

Annual Report 2021

HSC Cores Research Facilities



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HSC CORES

Facilities

Overall Financial Summary

Revenue & Expenses

- HSC Core Facilities budgeted \$9.30 million for FY21, with expenses totaling to \$8.25 million. Approximately \$4.5 million in expenses went to salaries and benefits while \$3.30 million was spent on equipment and operating supplies.
- In FY21, \$6.65 million in services were billed, and collected from all units combined. An overhead fee of 5% (\$332,403) was used for administrative support.

Core Research Facilities

Core	Total Expenses	Equipment Expenses	Total Revenue	SVPHS	VPR	RIF/Match
Administration	\$1,521,069	\$110,080	\$1,703,140	\$480,228	\$870,393	
BIDAC	\$96,950		\$68,741			
Cell Imaging	\$641,367	\$250,000	\$475,172	\$225,000		
DNA Peptide	\$258,178		\$247,349			
DNA Sequencing	\$337,556		\$357,417			
Drug Discovery	\$166,304		\$178,606	\$75,000		
Electron Microscopy	\$841,667		\$944,424	\$20,000	\$30,000	
Flow Cytometry	\$618,708	\$74,979	\$591,702			
Genomics	\$134,929		\$146,121			
Machine Shop	\$195,796		\$242,490	\$50,000		
Mass Spectrometry & Proteomics	\$271,692		\$406,064	\$145,000		
Metabolic Phenotyping	\$144,876		\$158,218	\$70,000		
Metabolomics	\$514,798		\$557,638	\$240,000		
Mutation Generation & Detection	\$124,731		\$142,491	\$50,000		
Nuclear Magnetic Resonance	\$108,444		\$108,678	\$70,000		
PreClinical Imaging	\$207,159		\$176,868	\$50,000	\$60,000	
Small Animal Ultrasound	\$20,262		\$40,774	\$10,000		
Transgenic Mouse	\$544,892		\$693,087	\$434,603		
UTAH Center Genetic Discovery	\$704,023		\$807,022	\$654,395		
Zebrafish	\$416,454		\$602,106	\$150,000	\$50,000	

Service Recharge Centers

Service Recharge Center	Total Expenses	Equipment Expenses	Total Revenue	SVPHS	VPR	RIF
Genetics Science Learning Center	\$1,569,425		\$1,897,848			
Iron & Hematology	\$22,072		\$53,555			
Material Sciences-Engineering	\$126,438		\$85,473			
Behavioral Health Innovation	\$2,593		0			
Nuclear Engineering	\$3,419		\$3,978			
Scalable Analytics & Informatics	\$21,059		\$71,053			

Cores Administration

Overview

The Health Sciences Center (HSC) Core Facilities administratively reports to the Director Dr. John Phillips, and Associate Director Dr. James Cox, who report to Dr. Will Dere. The administrative office is managed by Ms. Brenda Smith, with assistance from Ms. Iryna Wiley, Ms. Terra Curley, and Mr. Derek Schlotfeldt. 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 billing and collection services.

Personnel

- John D. Phillips, Ph.D., Director HSC Core Facilities
- James E. Cox, Ph.D., Associate Director HSC Core Facilities
- Brenda Smith, Director of Finance
- Iryna Wiley, Administrative Officer
- Terra Curley, Accountant
- Derek Schlotfeldt, Manager Administrative
- Elliott Francis, Sr. Software Developer

2021 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 FY21, the Cores Administration office was successfully able to process billing in 1/2 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 FY21 the core billed \$6.48 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 (Anticonvulsant Drug Lab and Fly Food) are now managed through the administrative office to increase accountability and reduce expenses associated with billing and collections.
- The annual retreat was not held in September 2020 due to COVID.
- 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 FY21 allow more reporting and tracking of equipment and better access from hand held devices. As of July 2021, there are 85 Departments, and 6,627 items entered into the system. These items are located in 1,274 rooms across campus. The total asset value of these items is \$106.7 million. This system continues to expand and is free to use by any group on campus.

FY2021 Goals

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

Cores Administration Revenue & Expenses

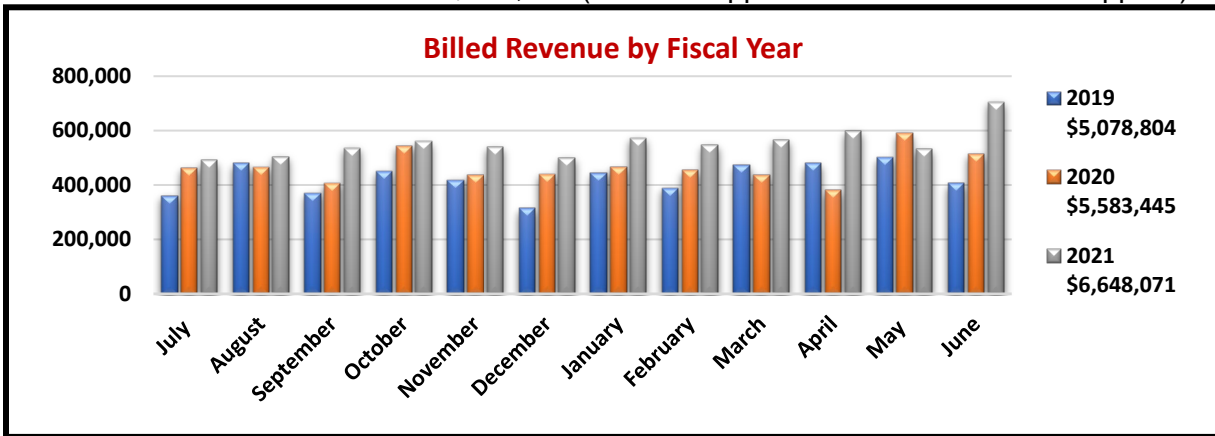
FY21 Expenses: Total \$1,521,069

The Cores Administration Budget covers the following expenses:

- Salaries/Benefits: \$636,060
- Fixed Expenses (IT Support for 76 staff, developer, x-ray, software, COVID Expenses): \$725,017.
- Unanticipated equipment repairs and replacement: \$159,992

FY21 Revenues: Total \$1,703,140

- VP of Health Sciences Support: \$480,228
- FY21 Revenue Generated from Services: \$352,519
- FY21 VP for Research: \$870,393 (COVID Support for Sal/Benefits and Supplies)



* 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: January 28th, 2021 by Zoom

- Andy Weyrich, Associate Dean for Basic and Translational Sciences
- Joseph Yost, Professor, Neurobiology and Anatomy
- Mark Yandell, Professor, Human Genetics
- John Phillips, Director, Core Facilities
- Will Dere, Professor, Professor, Endocrinology
- Alana Welm, Professor, Oncological Sciences
- Wes Sundquist, Professor, Biochemistry
- Dean Tantin, Professor, Huntsman Cancer Institute
- James Cox, Assoc. Director, Core Facilities
- Eric Schmidt, Professor, Medicinal Chemistry
- Matthew Rondina, Associate Professor, Internal Medicine
- Sarah Franklin, Associate Professor, Internal Medicine

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 are 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

2021 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

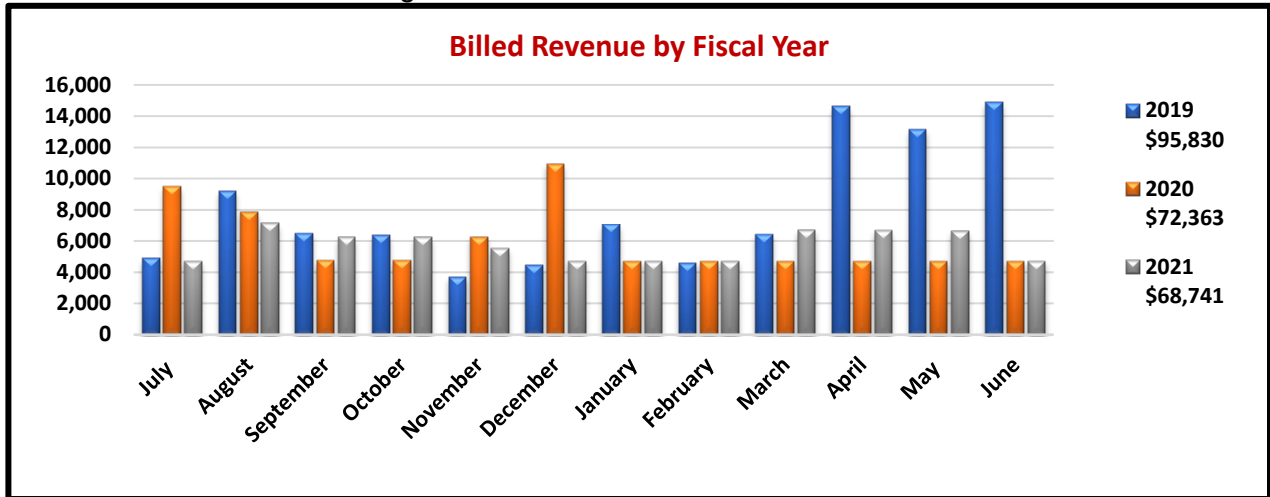
Inter-disciplinary collaborations - projects to enhance imaging capabilities have been performed with the Center for High Performance Computing (CHPC) and with Health Sciences Cores (directly or involving end-users).

Revenue/Expenses

FY21 Expenses: Total \$96,950

FY21 Revenue: Total \$68,741

- VP of Health Sciences Support: \$ 0
- FY21 Revenue generated from services: \$68,741



* Legend displays total annual revenue by year earned.

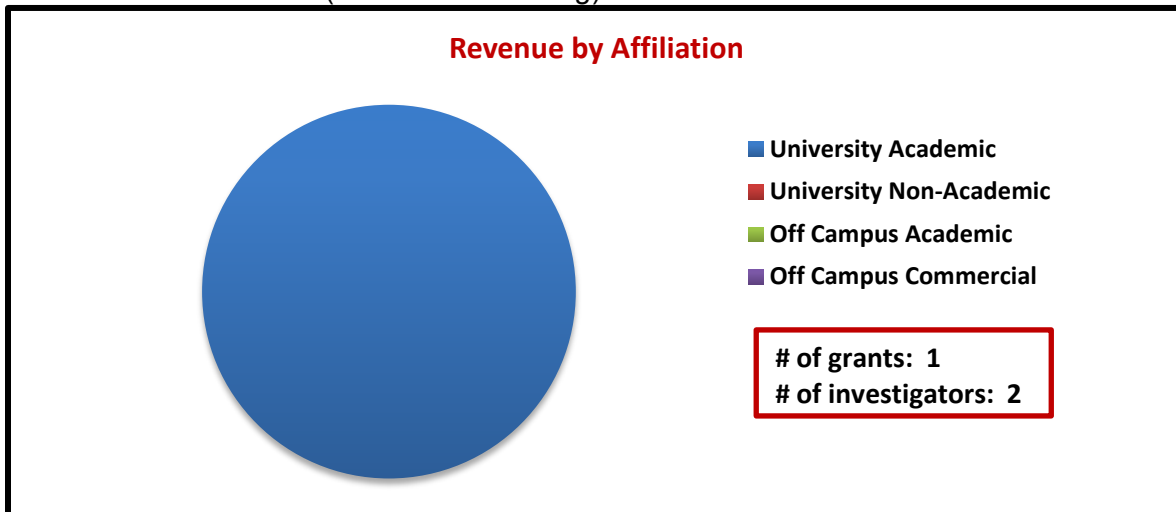
Advisory Board Committee

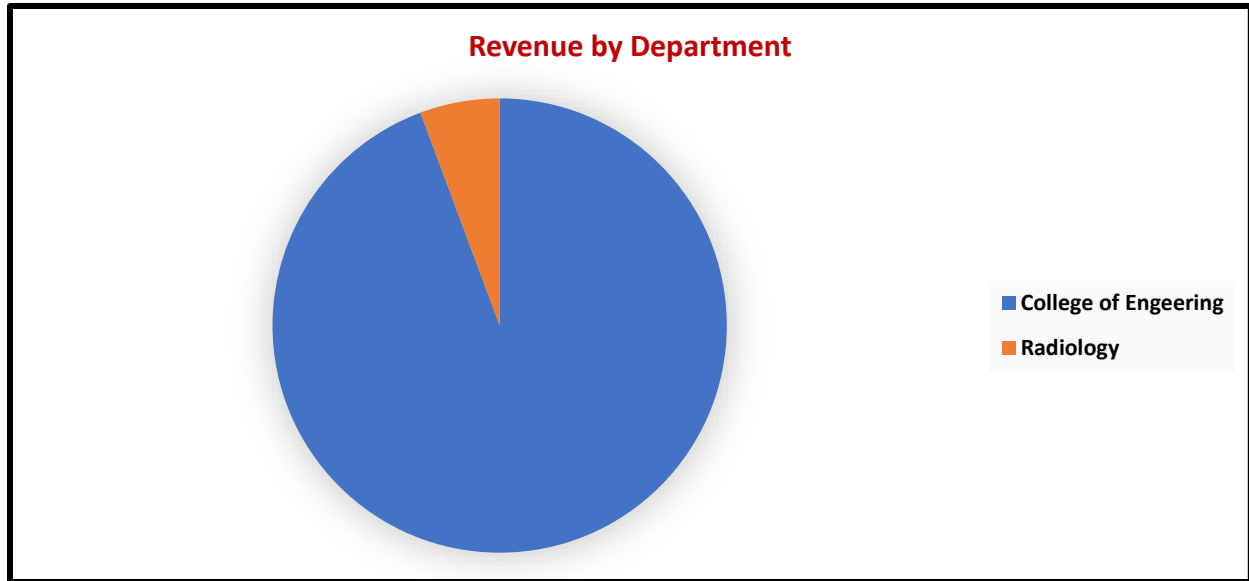
- Tolga Tasdizen, PhD, Associate Professor Electrical and Computer Engineering
- Edward DiBella, PhD, Prof. Radiology and Imaging Sciences, Director UCAIR
- Florian Solzbacher, PhD, Professor Electrical & Computer Engineering, Director CEI

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Tasdizen, Tolga	DHS, Department
2	McNally, Scott	Department

Publications

1. Ricardo, Joyce, C. Vachet and T. Tasdizen (2020). "Interpretation of Disease Evidence for Medical Images Using Adversarial Deformation Fields." [arXiv pre-print server](#). DOI: None arxiv:2007.01975.

Cell Imaging Facility

Overview

The Cell Imaging Facility provides training and consultation on the use of confocal, automated widefield, and two-photon microscopy, as well as the software tools for quantitative analysis of image data. The facility has a Zeiss 880 Airyscan confocal, a Leica SP8 White light laser confocal, a Leica SP8 405/488/561/633 confocal, two Olympus FV1000 Spectral confocals, one Nikon A1R confocal, one Zeiss 700 confocal, and two multi-photon microscopes from Prairie/Bruker. In addition, one Nikon Ti automated widefield microscope, one DeltaVision Ultra widefield microscope and a spinning disk confocal (CSUW1) are available for live cell imaging. STEDYCON, a super-resolution microscope from Abberior-instruments that is integrated for resolving 40nm resolution is now available. 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, hypoxia) for live cell imaging. Nikon Elements AI, 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 Location

HSC Location

- Zeiss 700 Confocal Microscope
- Nikon A1R Confocal Microscope
- 2x Prairie Multi-Photon Microscope
- Zeiss Axioscan Z1 automated slide scanner with 100 slide loader
- EVOS FL Widefield Microscope
- Imaris/Nikon Elements AI Work Station

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
- Imaris Work Station

SMBB Location

- Olympus FV1000 Confocal Microscope

Biology ASB/Crocker Location

- Olympus FV1000 Confocal Microscope
- Zeiss 880 Airyscan Confocal
- Vutara super resolution

EEJMRB Location

- Spinning Disk Confocal Microscope
- DeltaVision Ultra Widefield Microscope

Personnel

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

2021 Annual Update

New Services

- Consultation is available at five locations: 5 CSC, 151 SMBB, 555 HCI, 565 EEJMRB and Building 585 HSC

New Equipment

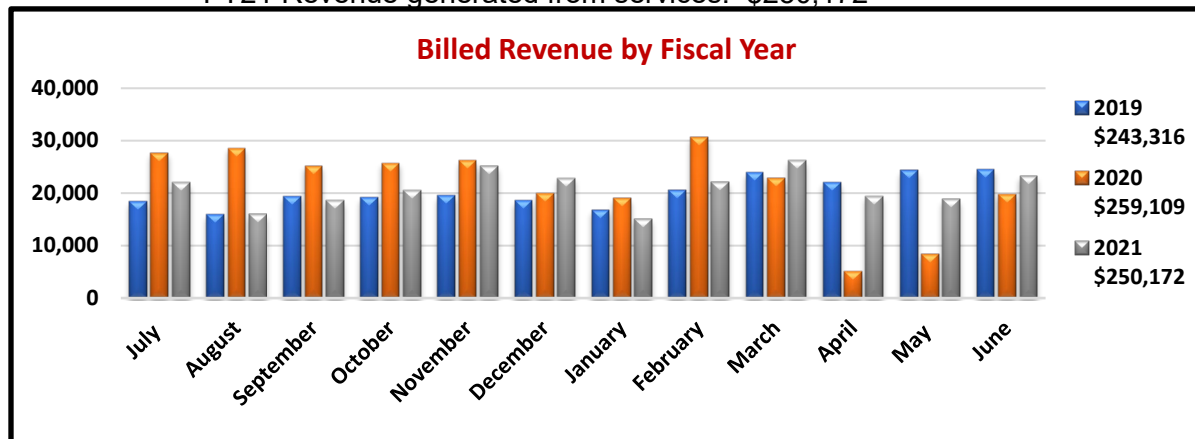
- Spinning disk confocal W1 from Visitek in EEJMRB
- Zeiss 700 Confocal Microscope from Zeiss in HSC
- DeltaVision Ultra Widefield Microscope from Leica in EEJMRB
- STEDYCON Super resolution microscope from Abberior-instruments in CSC

Revenue/Expenses

FY21 Expenses: Total \$641,367

FY21 Revenue: Total \$475,172

- VP of Health Sciences Support: \$225,000
- FY21 Revenue generated from services: \$250,172



