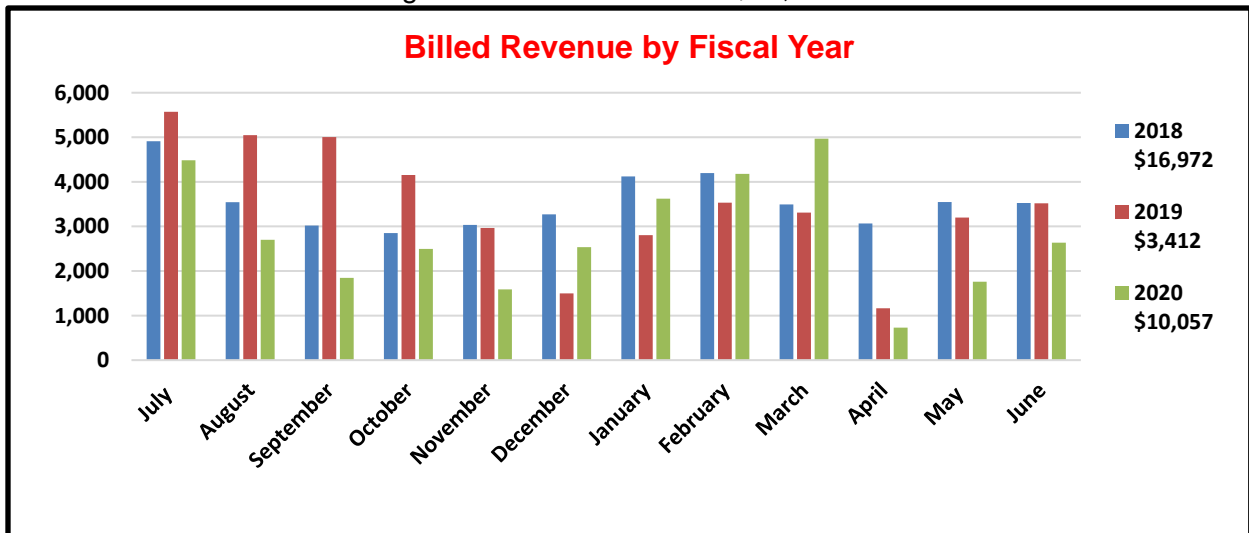
2020 Annual Update

Revenue/Expenses

FY 2020 Expenses: \$13,035

FY 2020 Revenue: \$10,057

- VP of Health Sciences Support: \$0
- FY20 Revenue generated from services: \$10,057



* Legend displays total annual revenue by year earned.