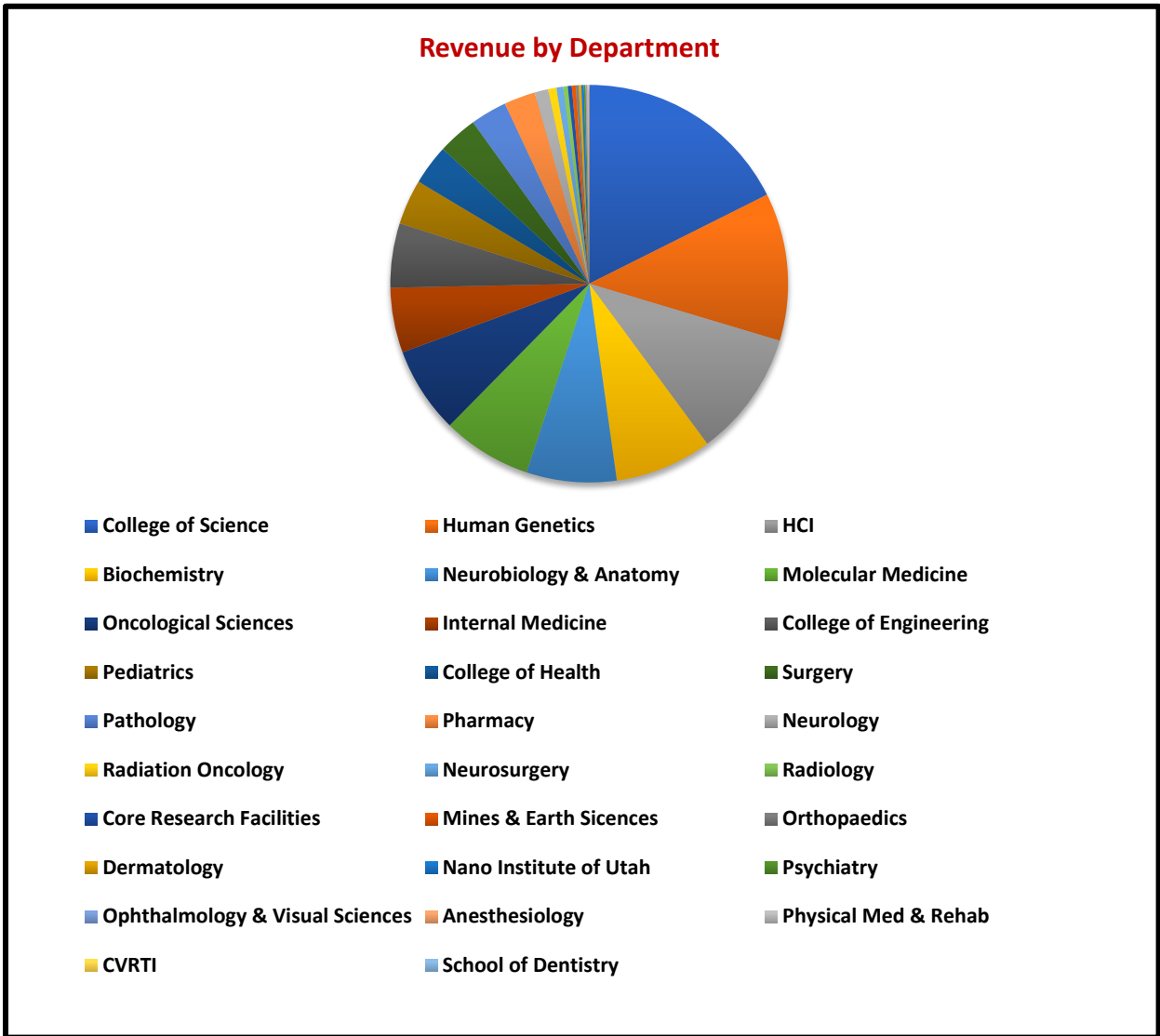
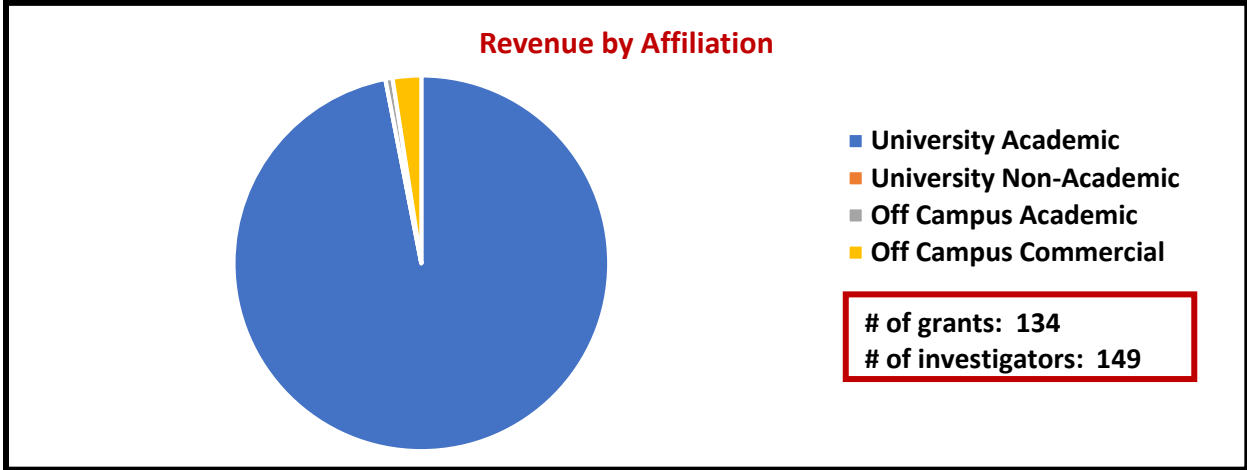
* Legend displays total annual revenue by year earned.

Advisory Board Committee

Last meeting date: July 15th, 2021

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

**FY21 Scientific Impact
Research Support
Revenue Generated (see charts following)**



Top Users

1	Jorgensen, Erik	Department
2	Kardon, Gabrielle	NIH, Wheeler Foundation
3	Caron, Sophie	Department, NIH
4	Beckerle, Mary	NIH
5	Roh-Johnson, Minna	American Cancer Society, DOD, MaryKay Ash FTD
6	Jorde, Lynn	NIH
7	Shcheglovitov, Oleksandr	Department, NIH
8	Edgar, Bruce	NIH
9	Rothenfluh, Adrian	Department, NIH
10	Mendoza, Michelle	Department, American Cancer Society

Publications

- Ahmed, S. M. H., J. A. Maldera, D. Kronic, G. O. Paiva-Silva, C. Penalva, A. A. Teleman and B. A. Edgar (2020). "Fitness trade-offs incurred by ovary-to-gut steroid signalling in *Drosophila*." *Nature* **584**(7821): 415-419. DOI: 10.1038/s41586-020-2462-y.
- Bell, L. A., G. J. Wallis and K. S. Wilcox (2020). "Reactivity and increased proliferation of NG2 cells following central nervous system infection with Theiler's murine encephalomyelitis virus." *J Neuroinflammation* **17**(1): 369. DOI: 10.1186/s12974-020-02043-5.
- Bhatlekar, S., B. K. Manne, I. Basak, L. C. Edelstein, E. Tugolukova, M. L. Stoller, M. J. Cody, S. C. Morley, S. Nagalla, A. S. Weyrich, J. W. Rowley, R. M. O'Connell, M. T. Rondina, R. A. Campbell and P. F. Bray (2020). "miR-125a-5p regulates megakaryocyte proplatelet formation via the actin-bundling protein L-plastin." *Blood* **136**(15): 1760-1772. DOI: 10.1182/blood.2020005230.
- Davis, B., S. Erickson, S. Wojtalewicz, A. Simpson, C. Metcalf, H. Sant, J. Shea, B. Gale and J. Agarwal (2020). "Entrapping bupivacaine-loaded emulsions in a crosslinked-hydrogel increases anesthetic effect and duration in a rat sciatic nerve block model." *Int J Pharm* **588**: 119703. DOI: 10.1016/j.ijpharm.2020.119703.
- de Hart, N., Z. S. Mahmassani, P. T. Reidy, J. J. Kelley, A. I. McKenzie, J. J. Petrocelli, M. J. Bridge, L. M. Baird, E. D. Bastian, L. S. Ward, M. T. Howard and M. J. Drummond (2021). "Acute Effects of Cheddar Cheese Consumption on Circulating Amino Acids and Human Skeletal Muscle." *Nutrients* **13**(2). DOI: 10.3390/nu13020614.
- Derksen, A., H.-Y. Shih, D. Forget, L. Darbelli, L. T. Tran, C. Poitras, K. Guerrero, S. Tharun, F. S. Alkuraya, W. I. Kurdi, C.-T. E. Nguyen, A.-M. Laberge, Y. Si, M.-S. Gauthier, J. L. Bonkowsky, B. Coulombe and G. Bernard (2021). "Variants in LSM7 impair LSM complexes assembly, neurodevelopment in zebrafish and may be associated with an ultra-rare neurological disease." *Human Genetics and Genomics Advances* **2**(3): 100034. DOI: <https://doi.org/10.1016/j.xhgg.2021.100034>.
- Ferrara, P. J., X. Rong, J. A. Maschek, A. R. Verkerke, P. Siripoksup, H. Song, T. D. Green, K. C. Krishnan, J. M. Johnson, J. Turk, J. A. Houmard, A. J. Lusic, M. J. Drummond, J. M. McClung, J. E. Cox, S. R. Shaikh, P. Tontonoz, W. L. Holland and K. Funai (2021). "Lysophospholipid acylation modulates plasma membrane lipid organization and insulin sensitivity in skeletal muscle." *J Clin Invest* **131**(8). DOI: 10.1172/JCI135963.
- Ferrari, L. F., J. Pei, M. Zickella, C. Rey, J. Zickella, A. Ramirez and N. E. Taylor (2021). "D2 Receptors in the Periaqueductal Gray/Dorsal Raphe Modulate Peripheral Inflammatory Hyperalgesia via the Rostral Ventral Medulla." *Neuroscience* **463**: 159-173. DOI: 10.1016/j.neuroscience.2021.03.035.
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- Lewis, M. R., Edgar, B. A., & ØVrebø, J. I. (2021). SIGNALING PATHWAY REGULATION OF TRANSCRIPTION FACTOR E2F1 ALTERS CELL CYCLE PROGRESSION IN DROSOPHILA MIDGUT. SIGNALING PATHWAY REGULATION OF TRANSCRIPTION FACTOR E2F1 ALTERS CELL CYCLE PROGRESSION IN DROSOPHILA MIDGUT, 21(2021). https://d2vxd53ymoe6ju.cloudfront.net/wp-content/uploads/sites/19/2021/05/21165945/LEWIS_MEGAN.pdf
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- Lyu, Y., V. K. Verma, Y. Lee, I. Taleb, R. Badolia, T. S. Shankar, C. P. Kyriakopoulos, C. H. Selzman, W. Caine, R. Alharethi, S. Navankasattusas, T. Seidel, S. G. Drakos and F. B. Sachse (2021). "Remodeling of t-system and proteins underlying excitation-contraction coupling in aging versus failing human heart." *NPJ Aging Mech Dis* **7**(1): 16. DOI: 10.1038/s41514-021-00066-7.

13. Mahmassani, Z. S., A. I. McKenzie, J. J. Petrocelli, N. M. de Hart, P. T. Reidy, D. K. Fix, P. J. Ferrara, K. Funai and M. J. Drummond (2021). "Short-term metformin ingestion by healthy older adults improves myoblast function." *Am J Physiol Cell Physiol* **320**(4): C566-C576. DOI: 10.1152/ajpcell.00469.2020.
14. Mathew, B., K. L. Aoyagi and M. A. Fisher (2021). "Yersinia pestis lipopolysaccharide remodeling confers resistance to a Xenopsylla cheopis cecropin." *bioRxiv*: 2021.2003.2012.435208. DOI: 10.1101/2021.03.12.435208.
15. Okada, M., P. Guo, S. A. Nalder and P. A. Sigala (2020). "Doxycycline has distinct apicoplast-specific mechanisms of antimalarial activity." *Elife* **9**. DOI: 10.7554/eLife.60246.
16. Russell, K. L., J. M. Downie, S. B. Gibson, S. Tsetsou, M. D. Keefe, J. A. Duran, K. P. Figueroa, M. B. Bromberg, L. C. Murtaugh, J. L. Bonkowsky, S. M. Pulst and L. B. Jorde (2021). "Pathogenic effect of TP73 Gene Variants in People With Amyotrophic Lateral Sclerosis." *Neurology*. DOI: 10.1212/WNL.00000000000012285.
17. Strobel, H. A., S. A. LaBelle, L. Krishnan, J. Dale, A. Rauff, A. M. t. Poulson, N. Bader, J. E. Beare, K. Aliaj, J. A. Weiss and J. B. Hoying (2020). "Stromal Cells Promote Neovascular Invasion Across Tissue Interfaces." *Front Physiol* **11**: 1026. DOI: 10.3389/fphys.2020.01026.
18. Tamamouna, V., M. M. Rahman, M. Petersson, I. Charalambous, K. Kux, H. Mainor, V. Bolender, B. Isbilir, B. A. Edgar and C. Pitsouli (2021). "Remodelling of oxygen-transporting tracheoles drives intestinal regeneration and tumorigenesis in Drosophila." *Nat Cell Biol* **23**(5): 497-510. DOI: 10.1038/s41556-021-00674-1.
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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, 9 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, 3 fluorescence stereomicroscopes, and 3 Zebrafish Embryonic Genotyper (ZEG) units.
- 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.

Equipment

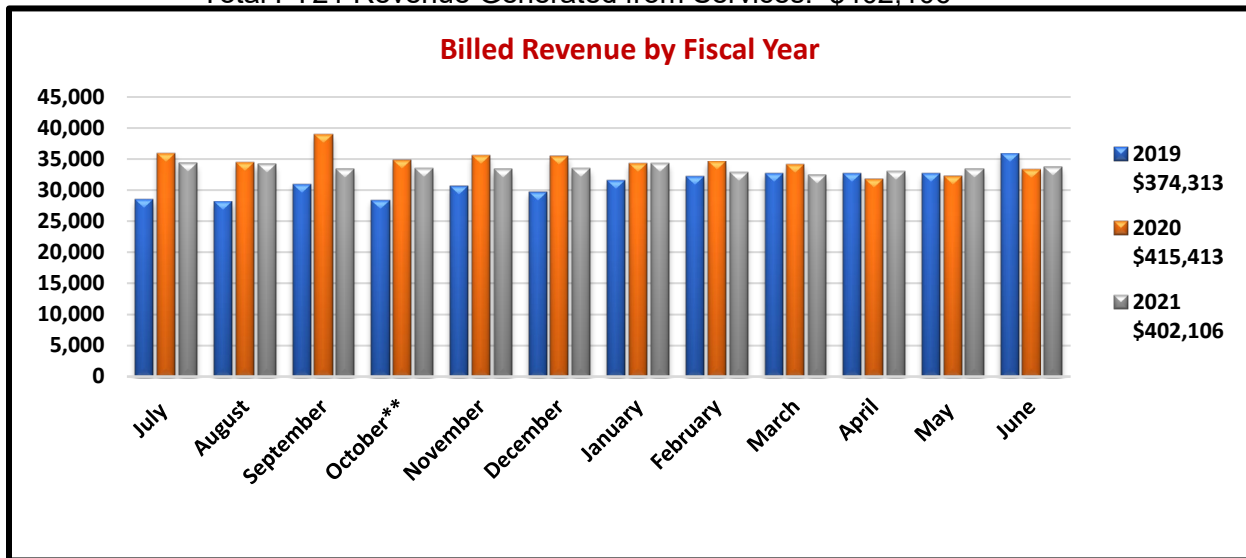
- M205 FA Leica Fluorescence Microscope
- Zeiss Fluorescence Microscope with LED light source
- Olympus Fluorescence Microscope
- 7 microinjection stations with bright field stereomicroscopes
- Microinjection needle pulling machine and micro grinder for sharpening needles
- Analog camera and monitor to facilitate teaching microinjection in real time
- FluidX Zebrafish Embryonic Genotypers to allow genotyping selection of embryos prior to growing in the nursery
- 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

2021 Annual Update

- **New Services – Zebrafish Embryonic Genotyping**
- **Revenue/Expenses**
 FY21 Expenses: Total \$416,454
 FY21 Revenue: Total \$602,106
 - VP of Health Sciences Support: \$150,000
 - VP of Research: \$50,000
 - Total FY21 Revenue Generated from Services: \$402,106



* Legend displays total annual revenue.

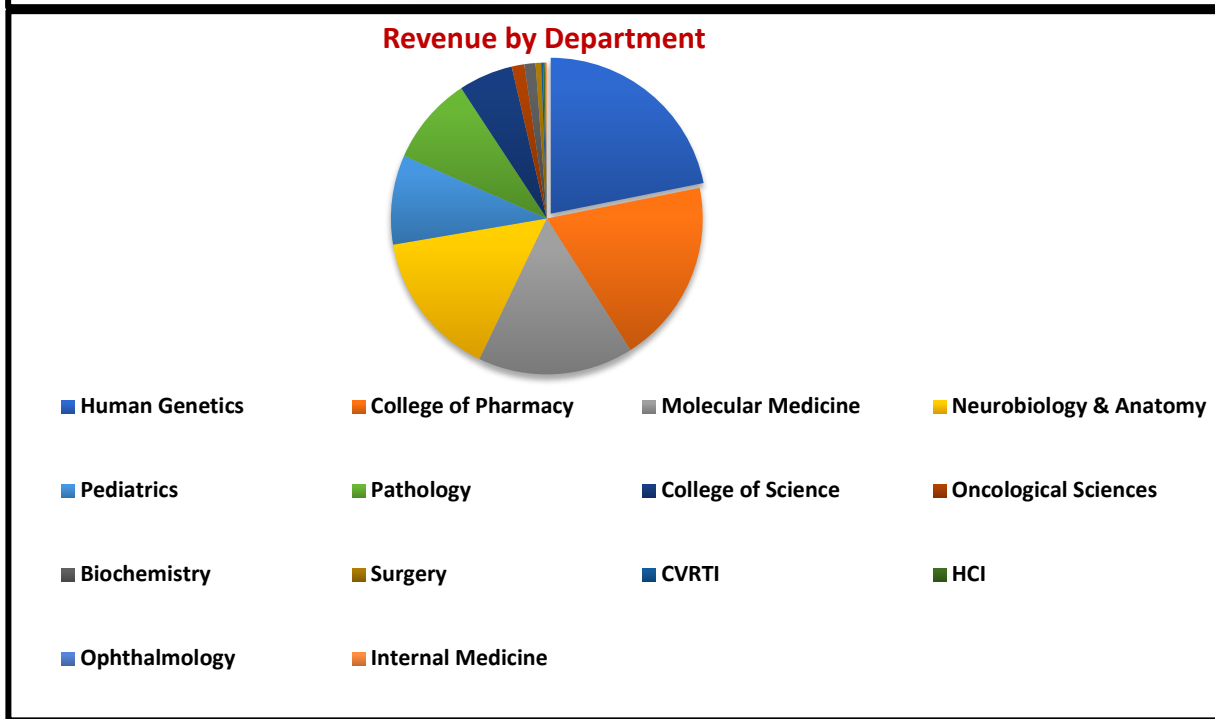
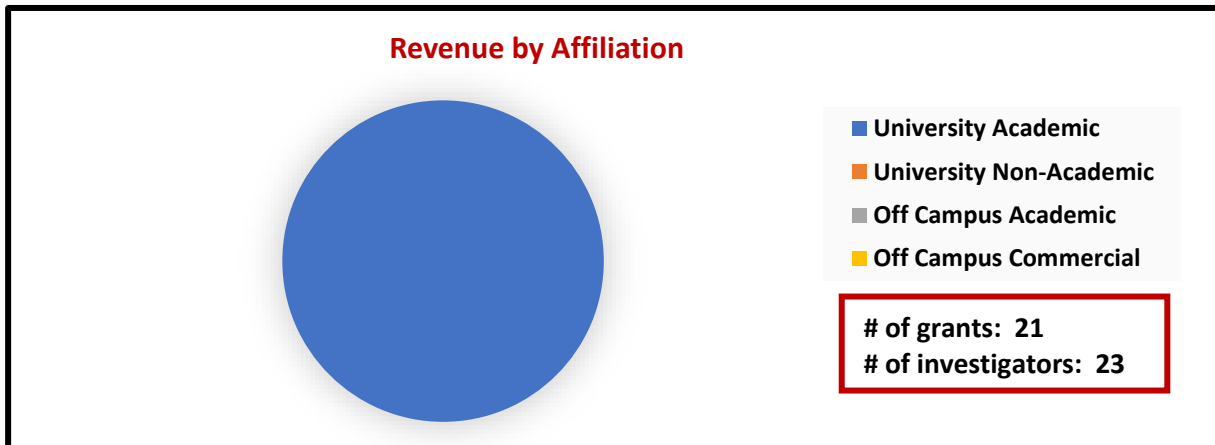
Advisory Board Committee

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
- Rodney Stewart, Assistant Professor, Oncological Sciences
- Randall Peterson, Dean, College of Pharmacy
- H. Joseph Yost, Professor, Neurobiology and Anatomy and Pediatrics
- Kimberly Evason, Assistant Professor, Pathology

FY21 Scientific Impact

- **Research Support**
- Research Instrumentation Fund Grant ----
- Grants supported by this core, as of July 2021, are listed as an appendix following this report



Top Users

1	Peterson, Randall	Department
2	Yost, H Joseph	Department
3	Grunwald, David	Department, NIH
4	Gagnon, James	Department, Zuckerberg Initiative
5	Bonkowsky, Josh	NIH
6	Dorsky, Richard	NIH
7	Evason, Kimberly	Damon Runyon Cancer Research FTD
8	Douglass, Adam	NIH
9	Mulvey, Matthew	NIH

Publications

- Adolfi, M. C., A. Herpin, A. Martinez-Bengochea, S. Kneitz, M. Regensburger, D. J. Grunwald and M. Schartl (2020). "Crosstalk Between Retinoic Acid and Sex-Related Genes Controls Germ Cell Fate and Gametogenesis in Medaka." *Front Cell Dev Biol* **8**: 613497. DOI: 10.3389/fcell.2020.613497.
- Arveseth, C. D., J. T. Happ, D. S. Hedeem, J. F. Zhu, J. L. Capener, D. Klatt Shaw, I. Deshpande, J. Liang, J. Xu, S. L. Stubben, I. B. Nelson, M. F. Walker, K. Kawakami, A. Inoue, N. J. Krogan, D. J. Grunwald, R. Huttenhain, A. Manglik and B. R. Myers (2021). "Smoothed transduces Hedgehog signals via activity-dependent sequestration of PKA catalytic subunits." *PLoS Biol* **19**(4): e3001191. DOI: 10.1371/journal.pbio.3001191.
- Barrios, J. P., W. C. Wang, R. England, E. Reifenberg and A. D. Douglass (2020). "Hypothalamic Dopamine Neurons Control Sensorimotor Behavior by Modulating Brainstem Premotor Nuclei in Zebrafish." *Curr Biol* **30**(23): 4606-4618 e4604. DOI: 10.1016/j.cub.2020.09.002.
- Bosse, G. D., R. Cadeddu, G. Floris, R. D. Farero, E. Vigato, S. J. Lee, T. Zhang, N. W. Gaikwad, K. A. Keefe, P. E. Phillips, M. Bortolato and R. T. Peterson (2021). "The 5alpha-reductase inhibitor finasteride reduces opioid self-administration in animal models of opioid use disorder." *J Clin Invest* **131**(10). DOI: 10.1172/JCI1143990.
- Bosse, G. D., C. Urcino, M. Watkins, P. Florez Salcedo, S. Kozel, K. Chase, A. Cabang, S. S. Espino, H. Safavi-Hemami, S. Raghuraman, B. M. Olivera, R. T. Peterson and J. Gajewiak (2021). "Discovery of a Potent Conoramide from *Conus episcopatus* Using a Novel Zebrafish Larvae Assay." *J Nat Prod* **84**(4): 1232-1243. DOI: 10.1021/acs.jnatprod.0c01297.
- D'Orazio, F. M., P. J. Balwierz, A. J. Gonzalez, Y. Guo, B. Hernandez-Rodriguez, L. Wheatley, A. Jasiulewicz, Y. Hadzhiev, J. M. Vaquerizas, B. Cairns, B. Lenhard and F. Muller (2021). "Germ cell differentiation requires Tdr7-dependent chromatin and transcriptome reprogramming marked by germ plasm relocalization." *Dev Cell* **56**(5): 641-656 e645. DOI: 10.1016/j.devcel.2021.02.007.
- Hutcheson, D. A., Y. Xie, P. Figueroa and R. I. Dorsky (2020). "A transgene targeted to the zebrafish *nkx2.4b* locus drives specific green fluorescent protein expression and disrupts thyroid development." *Dev Dyn* **249**(11): 1387-1393. DOI: 10.1002/dvdy.224.
- Kent, M. L., K. N. Murray, M. R. Hobbs, L. M. Weiss, S. T. Spagnoli and J. L. Sanders (2021). "Intranuclear inclusions consistent with a *Nucleospora* sp. in a lymphoid lesion in a laboratory zebrafish, *Danio rerio* (Hamilton 1822)." *J Fish Dis* **44**(1): 107-112. DOI: 10.1111/jfd.13271.
- Lusk, S., M. A. Casey and K. M. Kwan (2021). "4-Dimensional Imaging of Zebrafish Optic Cup Morphogenesis." *J Vis Exp*(171). DOI: 10.3791/62155.
- Pham, D. H., R. Kudira, L. Xu, C. A. Valencia, J. L. Ellis, T. Shi, K. J. Evason, I. Osuji, N. Matuschek, L. Pfuhrer, M. Mullen, S. K. Mohanty, A. Husami, L. N. Bull, K. Zhang, S. Wali, C. Yin and A. Miethke (2021). "Deleterious Variants in *ABCC12* are Detected in Idiopathic Chronic Cholestasis and Cause Intrahepatic Bile Duct Loss in Model Organisms." *Gastroenterology* **161**(1): 287-300 e216. DOI: 10.1053/j.gastro.2021.03.026.
- Raas, Q., M. C. van de Beek, S. Forss-Petter, I. M. Dijkstra, A. Deschiffart, B. C. Freshner, T. J. Stevenson, Y. R. Jaspers, L. Nagtzaam, R. J. Wanders, M. van Weeghel, J. Y. Engelen-Lee, M. Engelen, F. Eichler, J. Berger, J. L. Bonkowsky and S. Kemp (2021). "Metabolic rerouting via *SCD1* induction impacts X-linked adrenoleukodystrophy." *J Clin Invest* **131**(8). DOI: 10.1172/JCI142500.
- Russell, K. L., J. M. Downie, S. B. Gibson, S. Tsetsou, M. D. Keefe, J. A. Duran, K. P. Figueroa, M. B. Bromberg, L. C. Murtaugh, J. L. Bonkowsky, S. M. Pulst and L. B. Jorde (2021). "Pathogenic effect of TP73 Gene Variants in People With Amyotrophic Lateral Sclerosis." *Neurology*. DOI: 10.1212/WNL.00000000000012285.

13. Teerlink, C. C., M. J. Juryneec, R. Hernandez, J. Stevens, D. C. Hughes, C. P. Bruncker, K. Rowe, D. J. Grunwald, J. C. Facelli and L. A. Cannon-Albright (2021). "A role for the MEGF6 gene in predisposition to osteoporosis." *Ann Hum Genet* **85**(2): 58-72. DOI: 10.1111/ahg.12408.
14. Vasudevan, D., Y. C. Liu, J. P. Barrios, M. K. Wheeler, A. D. Douglass and R. I. Dorsky (2021). "Regenerated interneurons integrate into locomotor circuitry following spinal cord injury." *Exp Neurol* **342**: 113737. DOI: 10.1016/j.expneurol.2021.113737.

**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
Mulvey	Bacterial Invasion And Trafficking Within The Bladder	NIH/NIAIDIA BETE	\$250,000
Stewart	Foxd3-Dependent Pathways In Neural Crest Migration And Metastasis	American Cancer Society	\$150,000
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
Lim, Carol	Re-engineered Mitochondrially Targeted p53 Gene Therapy in Liver Cancer	NIH/NCI	
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
- Hitachi L-8800 Amino Acid Analyzer

Personnel

- Mike Hanson, Ph.D., Director
- Zhesen Tan, Lab Technician
- Meredith Ford, Lab Technician

2021 Annual Update

New Equipment

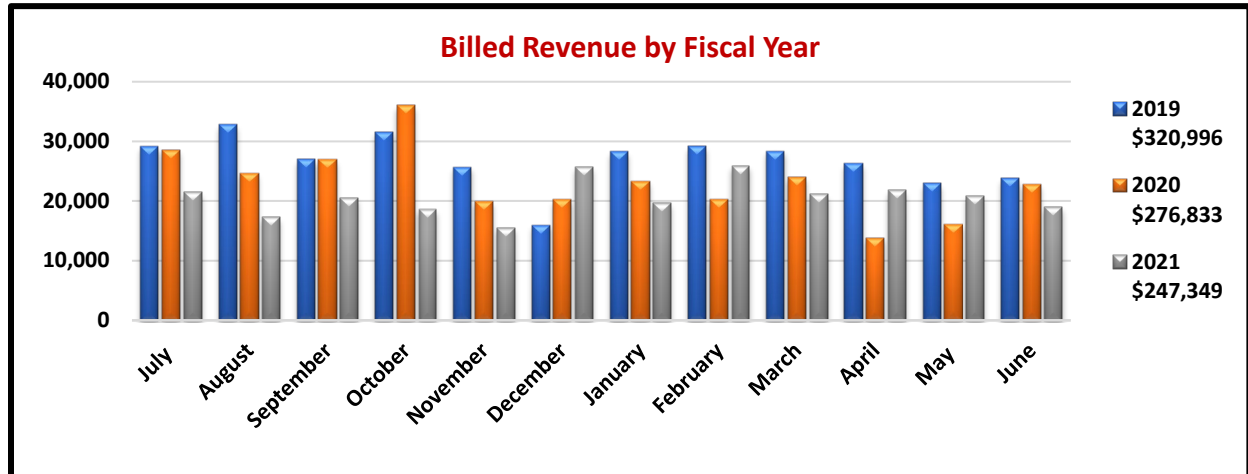
- The DNA Peptide Facility now offers a 25 nmole DNA Synthesis service. These prices make the facility much more competitive with commercial vendors.

Revenue/Expenses

FY21 Expenses: Total \$258,178

FY21 Revenue: Total \$247,349

- VP of Health Sciences Support: \$0
- FY21 Revenue Generated from Services: \$247,349



* Total billed annual revenue displayed in legend.

Advisory Board Committee

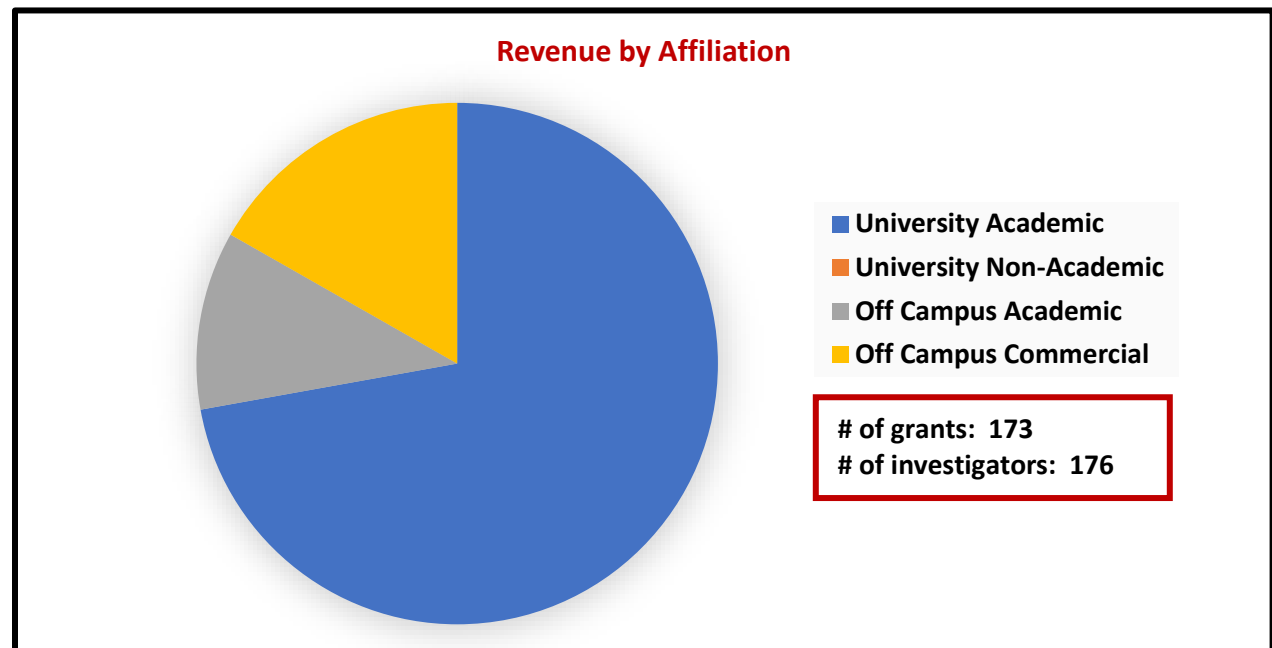
Last meeting date: June 2021

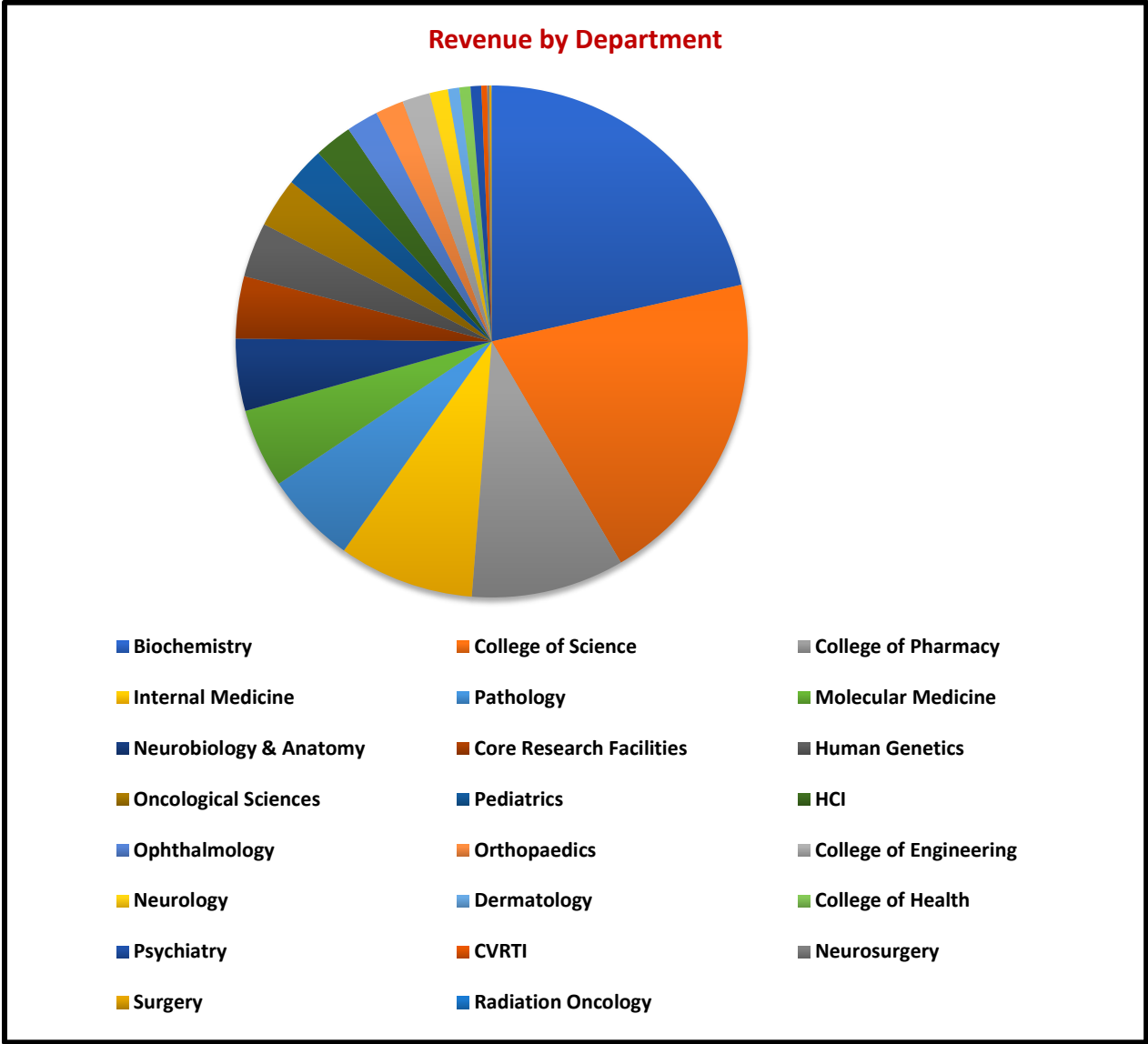
- Raphael Franzini, Professor, College of Pharmacy
- Ming Hammond, Professor, Chemistry Department
- Mahesh Chandrasekharan, Professor, Radiation Oncology

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Burrows, Cynthia	NIH
2	Emory University	Off Campus Academic
3	Sundquist, Wesley	Department, NIH
4	BioFire Diagnostics	Commercial
5	Yang, Tianxin	NIH
6	CoDiagnostics	Commercial
7	Rutter, Jared	Department, NIH, Global FTD for Peroxisomal Disorders
8	Davey-Hicks, Crystal	HSC Cores Research Facilities
9	Bass, Brenda	NIH
10	Davis, Darrell	Department, State of Utah

Publications

1. Campbell, R. A., H. D. Campbell, J. S. Bircher, C. V. de Araujo, F. Denorme, J. L. Crandell, J. L. Rustad, J. Monts, M. J. Cody, Y. Kosaka and C. C. Yost (2021). "Placental HTRA1 cleaves alpha-1-antitrypsin to generate a NET-Inhibitory Peptide." Blood. DOI: 10.1182/blood.2020009021.
2. Donelick, H. M., L. Talide, M. Bellet, P. J. Aruscavage, E. Lauret, E. Aguiar, J. T. Marques, C. Meignin and B. L. Bass (2020). "In vitro studies provide insight into effects of Dicer-2 helicase mutations in *Drosophila melanogaster*." RNA **26**(12): 1847-1861. DOI: 10.1261/rna.077289.120.
3. Knutson, S. D., A. A. Sanford, C. S. Swenson, M. M. Korn, B. A. Manuel and J. M. Heemstra (2020). "Thermoreversible Control of Nucleic Acid Structure and Function with Glyoxal Caging." J Am Chem Soc **142**(41): 17766-17781. DOI: 10.1021/jacs.0c08996.
4. Libbey, J. E., J. M. S. Sanchez, B. A. Fleming, D. J. Doty, A. B. DePaula-Silva, M. A. Mulvey and R. S. Fujinami (2020). "Modulation of experimental autoimmune encephalomyelitis through colonisation of the gut with *Escherichia coli*." Benef Microbes **11**(7): 669-684. DOI: 10.3920/BM2020.0012.
5. Myres, G. J., E. M. Peterson and J. M. Harris (2021). "Confocal Raman Microscopy Enables Label-Free, Quantitative, and Structurally Informative Detection of DNA Hybridization at Porous Silica Surfaces." Anal Chem **93**(22): 7978-7986. DOI: 10.1021/acs.analchem.1c00885.
6. Rogers, R. A., M. R. Meyer, K. M. Stewart, G. M. Eyring, A. M. Fleming and C. J. Burrows (2021). "Hysteresis in poly-2'-deoxycytidine i-motif folding is impacted by the method of analysis as well as loop and stem lengths." Biopolymers **112**(1): e23389. DOI: 10.1002/bip.23389.

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 DNA sequencers and lab robotics such as the Qiagen Q24 Pyrosequencer, 10x Genomics and the Biomek FXp for liquid handling needs. For Illumina sequencing we also have the capability of sending samples out for sequencing with approximately 3 week turnaround time run on both the Illumina NovaSeq and the MiSeq instruments. In addition we have a Minlon from Oxford Nanopore that we can work with you on completing runs of long read sequencing for your projects. 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 for download using a simple and secure interface.

Services

DNA Sequencing

- Standard Sanger DNA sequencing
- Primer walking on clones
- Mutation detection and resequencing custom projects
- Pyrosequencing
- 10x Genomics libraries for single cell sequencing
- Oxford Nanopore Minlon runs
- Illumina Sequencing with 3 week turnaround

Cell Line Authentication

- Human Cell Line Authentication by STR

Robotics

- Biomek FXp with Span-8 and 96 head

Fragment Analysis

- 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

- 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

2021 Annual Update

New Equipment

- BioMek FXp replaced the BioMek FX that became obsolete.

New Services

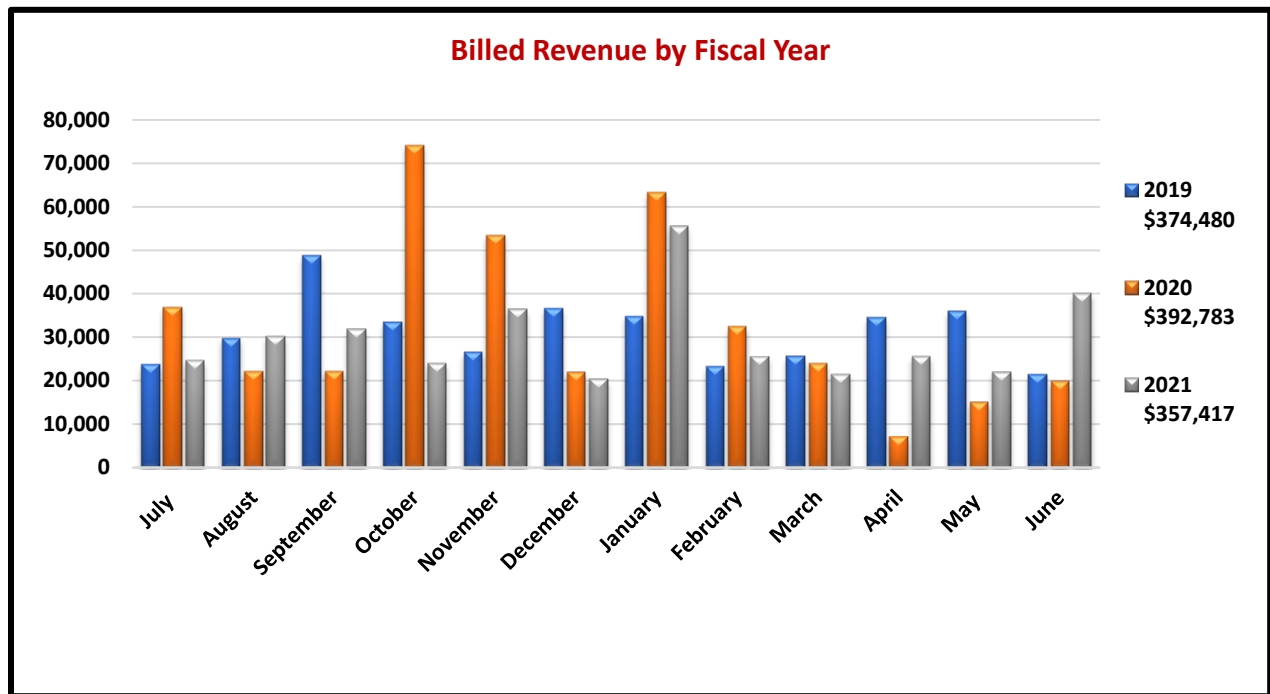
- The Sequencing Core did not implement additional services in FY21.