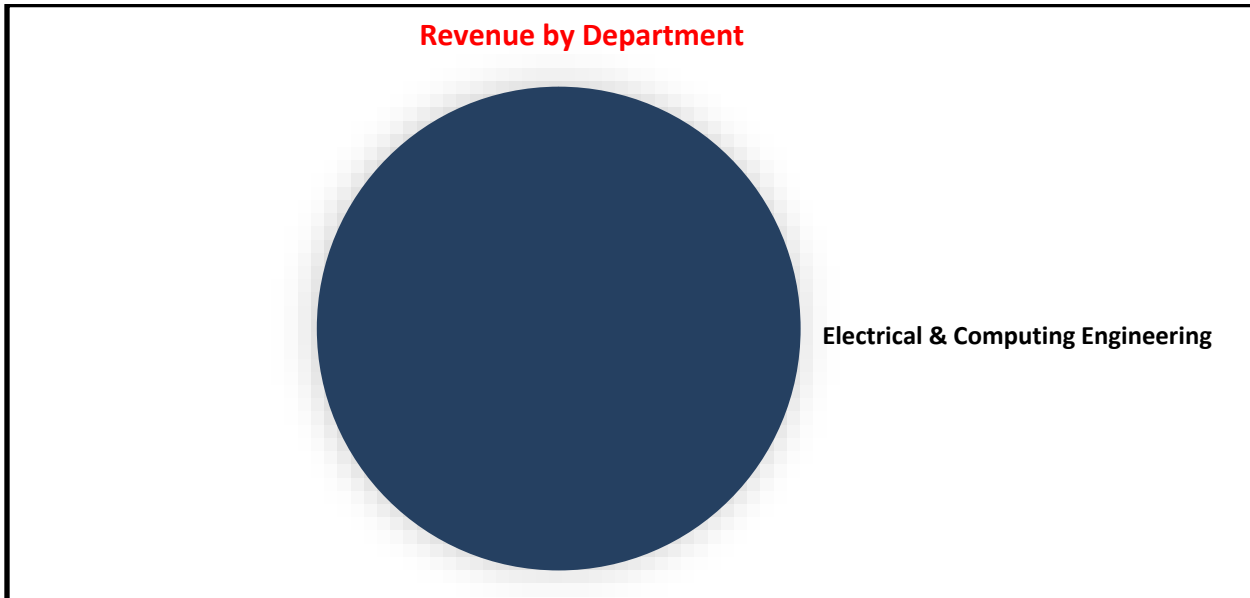
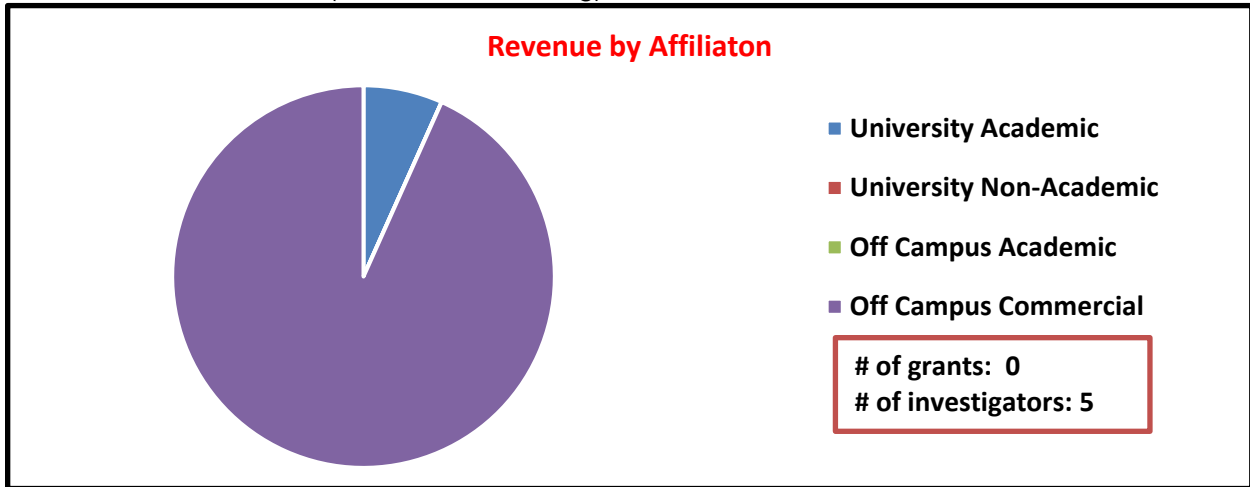
Advisory Board Committee

Last meeting date: March 27, 2017

- Ryan Schow, Reactor Safety Committee Chair
- Terry Ring, Professor, Chemical Engineering
- Greg Moffitt, Former Reactor Supervisor

**FY20 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Top Users

1	Shine Medical Technology	Commercial
2	InnoSys, Inc.	Off Campus Academic
3	Alpha Tech Research Corp	Commercial
4	Mohanty, Swomitra	Department
5	Life-E	Commercial

Goals for FY20

- Characterize FNIF
- Alpha spectrometry
- More consistent user base
- Installation of new control console, cooling system, power uprate.

Scalable Analytics & Informatics

Overview

The University of Utah Center for Scalable Analytics and Informatics (USAI) provides support to research and operations groups inside and outside the University of Utah. These services include Annotation and Chart Review, Natural Language Processing, EMR-driven Clinical Trial Recruitment, Analytics and Data Services, and Enterprise Architecture and Application Development.

Uniqueness

Utah Scalable Analytics and Informatics (USAI) provides multiple services for researchers utilizing electronic medical records. EMR-driven Clinical Trial Recruitment provides the ability to identify patients during an encounter with a healthcare provider that potentially could participate in a clinical trial and could drastically reduce cost and increase recruitment. Annotation and chart review products help machines and subject matter experts mark-up and abstract data for classification. Natural Language Processing (NLP) processes text data to extract structured data to infer concepts that can be understood by machines and humans for further analysis. USAI's annotation and chart review product line focuses on easing the burden and increasing consistency of manual chart review and annotation tasks. While annotation and chart review are time consuming and expensive, they are vital to many part of the research process: data exploration, feasibility, defining study variables, identifying information in text notes, classifying information within a document, at the document level, at the encounter or patient level, and validating study results. Natural language processing algorithms can help automate the identification of relevant clinical data from the medical record. Data science and machine learning are new areas that expand the capability from traditional statistical modeling. USAI provides Enterprise Architecture and Application Development and has developed tools to improves efficiency and outcomes in health services research, reduces the costs to researchers. Education is also important to USAI and therefore USAI has recruited and trained computer science students.