Revenue/Expenses

FY21 Expenses: Total \$337,556

FY21 Revenue: Total \$357,417

- VP of Health Sciences Support: \$0
- FY21 Revenue generated from services: \$357,417



* Total annual revenue displayed in legend

Advisory Board Committee

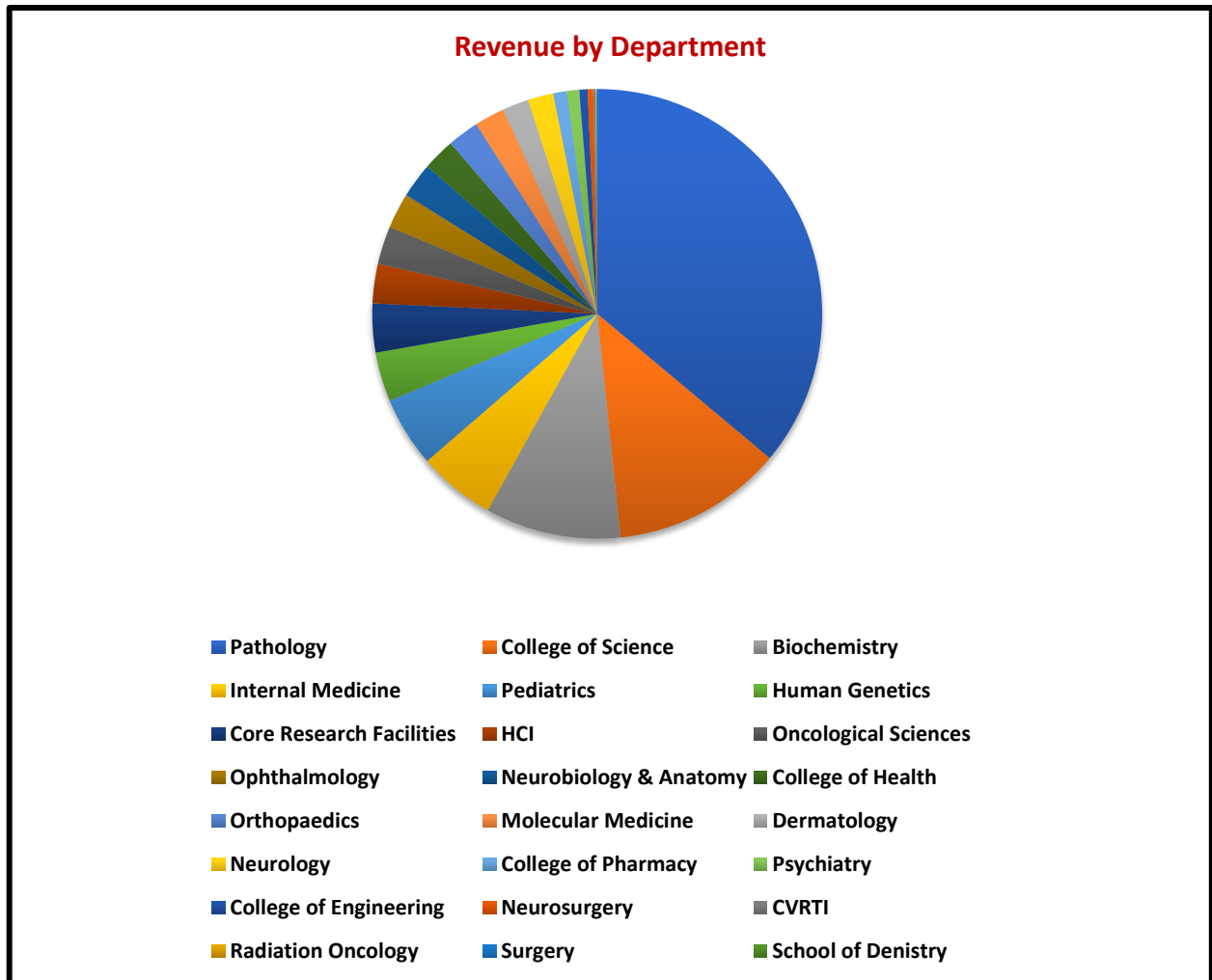
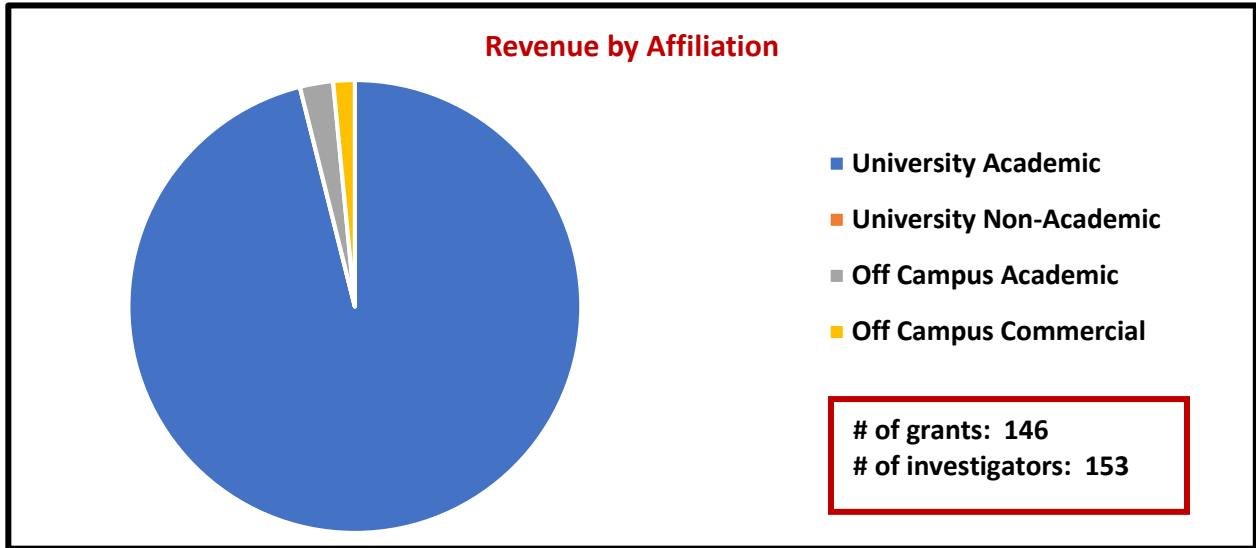
Last meeting date: June 29, 2021

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

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Top Users

1	Evavold, Brian	Department
2	Fairfax, Keke	Department, NIH
3	Mulvey, Matthew	NIH
4	Sundquist, Wesley	Department, NIH
5	Parkinson, John S.	NIH
6	Hageman, Gregory	Department
7	Davey-Hicks, Crystal	HSC Cores Research Facilities
8	Cannon-Albright, Lisa	Department, MD Anderson Cancer CTR
9	Lamb, Tracey	NIH
10	Holland, William	Department, NIH

Publications

- Arveseth, C. D., J. T. Happ, D. S. Hedeem, J.-F. Zhu, J. L. Capener, D. Klatt Shaw, I. Deshpande, J. Liang, J. Xu, S. L. Stubben, I. B. Nelson, M. F. Walker, K. Kawakami, A. Inoue, N. J. Krogan, D. J. Grunwald, R. Hüttenhain, A. Manglik and B. R. Myers (2021). "Smoothed transduces Hedgehog signals via activity-dependent sequestration of PKA catalytic subunits." *PLOS Biology* **19**(4): e3001191. DOI: 10.1371/journal.pbio.3001191.
- Camolotto, S. A., V. K. Belova, L. Torre-Healy, J. M. Vahrenkamp, K. C. Berrett, H. Conway, J. Shea, C. Stubben, R. Moffitt, J. Gertz and E. L. Snyder (2021). "Reciprocal regulation of pancreatic ductal adenocarcinoma growth and molecular subtype by HNF4alpha and SIX1/4." *Gut* **70**(5): 900-914. DOI: 10.1136/gutjnl-2020-321316.
- Chan, X. Y., E. Volkova, J. Eoh, R. Black, L. Fang, R. Gorashi, J. Song, J. Wang, M. B. Elliott, S. F. Barreto-Ortiz, J. Chen, B. L. Lin, L. Santhanam, L. Cheng, F. S. Lee, J. T. Prchal and S. Gerecht (2021). "HIF2A gain-of-function mutation modulates the stiffness of smooth muscle cells and compromises vascular mechanics." *iScience* **24**(4): 102246. DOI: 10.1016/j.isci.2021.102246.
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- Ghandehari, H., H. K. Chan, H. Harashima, J. A. MacKay, T. Minko, K. Schenke-Layland, Y. Shen and M. J. Vicent (2020). "Advanced drug delivery 2020 - Parts 1,2 and 3." *Adv Drug Deliv Rev* **156**: 1-2. DOI: 10.1016/j.addr.2020.11.003.
- Gordeuk, V. R., B. N. Shah, X. Zhang, P. E. Thuma, S. Zulu, R. Moono, N. S. Reading, J. Song, Y. Zhang, M. Nouraie, A. Campbell, C. P. Minniti, S. R. Rana, D. S. Darbari, G. J. Kato, M. Niu, O. L. Castro, R. Machado, M. T. Gladwin and J. T. Prchal (2020). "The CYB5R3(c) (.350C>G) and G6PD A alleles modify severity of anemia in malaria and sickle cell disease." *Am J Hematol* **95**(11): 1269-1279. DOI: 10.1002/ajh.25941.
- Guillen, K. P., M. Fujita, A. J. Butterfield, S. D. Scherer, M. H. Bailey, Z. Chu, Y. S. DeRose, L. Zhao, E. Cortes-Sanchez, C.-H. Yang, J. Toner, G. Wang, Y. Qiao, X. Huang, J. A. Greenland, J. M. Vahrenkamp, D. H. Lum, R. E. Factor, E. W. Nelson, C. B. Matsen, J. M. Poretta, R. Rosenthal, A. C. Beck, S. S. Buys, C. Vaklavas, J. H. Ward, R. L. Jensen, K. B. Jones, Z. Li, S. Oesterreich, L. E. Dobrolecki, S. S. Pathi, X. Y. Woo, K. C. Berrett, M. E. Wadsworth, J. H. Chuang, M. T. Lewis, G. T. Marth, J. Gertz, K. E. Varley, B. E. Welm and A. L. Welm (2021). "A breast cancer patient-derived xenograft and organoid platform for drug discovery and precision oncology." *bioRxiv*: 2021.2002.2028.433268. DOI: 10.1101/2021.02.28.433268.
- Kaur, K., D. Overacker, H. Ghandehari, C. Reilly, R. Paine, 3rd and K. E. Kelly (2021). "Determining real-time mass deposition with a quartz crystal microbalance in an electrostatic, parallel-flow, air-liquid interface exposure system." *J Aerosol Sci* **151**. DOI: 10.1016/j.jaerosci.2020.105653.

11. Keefe, M. D., H. E. Soderholm, H. Y. Shih, T. J. Stevenson, K. A. Glaittli, D. M. Bowles, E. Scholl, S. Colby, S. Merchant, E. W. Hsu and J. L. Bonkowsky (2020). "Vanishing white matter disease expression of truncated EIF2B5 activates induced stress response." *Elife* **9**. DOI: 10.7554/eLife.56319.
12. Khurana, N., A. Pulsipher, H. Ghandehari and J. A. Alt (2021). "Meta-analysis of global and high throughput public gene array data for robust vascular gene expression discovery in chronic rhinosinusitis: Implications in controlled release." *J Control Release* **330**: 878-888. DOI: 10.1016/j.jconrel.2020.10.061.
13. Khurana, N., A. Pulsipher, J. Jedrzkiewicz, S. Ashby, C. E. Pollard, H. Ghandehari and J. A. Alt (2021). "Inflammation-driven vascular dysregulation in chronic rhinosinusitis." *Int Forum Allergy Rhinol* **11**(6): 976-983. DOI: 10.1002/alf.22723.
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15. Lang, J., E. Haas, J. Hubener-Schmid, C. J. Anderson, S. M. Pulst, M. A. Giese and W. Ilg (2020). "Detecting and Quantifying Ataxia-Related Motor Impairments in Rodents Using Markerless Motion Tracking With Deep Neural Networks." *Annu Int Conf IEEE Eng Med Biol Soc* **2020**: 3642-3648. DOI: 10.1109/EMBC44109.2020.9176701.
16. Lewis, M. R., Edgar, B. A., & ØVrebø, J. I. (2021). SIGNALING PATHWAY REGULATION OF TRANSCRIPTION FACTOR E2F1 ALTERS CELL CYCLE PROGRESSION IN DROSOPHILA MIDGUT. SIGNALING PATHWAY REGULATION OF TRANSCRIPTION FACTOR E2F1 ALTERS CELL CYCLE PROGRESSION IN DROSOPHILA MIDGUT, 21(2021). https://d2vxd53ymoe6ju.cloudfront.net/wp-content/uploads/sites/19/2021/05/21165945/LEWIS_MEGAN.pdf
17. Manna, S., J. Truong and M. C. Hammond (2021). "Guanidine Biosensors Enable Comparison of Cellular Turn-on Kinetics of Riboswitch-Based Biosensor and Reporter." *ACS Synth Biol* **10**(3): 566-578. DOI: 10.1021/acssynbio.0c00583.
18. Olsen, R. R., A. S. Ireland, D. W. Kastner, S. M. Groves, K. B. Spainhower, K. Pozo, D. P. Kelenis, C. P. Whitney, M. R. Guthrie, S. J. Wait, D. Soltero, B. L. Witt, V. Quaranta, J. E. Johnson and T. G. Oliver (2021). "ASCL1 represses a SOX9(+) neural crest stem-like state in small cell lung cancer." *Genes Dev* **35**(11-12): 847-869. DOI: 10.1101/gad.348295.121.
19. Russell, K. L., J. M. Downie, S. B. Gibson, S. Tsetsou, M. D. Keefe, J. A. Duran, K. P. Figueroa, M. B. Bromberg, L. C. Murtaugh, J. L. Bonkowsky, S. M. Pulst and L. B. Jorde (2021). "Pathogenic effect of TP73 Gene Variants in People With Amyotrophic Lateral Sclerosis." *Neurology*. DOI: 10.1212/WNL.0000000000012285.
20. Salas-Huetos, A., E. R. James, D. S. Broberg, K. I. Aston, D. T. Carrell and T. G. Jenkins (2020). "The combined effect of obesity and aging on human sperm DNA methylation signatures: inclusion of BMI in the paternal germ line age prediction model." *Sci Rep* **10**(1): 15409. DOI: 10.1038/s41598-020-71979-8.
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24. Subrahmanyam, N. and H. Ghandehari (2021). "Harnessing Extracellular Matrix Biology for Tumor Drug Delivery." *J Pers Med* **11**(2). DOI: 10.3390/jpm11020088.
25. Thiagarajan, P., C. J. Parker and J. T. Prchal (2021). "How Do Red Blood Cells Die?" *Front Physiol* **12**: 655393. DOI: 10.3389/fphys.2021.655393.
26. Young, A. P. and V. Bandarian (2021). "Eukaryotic TYW1 Is a Radical SAM Flavoenzyme." *Biochemistry* **60**(27): 2179-2185. DOI: 10.1021/acs.biochem.1c00349.

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 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.

Viral Packaging Service

- Small/large scale viral (lentivirus, 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

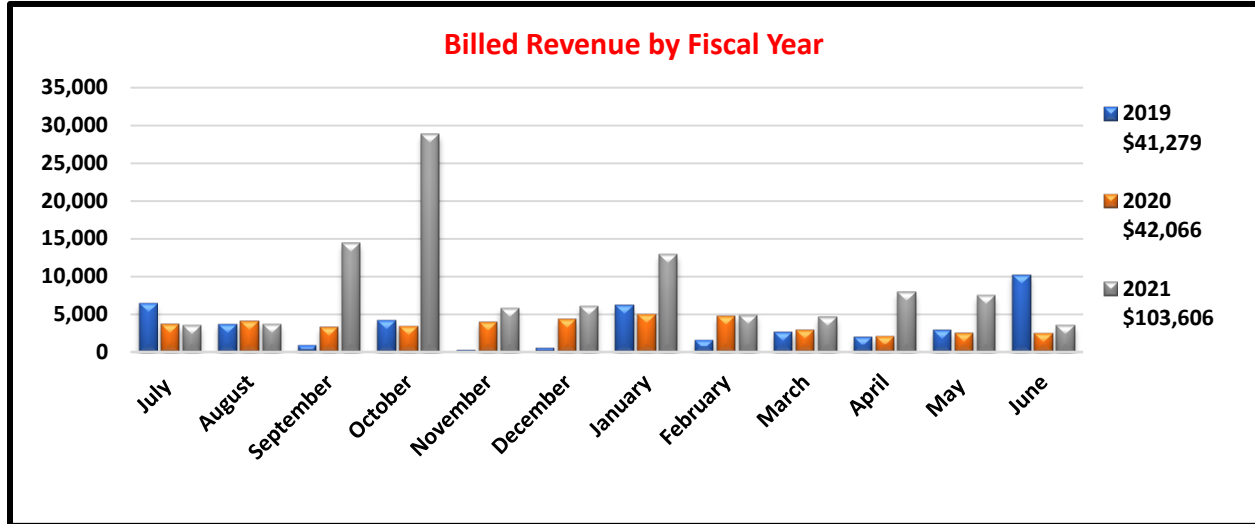
- Bai Luo, Ph.D., Director

Revenue/Expenses

FY21 Expenses: Total \$166,304

FY21 Revenue: Total \$178,606

- VP of Health Sciences Support: \$75,000
- FY21 Revenue Generated from Services: \$103,606



* Total annual revenue displayed in legend.

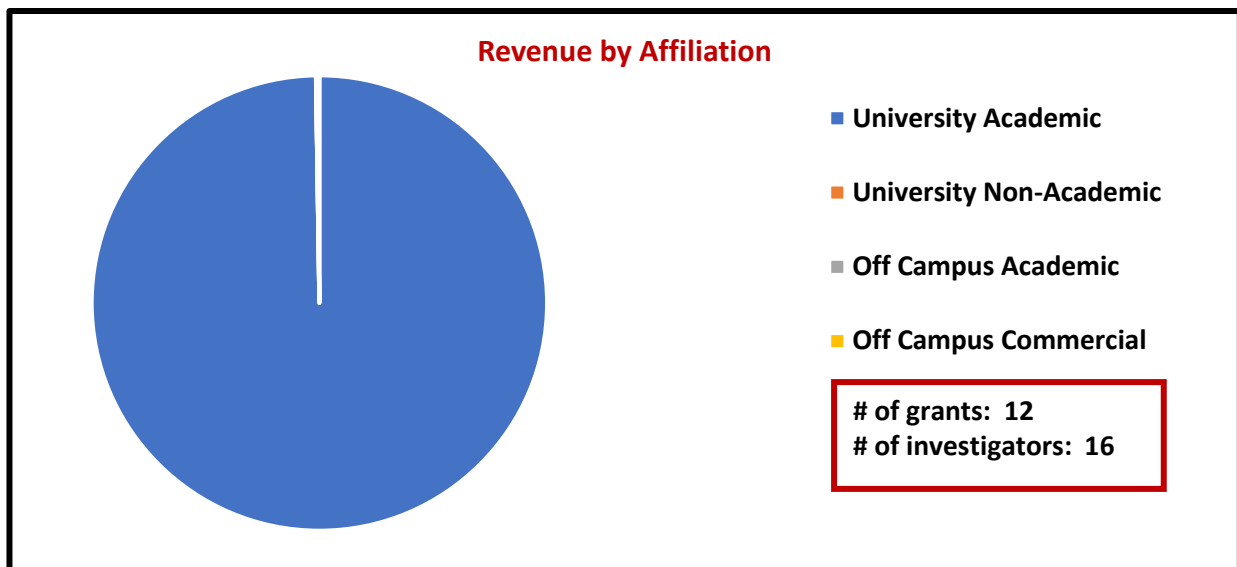
Advisory Board Committee

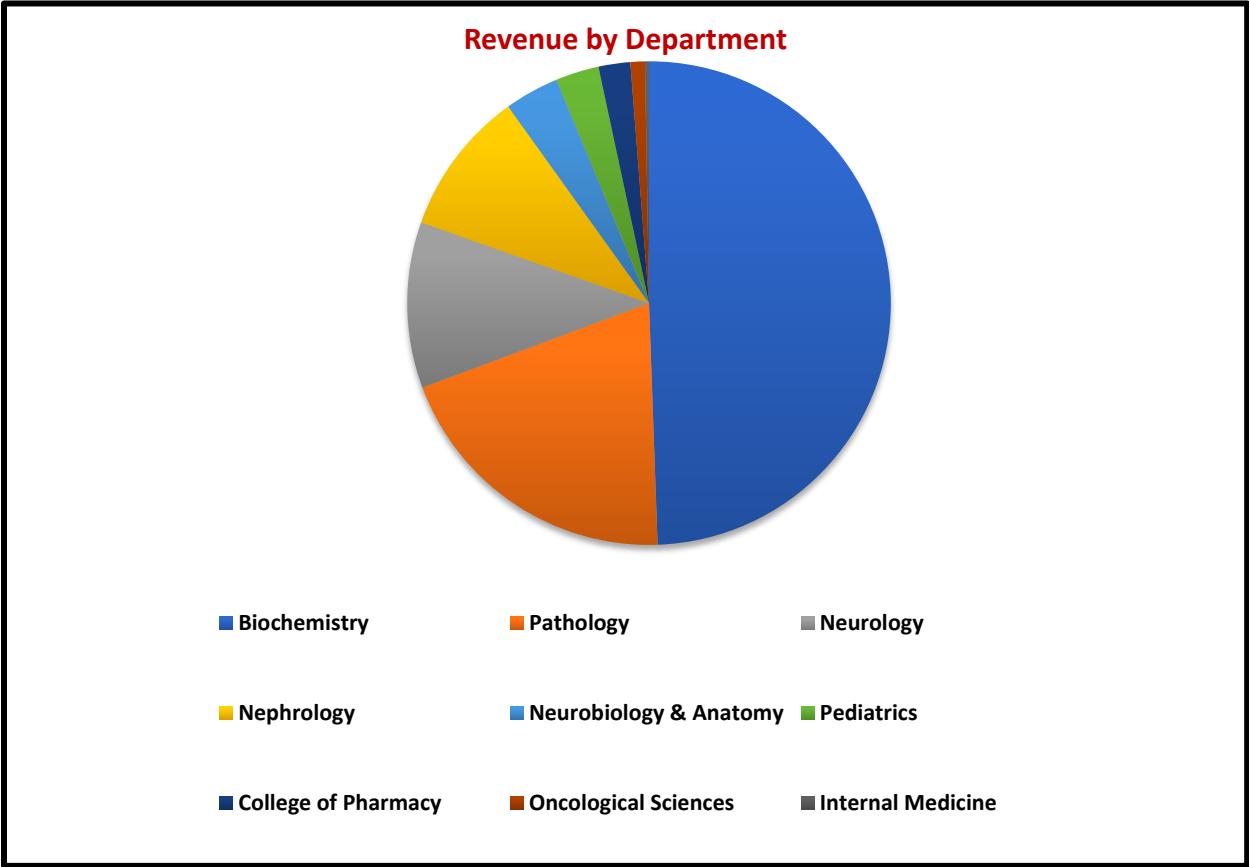
- Darrell Davis, Professor, College of Pharmacy
- Ryan Looper, Associate Professor, Chemistry Department
- John Phillips, Professor, Internal Medicine
- Jared Rutter, Professor, Department of Biochemistry
- Bryan Welm, Associate Professor, HCI

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Rutter, Jared	Department
2	Haeckler, Hans	NIH
3	Penovich, Wanda	Department
4	Yang, Tianxin	NIH
5	Evason, Kimberly	Damon Runyon Cancer Research FTD
6	Shepherd, Jason	E Matilida Ziegler FTD, Silicon Valley Comm. FTD
7	Sherwin, Catherine	Department
8	Franzini, Raphael	Department, NIH
9	Gertz, Jason	Department
10	Kuda Therapeutics LLC	Commercial

Goals for FY22

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

Publications

No publications acknowledged this facility in FY21.

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

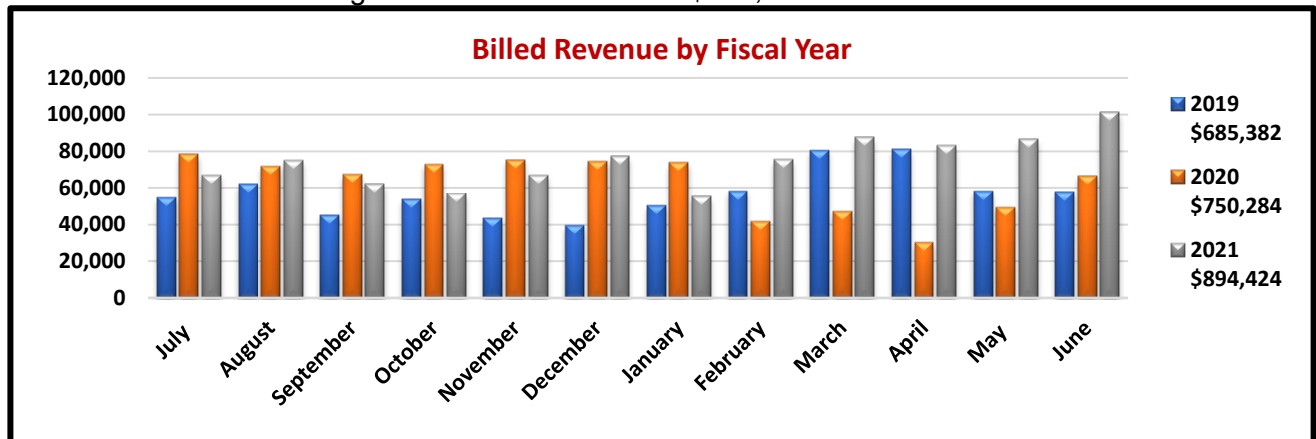
2021 Annual Update

Revenue/Expenses

FY21 Expenses: Total \$841,667

FY21 Revenue: Total \$944,424

- VP of Health Sciences Support: \$20,000
- VP of Research Support : \$30,000
- FY21 Revenue generated from services: \$894,424



*Legend displays total annual revenue by year earned.

Advisory Board Committee

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

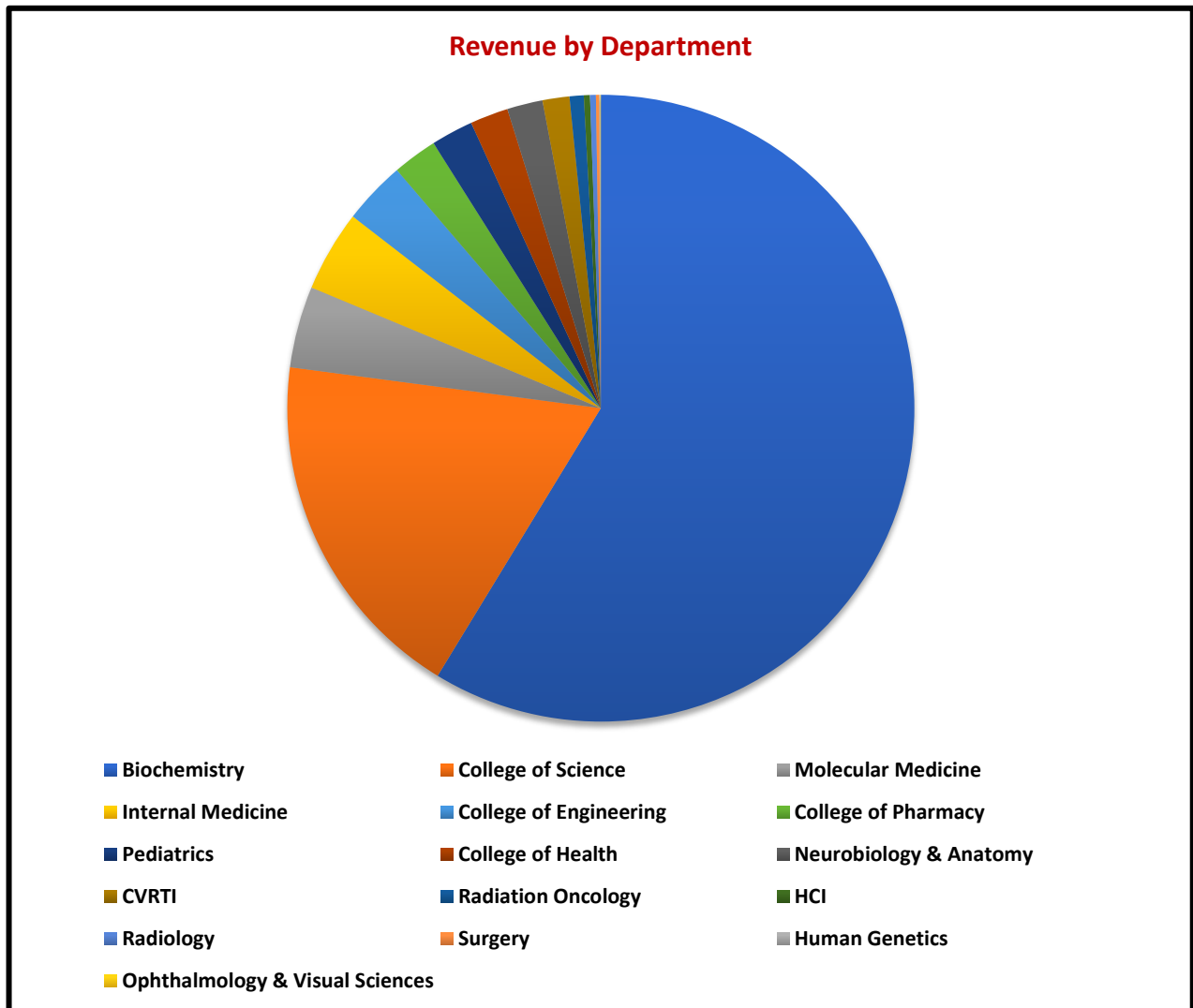
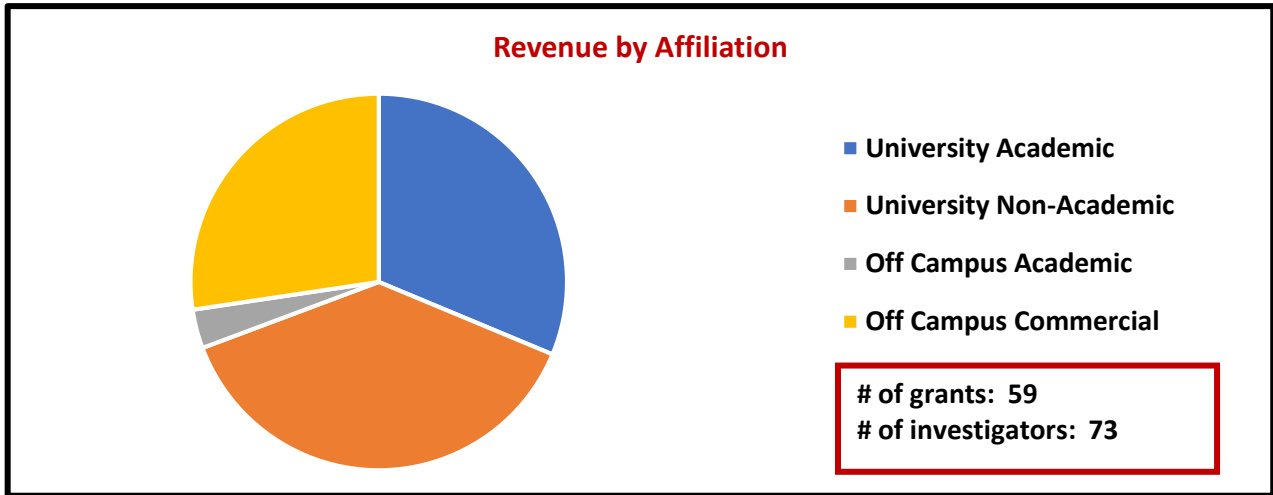
- Erik Jorgensen, Distinguished Professor, Department of Biology
- Patricia Revelo, Professor, Department of Pathology
- Erhu Cao, Assistant Professor, Department of Biochemistry
- Richard Rabbitt, Professor, Department of Bioengineering

Cryo-EM Implementation Committee

Last meeting date: April 8, 2021.

- 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

**FY21 Scientific Impact
Research Support
Revenue Generated (see charts following):**



Top Users

1	ARUP	University Non-Academic
2	Bristol-Myers Squibb	Off Campus Commercial
3	Shen, Peter	Department, BYU, NIH
4	Saint John’s Medical Center	Off Campus Commercial
5	Sundquist, Wesley	Department, NIH
6	Science Exchange	Commercial
7	Cao, Erhu	Department, NIH
8	Primary Children’s Medical Center	Commercial
9	Vir Biotechnology	Commercial
10	EVOQ Nano	Commercial

Goals for FY22

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

Publications

No known publications acknowledged this facility in FY 21.

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

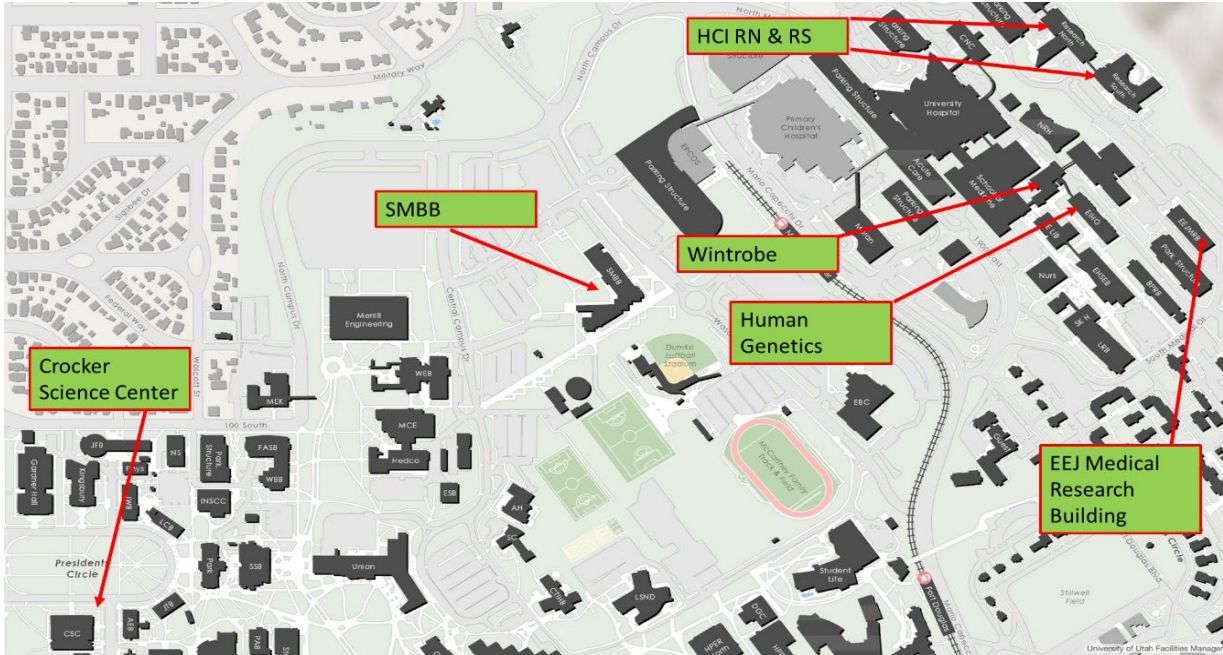
Personnel

- James Marvin, Director
- Tessa Galland, Senior Lab Technician
- Kirk Heitpas, Lab Technician
- Josh Monts, Senior Lab Technician
- Vimal Kaliraj, Lab Technician
- Ashley Taylor, Senior Lab Specialist
- Elijah Counterman, Lab Technician

FY21 Annual Update

New Equipment

Compared to other years, FY21 was a relatively quiet year for new equipment. The Pathology department added a 4 laser Beckman Coulter Cytoflex which we will manage along with their other instruments. In addition, the NIH Shared Instrumentation Grant for an Amnis Imagestream was funded with instrument installation taking place in September of 2020.



Staffing

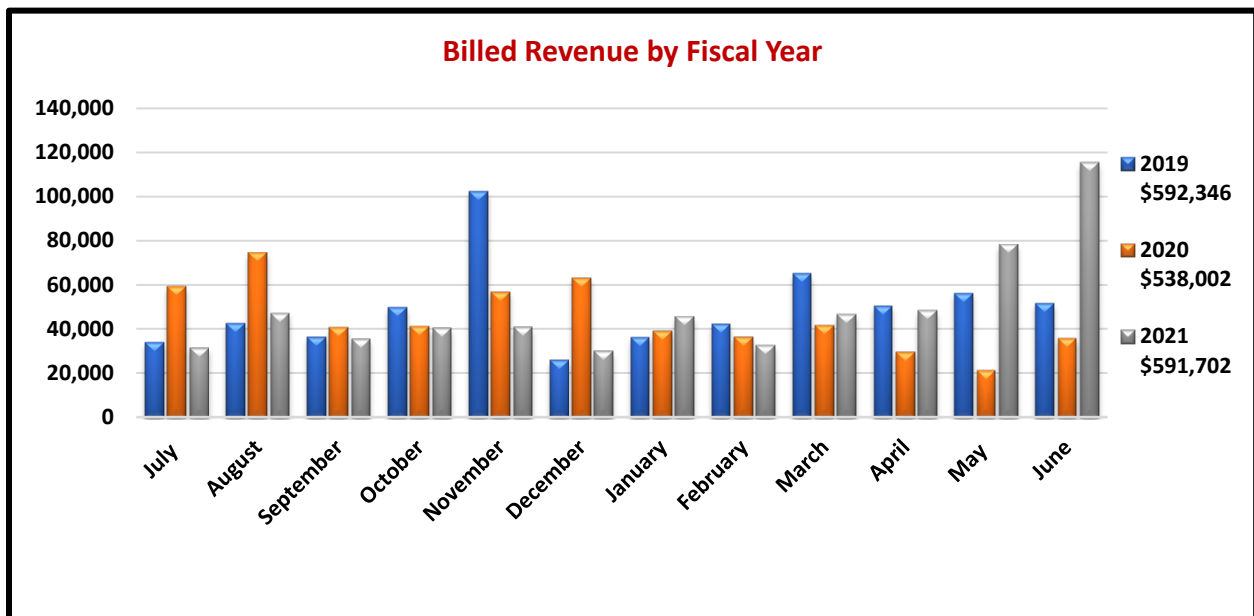
There have been significant staffing changes in the Flow Core in FY21. Nidhi Choksi has left the lab and Kirk Heitpas dropped to part time. We also added Vimal Kaliraj and Ashley Taylor in early 2021.

Revenue/Expenses

FY21 Expenses: Total \$618,708

FY21 Revenue: Total \$591,702

- FY21 Revenue generated from services: \$591,702



* Total annual revenue displayed in legend.