Services

The following services are offered by USAI:

- Annotation and Chart Review
- Natural Language Processing
- EMR-driven Clinical Trial Recruitment
- Analytics and Data Services
- Data Science and Machine Learning
- Enterprise Architecture and Application Development

Consultation is provided in order to define a projects scope and budget in the early stages of development to make optimal and efficient use of USAI's services. The staff will also handle regulatory requirements and project management if needed.

Specialized Software

Chart Review

- eHOST
- ChartReview
- Abstract

Natural Language Processing

- Leo
- Chex

Clinical Trial Management

- ProjectFlow

Data Exploration and Visualization

- OHDSI Atlas

Personnel

- Scott L DuVall, PhD, Director
- Chris Ledding, Financial Analyst
- Jeffrey Ferraro, Data Science Lead
- Chris Wilson, Data Scientist
- Udara Abeysekara, Data Scientist
- Qingzhu Liu, Software Designer and Programmer
- Shaoyu Su, Software Designer and Programmer
- Hamid Saoudian, Enterprise Architect
- Ramana Seerapu, IT Project Manager
- Olga Patterson, Applied NLP Lead
- Patrick Alba, NLP Analyst
- Hannah Eyre, NLP Analyst
- Holly Andreason, Clinical Annotator
- Camille Bateman, Clinical Annotator
- Lacy Castleton, Clinical Annotator
- Kristi Gregory, Clinical Annotator
- David Kotter, Clinical Annotator
- Sally MacDonald, Clinical Annotator
- Tiffany Quilter, Clinical Annotator
- Cara Shimizu, Clinical Annotator
- Denise Stone, Clinical Annotator

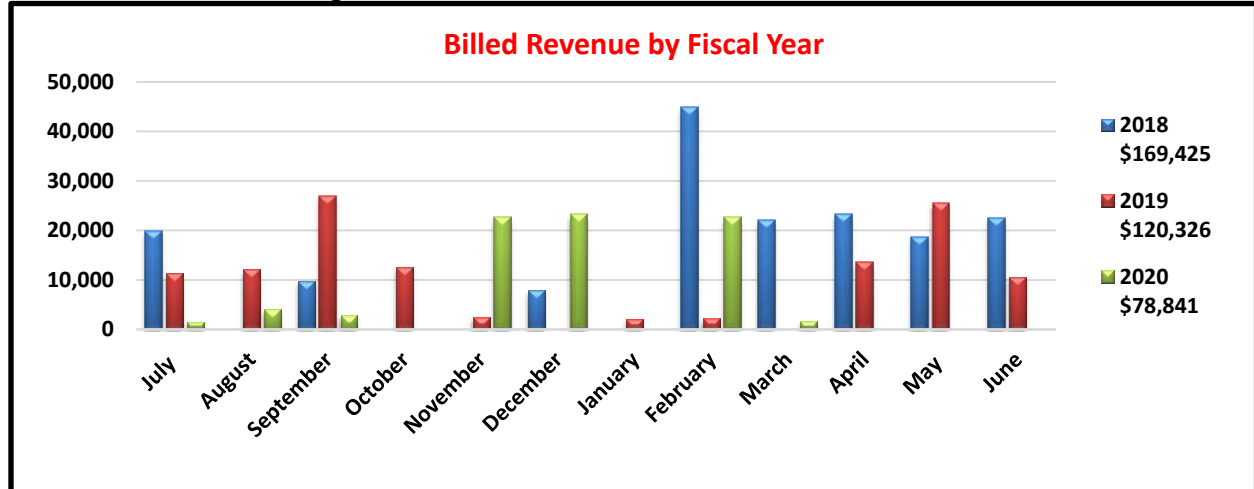
FY20 Annual Update

Revenue/Expenses

FY20 Expenses: \$137,799

FY20 Revenue: \$78,841

- VP of Research Support: \$0
- Revenue generated from services: \$78,841



* Legend displays total annual revenue by fiscal year earned.