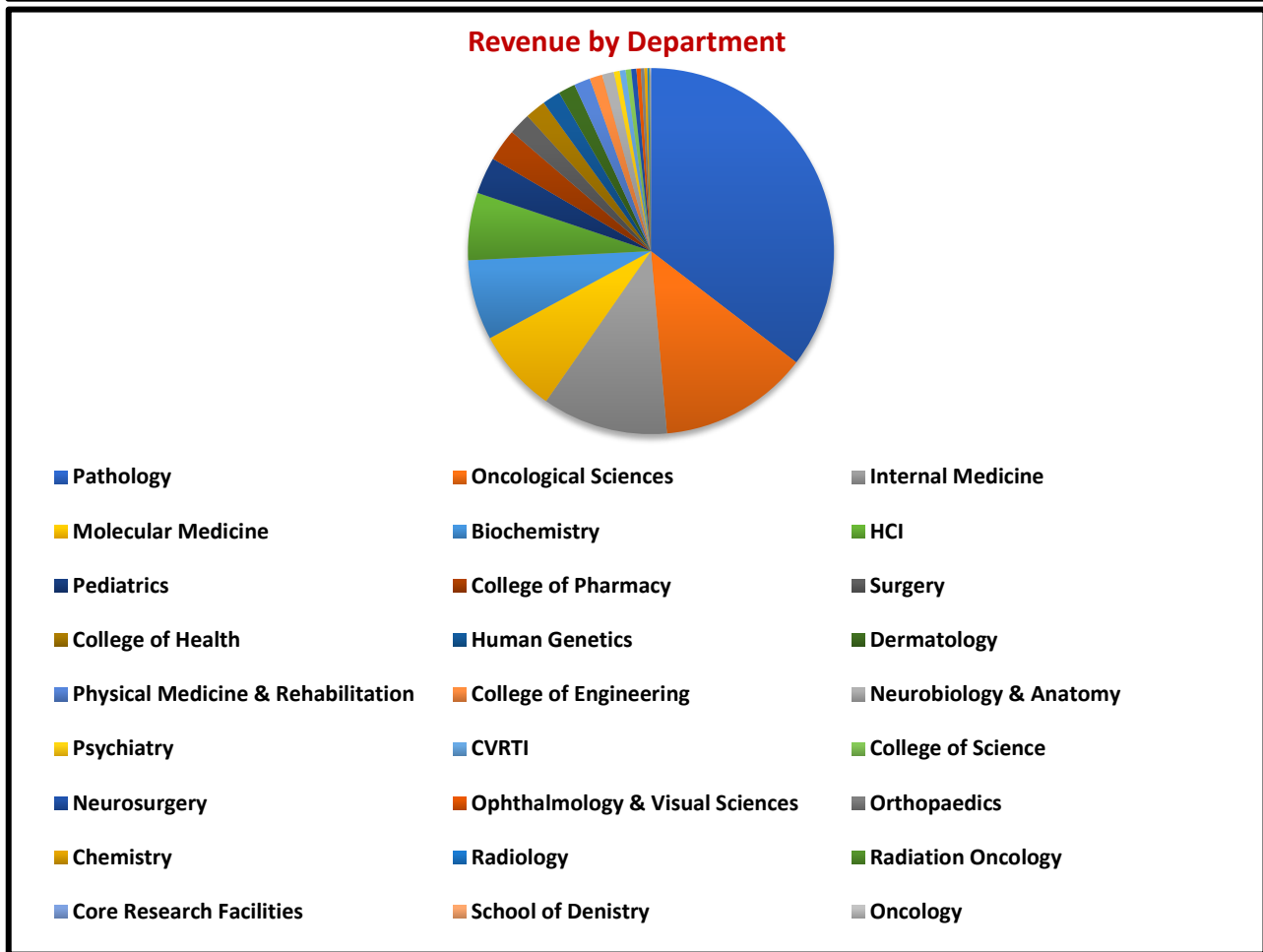
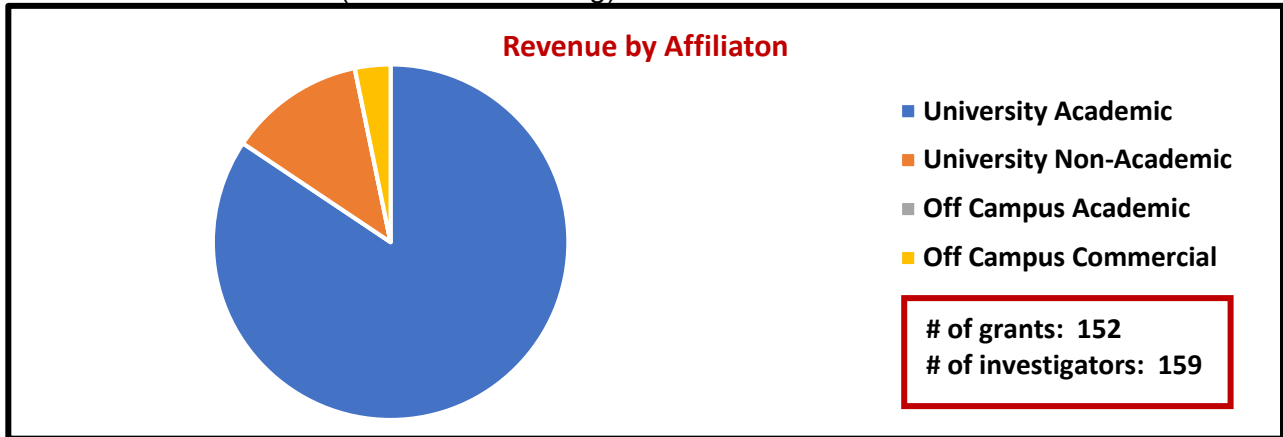
Advisory Board Committee

Last meeting date: June 16, 2021

- Matthew Williams, Assistant Professor, Pathology Advisory Board Chair
- Ryan O’Connell, Assistant Professor, Pathology
- Anna Beaudin, Assistant Professor, Hem and Hem Malignancies
- Daniel Leung, Assistant Professor, Internal Medicine
- Alessandro Venosa, Assistant Professor, Pharm and Toxicology

**FY21 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Top Users

1	Williams, Matthew	Department, NIH
2	ARUP	University Non-Academic
3	Deininger, Michael	Alex's Lemonade Stand FTD, Department, NIH, Pfizer, V FTD for Cancer Research
4	Beaudin, Anna	Department, NIH, PEW Charitable Trust
5	Leung, Daniel	NIH
6	Evavold, Brian	Department
7	Welm, Alana	Department, DOD, NIH
8	Roh-Johnson, Minna	NIH, DOD, Department, MaryKay Ash Charitable FTD
9	Schiffman, Joshua	Department, Arizona State University
10	Rondina, Matthew	NIH

Goals for FY21

FY21 looks to be another year of instrumentation proliferation. There are a number of cell sorters that will likely be purchased. This will involve a very uncertain amount of staffing to provide training and resources for these instruments. But thankfully current levels of staffing and expertise should make this feasible. There is also a possibility of adding a Fluidigm CyTOF Mass Cytometer. This will demand a fair amount of learning and training along with panel design and antibody conjugations. But again, we are situated well to take on this extra work load.

Publications

- Arveseth, C. D., J. T. Happ, D. S. Hedeem, J. F. Zhu, J. L. Capener, D. Klatt Shaw, I. Deshpande, J. Liang, J. Xu, S. L. Stubben, I. B. Nelson, M. F. Walker, K. Kawakami, A. Inoue, N. J. Krogan, D. J. Grunwald, R. Huttenhain, A. Manglik and B. R. Myers (2021). "Smoothed transduces Hedgehog signals via activity-dependent sequestration of PKA catalytic subunits." *PLoS Biol* **19**(4): e3001191. DOI: 10.1371/journal.pbio.3001191.
- Bhatlekar, S., B. K. Manne, I. Basak, L. C. Edelstein, E. Tugolukova, M. L. Stoller, M. J. Cody, S. C. Morley, S. Nagalla, A. S. Weyrich, J. W. Rowley, R. M. O'Connell, M. T. Rondina, R. A. Campbell and P. F. Bray (2020). "miR-125a-5p regulates megakaryocyte proplatelet formation via the actin-bundling protein L-plastin." *Blood* **136**(15): 1760-1772. DOI: 10.1182/blood.2020005230.
- Camolotto, S. A., V. K. Belova, L. Torre-Healy, J. M. Vahrenkamp, K. C. Berrett, H. Conway, J. Shea, C. Stubben, R. Moffitt, J. Gertz and E. L. Snyder (2021). "Reciprocal regulation of pancreatic ductal adenocarcinoma growth and molecular subtype by HNF4alpha and SIX1/4." *Gut* **70**(5): 900-914. DOI: 10.1136/gutjnl-2020-321316.
- Campbell, R. A., H. D. Campbell, J. S. Bircher, C. V. de Araujo, F. Denorme, J. L. Crandell, J. L. Rustad, J. Monts, M. J. Cody, Y. Kosaka and C. C. Yost (2021). "Placental HTRA1 cleaves alpha-1-antitrypsin to generate a NET-Inhibitory Peptide." *Blood*. DOI: 10.1182/blood.2020009021.
- Denorme, F., B. K. Manne, I. Portier, A. C. Petrey, E. A. Middleton, B. T. Kile, M. T. Rondina and R. A. Campbell (2020). "COVID-19 patients exhibit reduced procoagulant platelet responses." *J Thromb Haemost* **18**(11): 3067-3073. DOI: 10.1111/jth.15107.
- Feusier, J. E., S. Arunachalam, T. Tashi, M. J. Baker, C. VanSant-Webb, A. Ferdig, B. E. Welm, J. L. Rodriguez-Flores, C. Ours, L. B. Jorde, J. T. Prchal and C. C. Mason (2021). "Large-Scale Identification of Clonal Hematopoiesis and Mutations Recurrent in Blood Cancers." *Blood Cancer Discov* **2**(3): 226-237. DOI: 10.1158/2643-3230.bcd-20-0094.
- Gardner, M., J. E. Turner, O. A. Youssef and S. Cheshier (2020). "In Vitro Macrophage-Mediated Phagocytosis Assay of Brain Tumors." *Cureus* **12**(10): e10964. DOI: 10.7759/cureus.10964.
- Gordeuk, V. R., B. N. Shah, X. Zhang, P. E. Thuma, S. Zulu, R. Moono, N. S. Reading, J. Song, Y. Zhang, M. Nouraie, A. Campbell, C. P. Minniti, S. R. Rana, D. S. Darbari, G. J. Kato, M. Niu, O. L. Castro, R. Machado, M. T. Gladwin and J. T. Prchal (2020). "The CYB5R3(c) (.350C>G) and G6PD A alleles modify severity of anemia in malaria and sickle cell disease." *Am J Hematol* **95**(11): 1269-1279. DOI: 10.1002/ajh.25941.
- Guo, L., S. Shen, J. W. Rowley, N. D. Tolley, W. Jia, B. K. Manne, K. N. McComas, B. Bolingbroke, Y. Kosaka, K. Krauel, F. Denorme, S. P. Jacob, A. S. Eustes, R. A. Campbell, E. A. Middleton, X. He, S. M.

- Brown, C. N. Morrell, A. S. Weyrich and M. T. Rondina (2021). "Platelet MHC Class I Mediates CD8+ T Cell Suppression During Sepsis." *Blood*. DOI: 10.1182/blood.2020008958.
10. Kim, H., J. Perovanovic, A. Shakya, Z. Shen, C. N. German, A. Ibarra, J. L. Jafek, N. P. Lin, B. D. Evavold, D. H. Chou, P. E. Jensen, X. He and D. Tantin (2021). "Targeting transcriptional coregulator OCA-B/Pou2af1 blocks activated autoreactive T cells in the pancreas and type 1 diabetes." *J Exp Med* **218**(3). DOI: 10.1084/jem.20200533.
 11. Manne, B. K., F. Denorme, E. A. Middleton, I. Portier, J. W. Rowley, C. Stubben, A. C. Petrey, N. D. Tolley, L. Guo, M. Cody, A. S. Weyrich, C. C. Yost, M. T. Rondina and R. A. Campbell (2020). "Platelet gene expression and function in patients with COVID-19." *Blood* **136**(11): 1317-1329. DOI: 10.1182/blood.2020007214.
 12. Middleton, E. A., X. Y. He, F. Denorme, R. A. Campbell, D. Ng, S. P. Salvatore, M. Mostyka, A. Baxter-Stoltzfus, A. C. Borczuk, M. Loda, M. J. Cody, B. K. Manne, I. Portier, E. S. Harris, A. C. Petrey, E. J. Beswick, A. F. Caulin, A. Iovino, L. M. Abegglen, A. S. Weyrich, M. T. Rondina, M. Egeblad, J. D. Schiffman and C. C. Yost (2020). "Neutrophil extracellular traps contribute to immunothrombosis in COVID-19 acute respiratory distress syndrome." *Blood* **136**(10): 1169-1179. DOI: 10.1182/blood.2020007008.
 13. Scott, T. A., D. O'Meally, N. A. Grepo, C. Soemardy, D. C. Lazar, Y. Zheng, M. S. Weinberg, V. Planelles and K. V. Morris (2021). "Broadly active zinc finger protein-guided transcriptional activation of HIV-1." *Mol Ther Methods Clin Dev* **20**: 18-29. DOI: 10.1016/j.omtm.2020.10.018.
 14. Thiagarajan, P., C. J. Parker and J. T. Prchal (2021). "How Do Red Blood Cells Die?" *Front Physiol* **12**: 655393. DOI: 10.3389/fphys.2021.655393.
 15. Trivedi, S., T. Afroz, M. S. Bennett, K. Angell, F. Barros, R. A. Nell, J. Ying, A. M. Spivak and D. T. Leung (2021). "Diverse Mucosal-Associated Invariant TCR Usage in HIV Infection." *Immunohorizons* **5**(5): 360-369. DOI: 10.4049/immunohorizons.2100026.
 16. Trivedi, S., A. H. Grossmann, O. Jensen, M. J. Cody, T. A. Wahlig, P. Hayakawa Serpa, C. Langelier, K. J. Warren, C. C. Yost and D. T. Leung (2021). "Intestinal Infection Is Associated With Impaired Lung Innate Immunity to Secondary Respiratory Infection." *Open Forum Infect Dis* **8**(6): ofab237. DOI: 10.1093/ofid/ofab237.
 17. Trivedi, S., D. Labuz, C. P. Anderson, C. V. Araujo, A. Blair, E. A. Middleton, O. Jensen, A. Tran, M. A. Mulvey, R. A. Campbell, J. S. Hale, M. T. Rondina and D. T. Leung (2020). "Mucosal-associated invariant T (MAIT) cells mediate protective host responses in sepsis." *Elife* **9**. DOI: 10.7554/eLife.55615.
 18. Wuren, T., T. Huecksteadt, E. Beck, K. Warren, J. Hoidal, S. Ostrand-Rosenberg and K. Sanders (2021). "The receptor for advanced glycation endproducts (RAGE) decreases survival of tumor-bearing mice by enhancing the generation of lung metastasis-associated myeloid-derived suppressor cells." *Cell Immunol* **365**: 104379. DOI: 10.1016/j.cellimm.2021.104379.
 19. Zewdu, R., E. M. Mehrabad, K. Ingram, P. Fang, K. L. Gillis, S. A. Camolotto, G. Orstad, A. Jones, M. C. Mendoza, B. T. Spike and E. L. Snyder (2021). "An NKX2-1/ERK/WNT feedback loop modulates gastric identity and response to targeted therapy in lung adenocarcinoma." *Elife* **10**. DOI: 10.7554/eLife.66788.
 20. Zheng, Y., H. L. Schubert, P. K. Singh, L. J. Martins, A. N. Engelman, I. D'Orso, C. P. Hill and V. Planelles (2021). "Cleavage and Polyadenylation Specificity Factor 6 Is Required for Efficient HIV-1 Latency Reversal." *mBio* **12**(3): e0109821. DOI: 10.1128/mBio.01098-21.

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

2021 Annual Update

New Equipment

- The Genomics Facility did not acquire new equipment in FY21

New Services

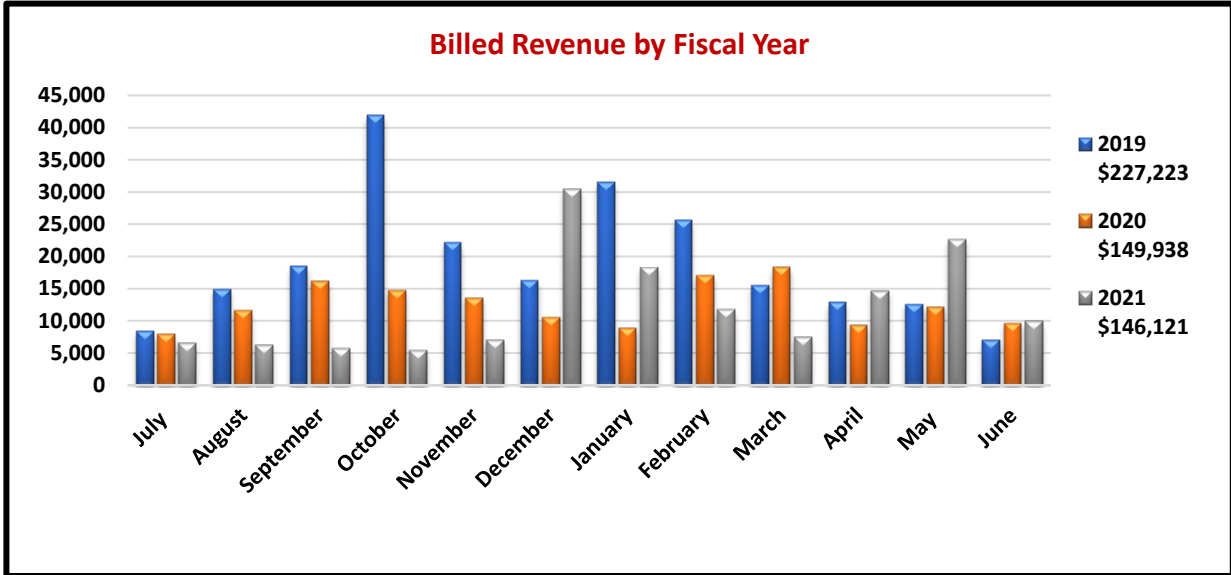
- The Genomics Facility did not implement additional services in FY21

Revenue/Expenses

FY21 Expenses: Total \$134,929

FY21 Revenue: Total \$146,121

- VP of Health Sciences Support: 0
- FY21 Revenue generated from services: \$146,121



* Legend displays total annual billed revenue by year.

Advisory Board Committee

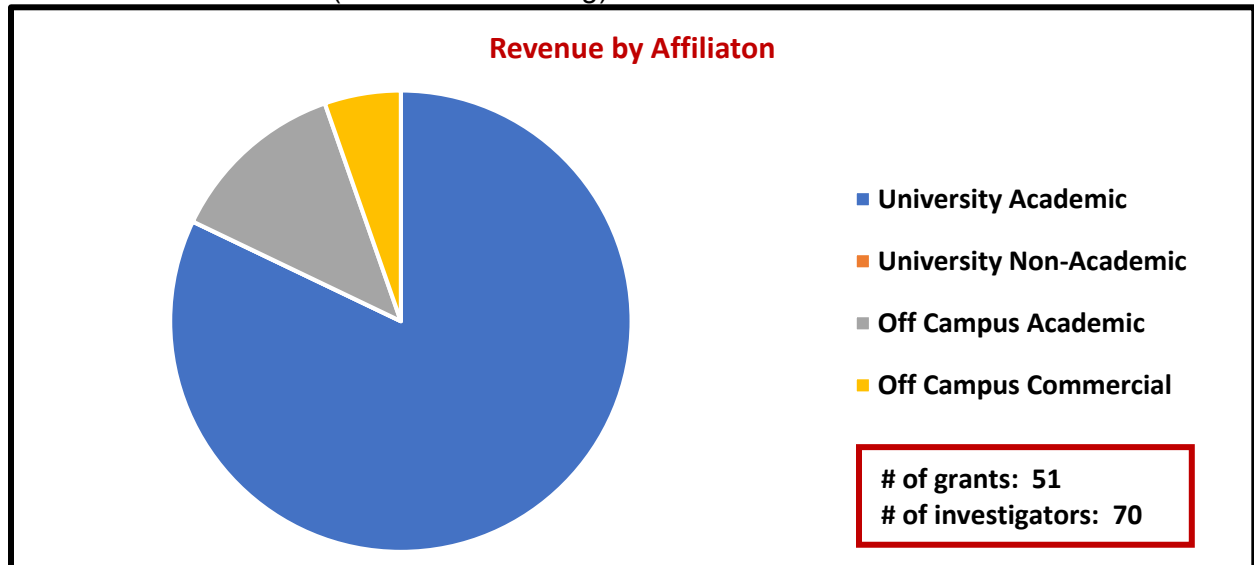
Last meeting date: July 6th, 2021

- Gerald Krueger, Professor, Dermatology
- Deborah Neklason, Research Associate Professor, Huntsman Cancer Institute
- Nicola Camp, Professor, Department of Pathology

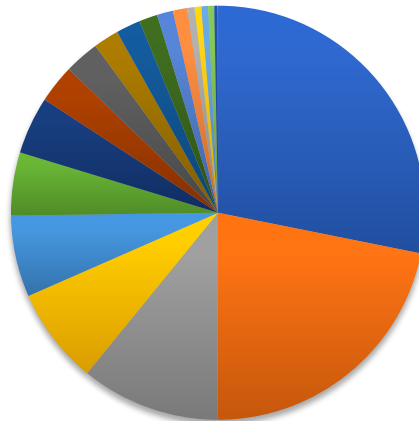
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Internal Medicine
- Neurology
- Obstetrics & Gynecology
- College of Health
- Human Genetics
- Molecular Medicine
- HCI
- Orthopaedics
- CVRTI
- Pediatrics
- Surgery
- College of Science
- Neurobiology & Anatomy
- Nutrition & Integrative Physiology
- Pathology
- College of Pharmacy
- College of Engineering
- Biochemistry
- Core Research Facilities
- Psychiatry

Top Users

1	Cannon-Albright, Lisa	Department, BYU, US Army Medical Research
2	Penovich, Wanda	Department
3	Jenkins, Tim	BYU
4	Silver, Robert	R Baby FTD
5	Weiss, Bob	University of Massachusetts, Department
6	Holland, William	Department, NIH
7	Summers, Scott	NIH, American Diabetes Assoc., Potrero Hill Therapeutics
8	Welm, Bryan	NIH
9	Jones, Kevin	NIH
10	Boudina, Sihem	Department, NIH

Publications

- Li, J., T. S. Mulvihill, L. Li, J. J. Barrott, M. L. Nelson, L. Wagner, I. C. Lock, A. Pozner, S. L. Lambert, B. B. Ozenberger, M. B. Ward, A. H. Grossmann, T. Liu, A. Banito, B. R. Cairns and K. B. Jones (2021). "A role for SMARCB1 in synovial sarcomagenesis reveals that SS18-SSX induces canonical BAF destruction." Cancer Discov. DOI: 10.1158/2159-8290.CD-20-1219.

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 Tormach lathe and manual Lathes
- CNC routing services and sign making capabilities
- Laser cutting and engraving services, 3D printing
- Silver soldering and brazing
- MIG, TIG, welding of steel, aluminum, and other types of fabrication
- Anodizing, powder coating and laser cutting project assistance.
- Repair and maintenance of specialty surgery equipment
- Fast surgery tool replication/modifications
- Onsite assessments, pickup, delivery of equipment and repairs

Equipment

- Two CNC mills
- One Shapeoko XL CNC Router
- One Matter Hackers Pulse XE 3D printer
- Two traditional mills
- Four manual lathes
- Two laser cutter/engraving machines.
- Grinders
- MIG, TIG, gas, arc, and spot welders
- Wood working equipment
- Band & table saws
- Polishing equipment

Personnel

- Shawn Colby, Machinist, Director
- Joshua Tenny, Machinist, Surgery Tool Repair Specialist

**2021 Annual Update
New Equipment**

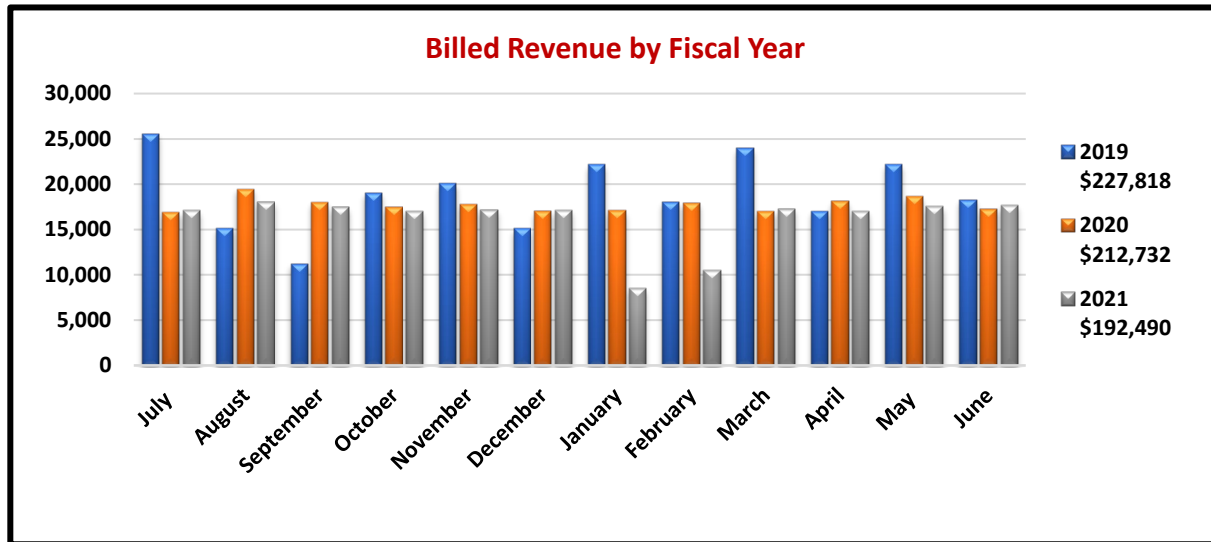
- One Matter Hackers Pulse XE 3D printer
- One Shapeoko XL CNC router
- One 50 watt laser cutter

Revenue/Expenses

FY21 Expenses: Total \$195,796

FY21 Revenue: Total \$242,490

- VP of Health Sciences Support: \$50,000
- FY21 Revenue generated from services: \$192,490



* Legend displays total annual revenue by year generated.

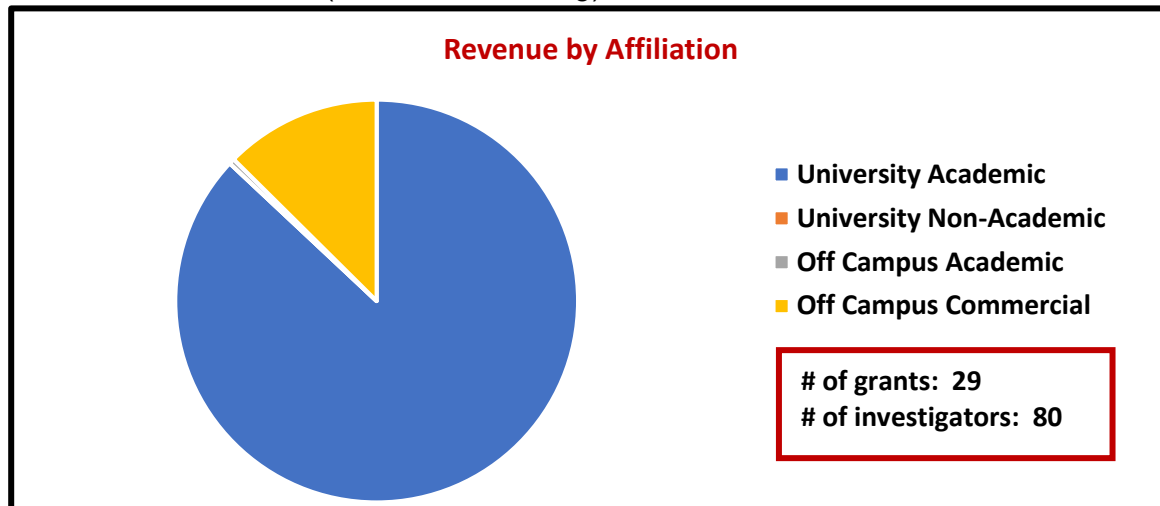
Advisory Board Committee

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

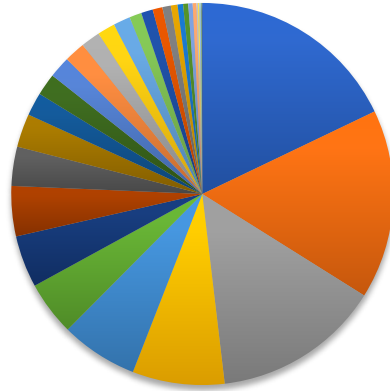
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Perioperative Services
- Surgical Services Hospital
- Orthopaedics
- Oncological Sciences
- Radiation Oncology
- Pathology
- Neurosurgery
- Biochemistry
- Internal Medicine
- Physical Medice & Rehab
- Pediatrics
- Neurobiology & Anatomy
- Sterile Processing
- Neurology
- University Pharmacy
- College of Science
- College of Engineering
- U of U Hospital
- Facilities & Engineering
- Core Research Facilities
- Ophthalmology & Visual Sciences
- Radiology
- College of Pharmacy
- Molecular Medicine
- College of Health
- Human Genetics
- Materials Management
- Mines & Earth Sciences
- Emergency Department
- HSC Cores Facilities
- Dermatology

Top Users

1	Hiatt, Catherine	Department
2	Henderson, Joey	Department
3	Kiev, Brent	HCI
4	Kingstedt, Owen	DOD, DOE
5	Van, Edmond	Department
6	Peacock, Darren	Department
7	Dalley, Brian	HCI
8	Primary Children's Medical CTR	Commercial
9	Active Medical Arthrex	Department
10	Czabaj, Michael	Michigan Technological University, Wichita State University

Publications

No publications acknowledged this facility in FY21.

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
- Special Project/Method Development

Equipment

Mass Spectrometers

- Thermo QExactive HF for proteomics
- Bruker Maxis II HD for high mass accuracy intact protein and small molecule analysis.

HPLC Systems

- Agilent 1260 Preparative HPLC for MudPIT peptide preparation

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

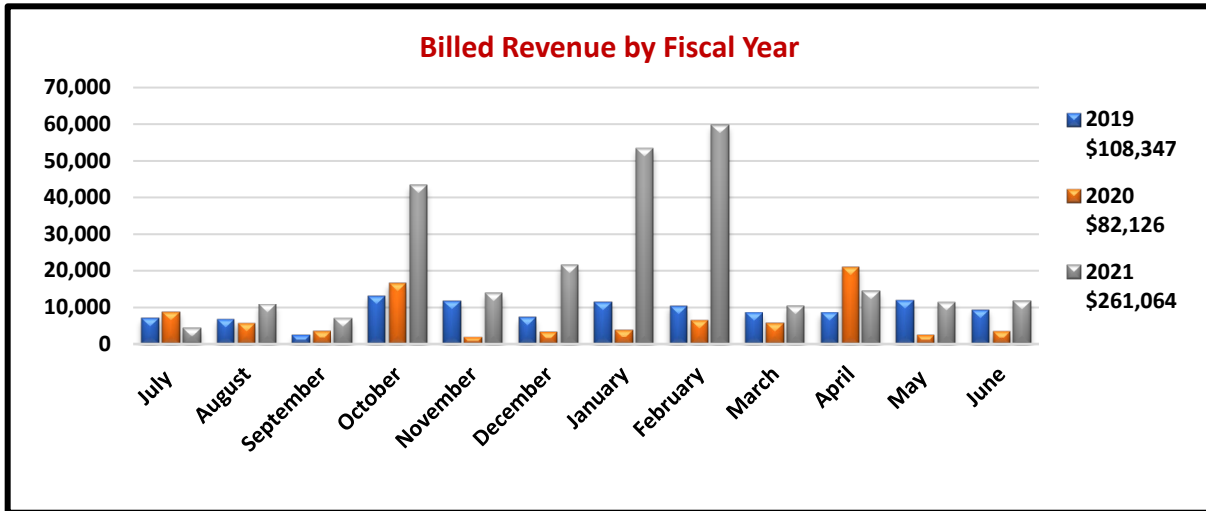
2021 Annual Update

Revenue/Expenses

FY21 Total Expenses: \$271,692

FY21 Revenue: Total \$406,064

- VP of Health Sciences Support: \$145,000
- FY21 revenue generated from services: \$261,064

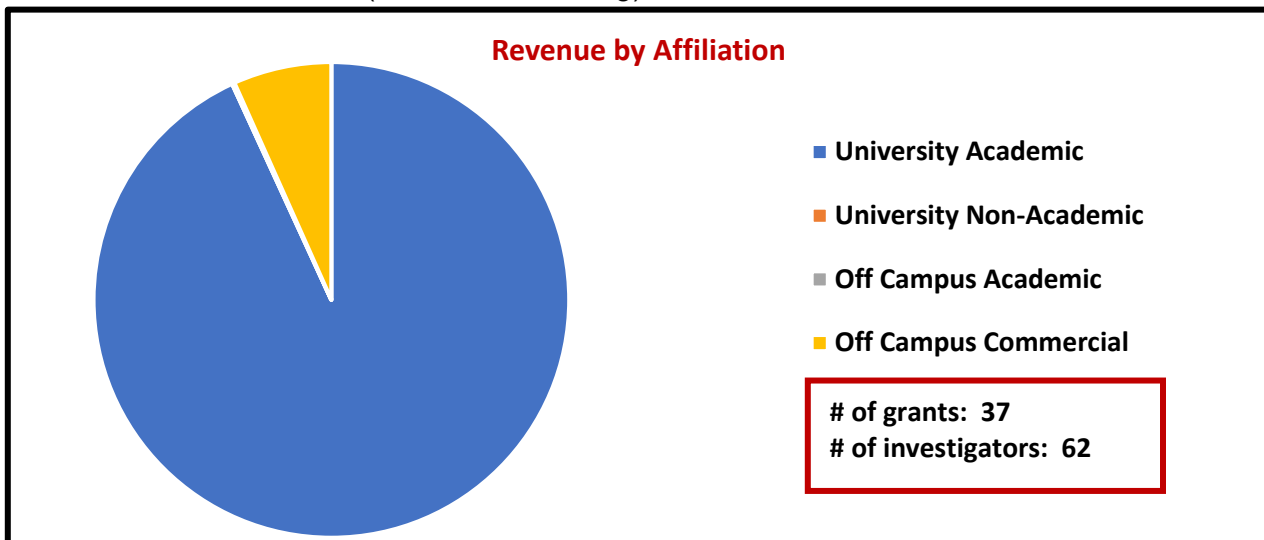


* Legend displays total annual revenue by year earned.

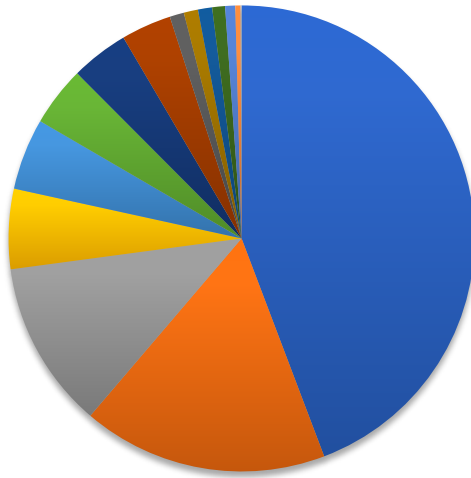
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- HCI
- Dermatology
- Internal Medicine
- Molecular Medicine
- Biochemistry
- College of Pharmacy
- Oncological Sciences
- College of Science
- Pathology
- College of Engineering
- Ophthalmology & Visual Sciences
- Psychiatry
- Human Genetics
- Core Research Facilities
- School of Denistry

Top Users

1	Ulrich, Neil	NIH
2	Feng, Bingjian	Department, Pfizer, Inc.
3	Peterson, Kathryn	Department
4	Yost, Christian	NIH
5	Olivera, Baldomero	US Army Medical Research
6	Sundquist, Wesley	Department, NIH
7	3Helix	Commercial
8	Zone, John	NIH
9	Tantin, Dean	NIH
10	Intronex LLC	Commercial

Publications

1. Bosse, G. D., C. Urcino, M. Watkins, P. Florez Salcedo, S. Kozel, K. Chase, A. Cabang, S. S. Espino, H. Safavi-Hemami, S. Raghuraman, B. M. Olivera, R. T. Peterson and J. Gajewiak (2021). "Discovery of a Potent Conoramide from *Conus episcopatus* Using a Novel Zebrafish Larvae Assay." J Nat Prod **84**(4): 1232-1243. DOI: 10.1021/acs.jnatprod.0c01297.
2. Liou, T. G., F. R. Adler, B. C. Cahill, D. R. Cox, J. E. Cox, G. J. Grant, K. E. Hanson, S. C. Hartsell, N. D. Hatton, M. N. Helms, J. L. Jensen, C. Kartsonaki, Y. Li, D. T. Leung, J. E. Marvin, E. A. Middleton, S. M. Osburn-Staker, K. A. Packer, S. M. Shakir, A. B. Sturrock, K. D. Tardif, K. J. Warren, L. J. Waddoups, L. J. Weaver, E. Zimmerman and R. Paine, 3rd (2021). "SARS-CoV-2 innate effector associations and viral load in early nasopharyngeal infection." Physiol Rep **9**(4): e14761. DOI: 10.14814/phy2.14761.

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, Director

2021 Annual Update**Equipment**

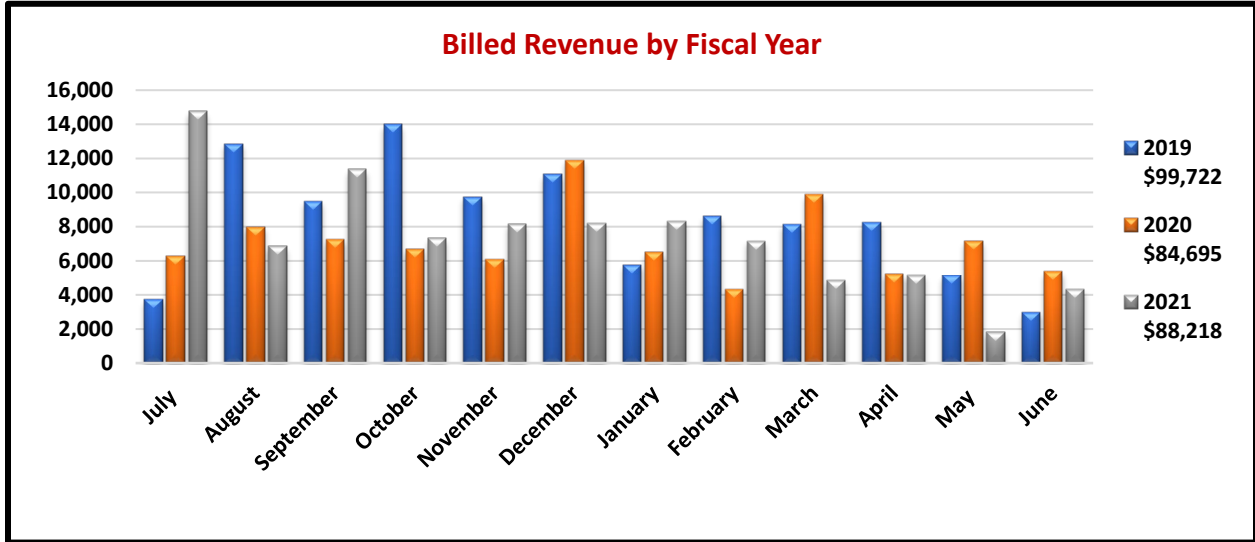
MPC has submitted a NIH R01 grant proposal for a state-of-the-art Promethion-Core system with environmental controls from Sable Systems International. Promethion-Core is a multiplex high definition indirect calorimetry system that measures and records metabolic, behavioral and physiological parameters simultaneously and continuously for up to 16 mice housed in the system. In vivo energy metabolism is determined by indirect calorimetry in unrestrained, conscious, unstressed mice. These studies yield quantitative measures of oxygen consumption (VO_2), carbon dioxide production (VCO_2), respiratory exchange ratio - an indicator of energy substrate utilization - total energy expenditure and body mass. It also records spontaneous and voluntary locomotor activity as well as caloric intake. It synchronizes metabolic data with physical activity, directly linking energy expenditure to accompanying physical activity. The metabolic chambers in the requested system are equipped with dual feeders and food access control which will be used for conducting yoked and paired feeding and to measure basal metabolic rate and dietary thermogenicity. These metabolic chambers are housed in a temperature-controlled cabinet, which allows precise control of experimental temperatures ranging from thermoneutral (30 °C) to cold temperatures (4 °C). This feature will be used for precise quantification of thermogenicity and capacity to generate heat from stored energy. The Promethion radiotelemetry module is capable of measuring physiological parameters such as core body temperature and heart rate. The Promethion-Core will be placed in the UofU-MPC, a comprehensive resource that provides internal and external investigators with access to state-of-the-art instruments and advanced metabolic phenotyping services for their rodent models.

Revenue/Expenses

FY21 Expenses: Total \$144,876

FY21 Revenue: Total \$158,218

- VP of Health Sciences Support: \$70,000
- FY21 revenue generated from services: \$88,218



* Legend displays total annual revenue by year earned.