Management Meeting

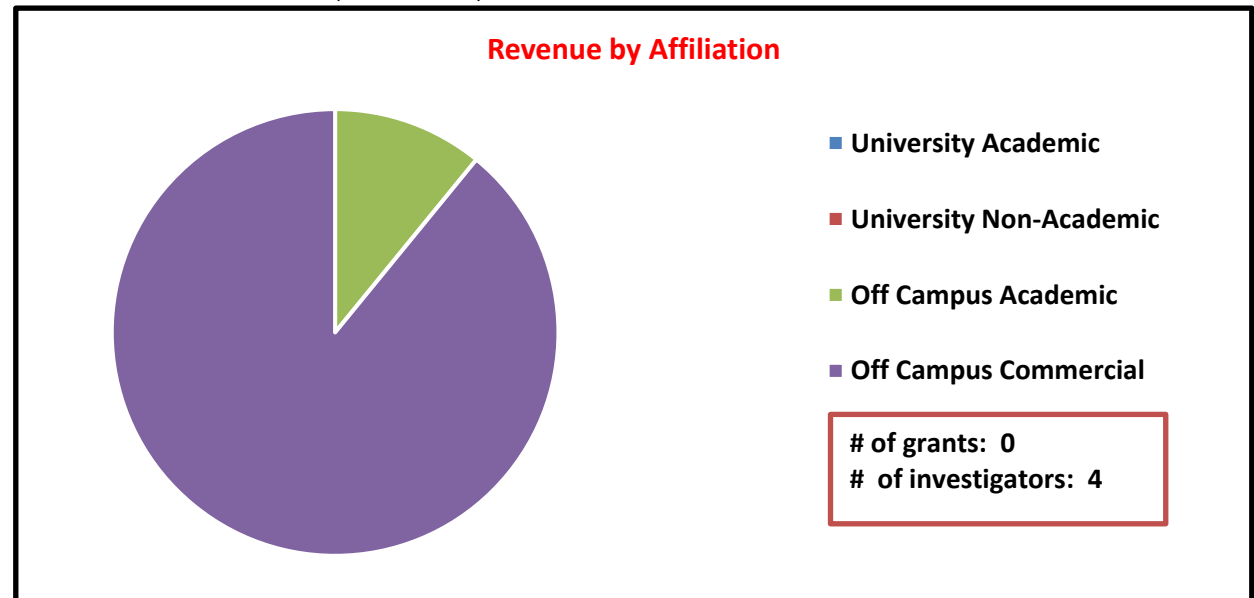
Last meeting date: June 25, 2020

- Scott L DuVall, PhD, Director
- Christopher Ledding, MBA, Financial Analyst

FY20 Scientific Impact

Research Support

Revenue Generated (see charts):



Top Users

1	Bedford VA Research Corporation, Inc.	Commercial
2	Sepulveda Research Corporation	Commercial
3	Western Inst. Biomedical Research	Off Campus Academic
4	Vanderbilt University Medical Center	Off Campus Academic
5	Parexel	Commercial

Goals for FY21

USAI will continue to offer and expand its services to University and Industry members in health sciences research by providing EMR-driven clinical trial recruitment, annotation and chart review, natural language processing, enterprise architecture and application development and data analysis. We will expand the data science and machine learning service in FY21. We have increased the team size and should be able to meet demand across FY21.

Publications

- Alba, P. R., Patterson, O. V., Richman, J. S., & DuVall, S. L. (2019). Automatic Methods to Extract Prescription Status Quality Measures from Unstructured Health Records. *Stud Health Technol Inform*, 264, 15-19. doi:10.3233/SHTI190174
- Bick, A. G., Akwo, E., Robinson-Cohen, C., Lee, K., Lynch, J., Assimes, T. L., Program, V. A. M. V. (2019). Association of APOL1 Risk Alleles With Cardiovascular Disease in Blacks in the Million Veteran Program. *Circulation*, 140(12), 1031-1040. doi:10.1161/CIRCULATIONAHA.118.036589
- Dong, X., Li, J., Soysal, E., Bian, J., DuVall, S. L., Hanchrow, E., Xu, H. (2020). COVID-19 TestNorm - A tool to normalize COVID-19 testing names to LOINC codes. *J Am Med Inform Assoc*. doi:10.1093/jamia/ocaa145
- DuVall, S. L., Matheny, M. E., Ibragimov, I. R., Oats, T. D., Tucker, J. N., South, B. R., Nebeker, J. R. (2019). A Tale of Two Databases: The DoD and VA Infrastructure for Clinical Intelligence (DaVINCI). *Stud Health Technol Inform*, 264, 1660-1661. doi:10.3233/SHTI190584
- Fang, H., Hui, Q., Lynch, J., Honerlaw, J., Assimes, T. L., Huang, J., Tang, H. (2019). Harmonizing Genetic Ancestry and Self-identified Race/Ethnicity in Genome-wide Association Studies. *Am J Hum Genet*, 105(4), 763-772. doi:10.1016/j.ajhg.2019.08.012
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