Advisory Board Committee

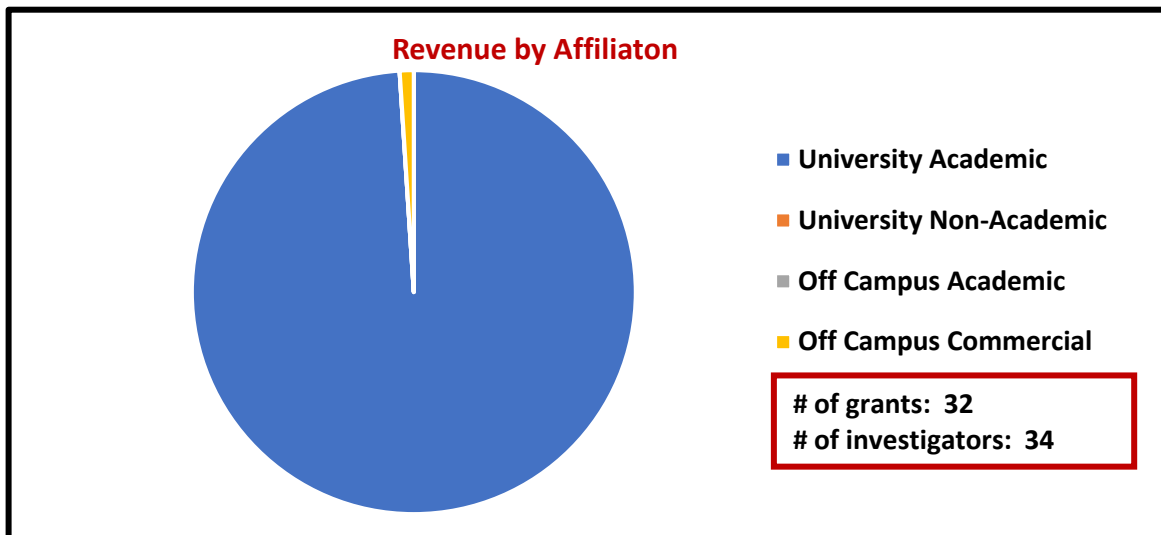
Last meeting date: March 8, 2019

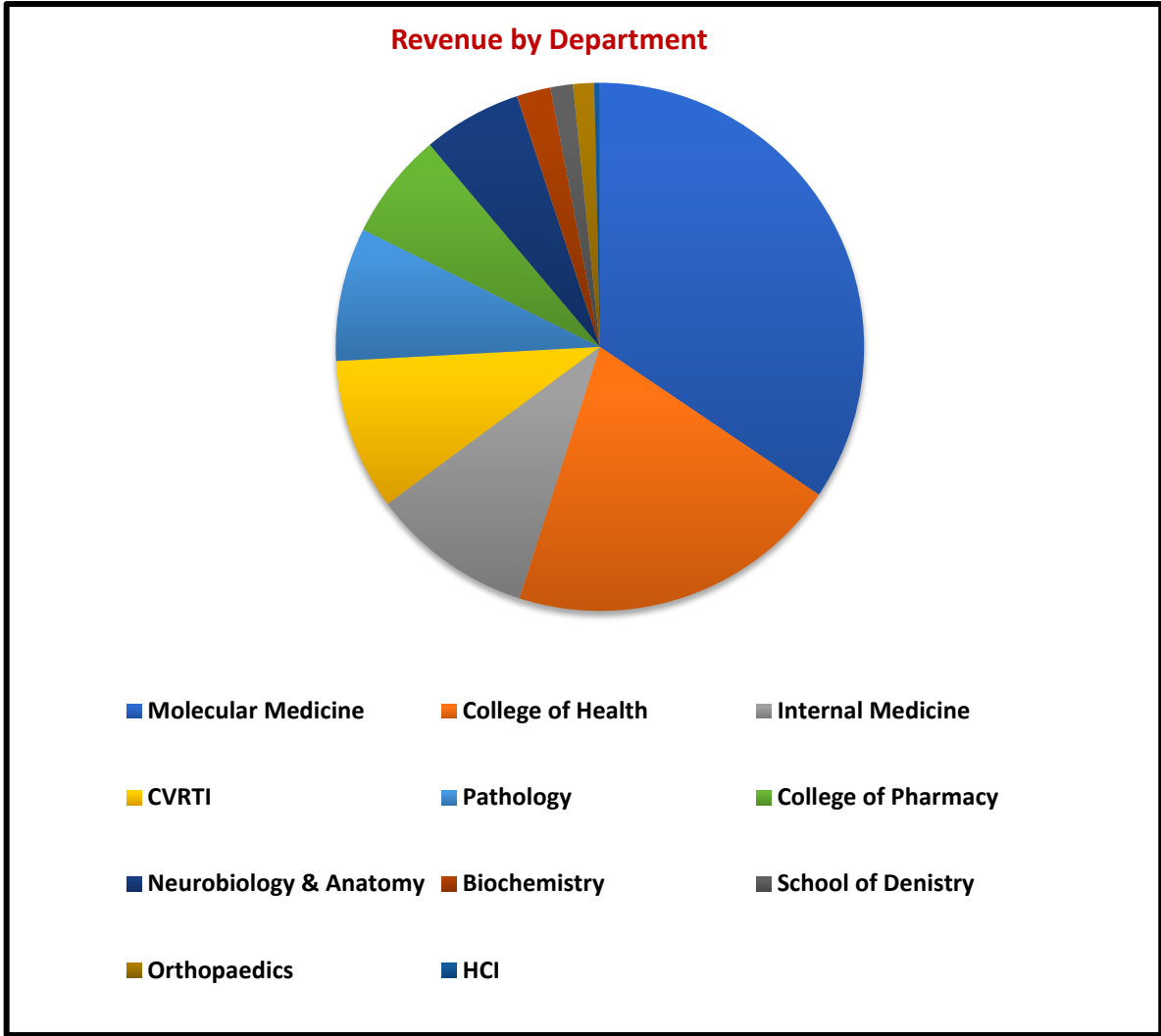
- Jared Rutter, Professor, Biochemistry
- Scott Summers, Professor, Nutrition and Integrative Physiology
- William Holland, Assistant Professor, Nutrition and Integrative Physiology
- Katsuhiko Funai, Assistant Professor, Physical Therapy and Athletic Training
- John Phillips, Professor, Director of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

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	Funai, Katsuhiko	Department, NIH
2	Summers, Scott	Potrero Hill Therapeutics
3	Boudina, Sihem	NIH, U of U Research FTD
4	Gregg, Christopher	NIH
5	Ramkumar, Nirupama	Department
6	Hong, TingTing	Department
7	Mimche, Patrice	Scleroderma FTD
8	Schlegel, Amnon	Washington University
9	Rowley, Jesse	NIH
10	Shaw, Robin	Department

Publications

1. Chaurasia, B., L. Ying, C. L. Talbot, J. A. Maschek, J. Cox, E. H. Schuchman, Y. Hirabayashi, W. L. Holland and S. A. Summers (2021). "Ceramide are necessary and sufficient for diet-induced impairment of thermogenic adipocytes." *Mol Metab* **45**: 101145. DOI: 10.1016/j.molmet.2020.101145.
2. Ferrara, P. J., X. Rong, J. A. Maschek, A. R. Verkerke, P. Siripoksup, H. Song, T. D. Green, K. C. Krishnan, J. M. Johnson, J. Turk, J. A. Houmard, A. J. Lusi, M. J. Drummond, J. M. McClung, J. E. Cox, S. R. Shaikh, P. Tontonoz, W. L. Holland and K. Funai (2021). "Lysophospholipid acylation modulates plasma membrane lipid organization and insulin sensitivity in skeletal muscle." *J Clin Invest* **131**(8). DOI: 10.1172/JCI135963.
3. Nowinski, S. M., A. Solmonson, S. F. Rusin, J. A. Maschek, C. L. Bensard, S. Fogarty, M. Y. Jeong, S. Lettlova, J. A. Berg, J. T. Morgan, Y. Ouyang, B. C. Naylor, J. A. Paulo, K. Funai, J. E. Cox, S. P. Gygi, D. R. Winge, R. J. DeBerardinis and J. Rutter (2020). "Mitochondrial fatty acid synthesis coordinates oxidative metabolism in mammalian mitochondria." *Elife* **9**. DOI: 10.7554/eLife.58041.
4. Ramkumar, N., D. Stuart, C. S. Peterson, C. Hu, W. Wheatley, J. Min Cho, J. D. Symons and D. E. Kohan (2021). "Loss of Soluble (Pro)renin Receptor Attenuates Angiotensin-II Induced Hypertension and Renal Injury." *Circ Res* **129**(1): 50-62. DOI: 10.1161/CIRCRESAHA.120.317532.

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 16 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 6545A Ultra Pressure Liquid Chromatograph-Quadrupole Time of Flight Mass-Spectrometer (UPLC-QToF-MS) for discovery lipidomics.
- Agilent 6545B 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
- Quentinn Pierce, BS, Technician

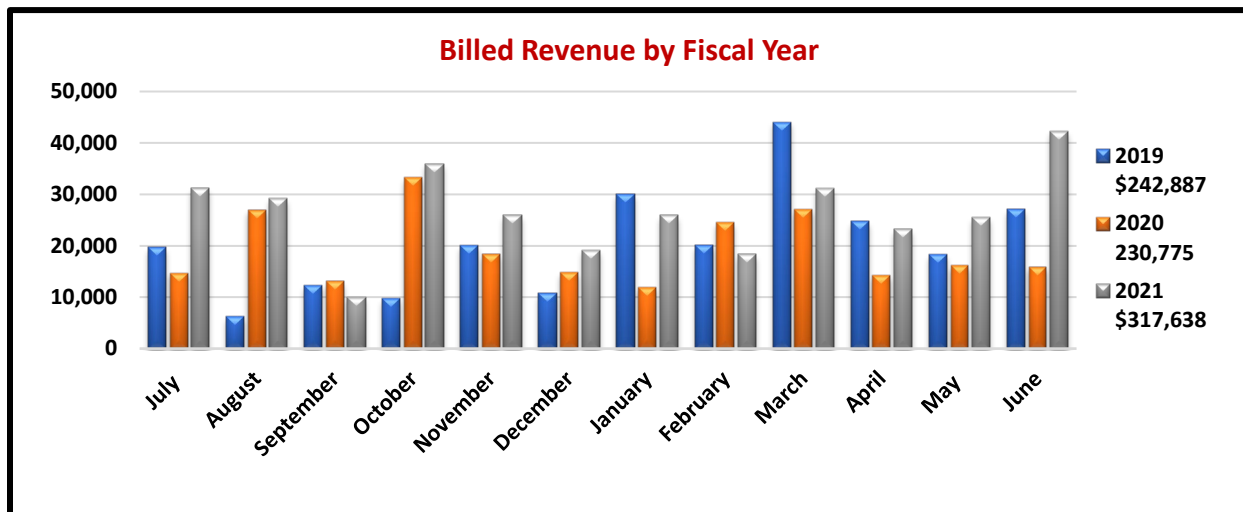
2021 Annual Update

Revenue/Expenses

FY21 Expenses: Total \$514,798

FY21 Revenue: Total \$557,638

- VP of Health Sciences Support: \$240,000
- FY21 Revenue generated from services: \$317,638



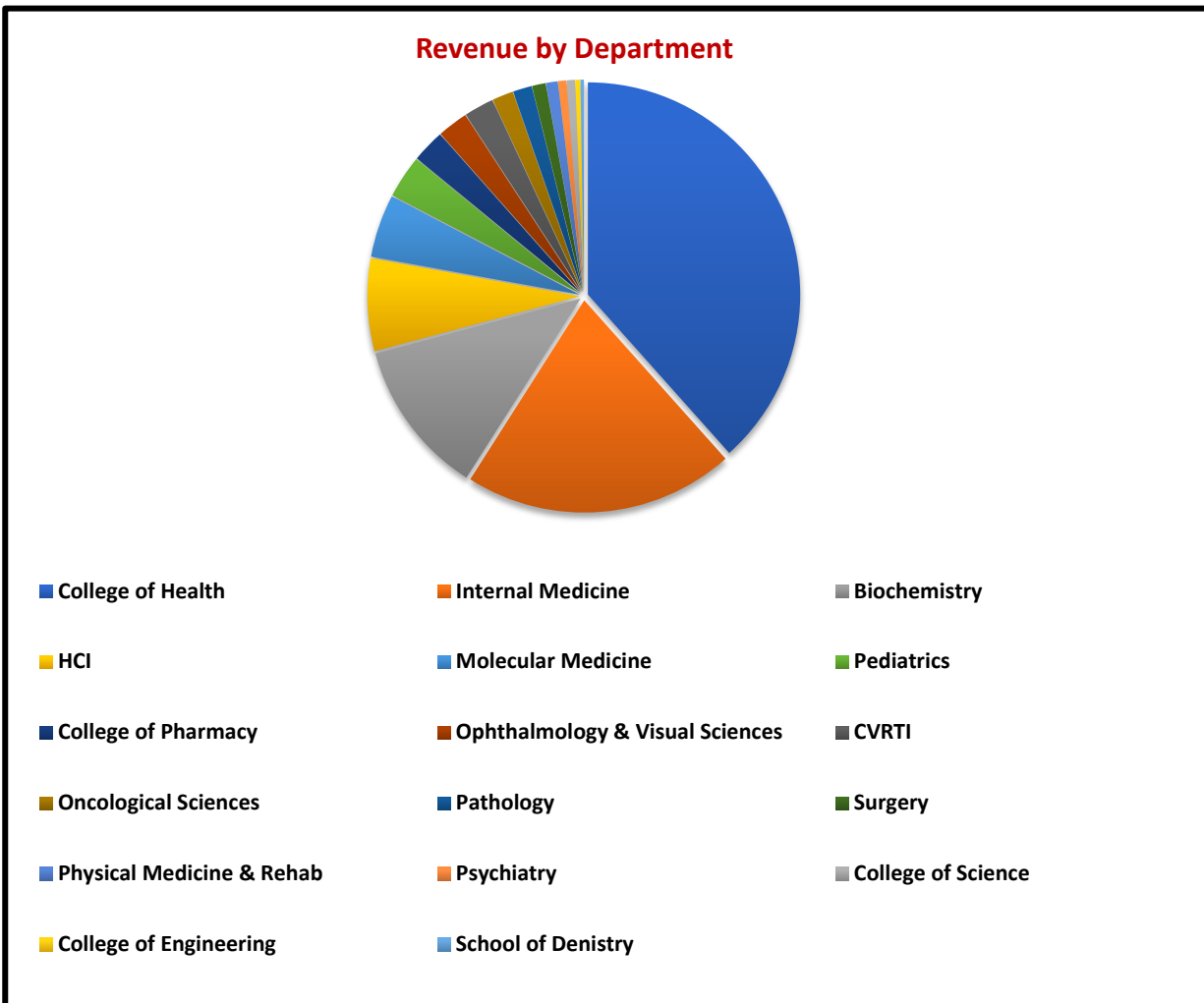
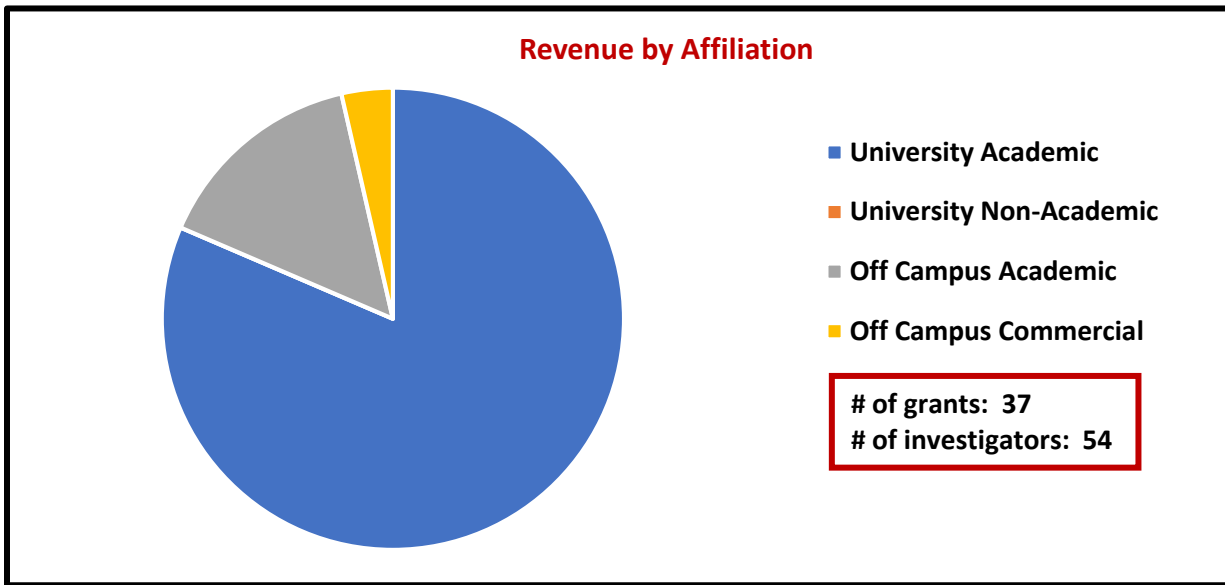
* Legend displays total annual revenue by year earned.

Advisory Board Committee

Last meeting date: August 23, 2021

- 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

**FY21 Scientific Impact
Research Support
Revenue Generated (see charts following):**



Top Users

1	Summers, Scott	Potrero Hill Therapeutics, NIH, American Diabetes Association
2	Phillips, John	Department, NIH
3	Holland, William	Department, NIH
4	Rutter, Jared	Department
5	Lu, Hui-Chen	Indiana University
6	Ulrich, Neil	NIH
7	Li, Ying	US Department of Agriculture
8	Funai, Katsuhiko	NIH
9	Simcox, Judith	University of Wisconsin
10	Shaw, Janet	HHMI

Publications

- Acoba, M. G., E. S. S. Alpergin, S. Renuse, L. Fernandez-Del-Rio, Y. W. Lu, O. Khalimonchuk, C. F. Clarke, A. Pandey, M. J. Wolfgang and S. M. Claypool (2021). "The mitochondrial carrier SFXN1 is critical for complex III integrity and cellular metabolism." *Cell Rep* **34**(11): 108869. DOI: 10.1016/j.celrep.2021.108869.
- Chaurasia, B., L. Ying, C. L. Talbot, J. A. Maschek, J. Cox, E. H. Schuchman, Y. Hirabayashi, W. L. Holland and S. A. Summers (2021). "Ceramide are necessary and sufficient for diet-induced impairment of thermogenic adipocytes." *Mol Metab* **45**: 101145. DOI: 10.1016/j.molmet.2020.101145.
- Cluntun, A. A., R. Badolia, S. Lettlova, K. M. Parnell, T. S. Shankar, N. A. Diakos, K. A. Olson, I. Taleb, S. M. Tatum, J. A. Berg, C. N. Cunningham, T. Van Ry, A. J. Bott, A. T. Krokidi, S. Fogarty, S. Skedros, W. I. Swiatek, X. Yu, B. Luo, S. Merx, S. Navankasattusas, J. E. Cox, G. S. Ducker, W. L. Holland, S. H. McKellar, J. Rutter and S. G. Drakos (2021). "The pyruvate-lactate axis modulates cardiac hypertrophy and heart failure." *Cell Metab* **33**(3): 629-648 e610. DOI: 10.1016/j.cmet.2020.12.003.
- Cortes-Selva, D., L. Gibbs, J. A. Maschek, M. Nascimento, T. Van Ry, J. E. Cox, E. Amiel and K. C. Fairfax (2021). "Metabolic reprogramming of the myeloid lineage by *Schistosoma mansoni* infection persists independently of antigen exposure." *PLoS Pathog* **17**(1): e1009198. DOI: 10.1371/journal.ppat.1009198.
- Ferrara, P. J., X. Rong, J. A. Maschek, A. R. Verkerke, P. Siripoksup, H. Song, T. D. Green, K. C. Krishnan, J. M. Johnson, J. Turk, J. A. Houmard, A. J. Lusic, M. J. Drummond, J. M. McClung, J. E. Cox, S. R. Shaikh, P. Tontonoz, W. L. Holland and K. Funai (2021). "Lysophospholipid acylation modulates plasma membrane lipid organization and insulin sensitivity in skeletal muscle." *J Clin Invest* **131**(8). DOI: 10.1172/JCI135963.
- Huffaker, T. B., H. A. Ekiz, C. Barba, S. H. Lee, M. C. Runtsch, M. C. Nelson, K. M. Bauer, W. W. Tang, T. L. Mosbrugger, J. E. Cox, J. L. Round, W. P. Voth and R. M. O'Connell (2021). "A Stat1 bound enhancer promotes Nampt expression and function within tumor associated macrophages." *Nat Commun* **12**(1): 2620. DOI: 10.1038/s41467-021-22923-5.
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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, custom cloning services 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.

Main Services

CRISPR Services

- CRISPR sgRNA
- High fidelity Cas9 protein
- Custom CRISPR plasmid design and construction
 - CRISPRa, CRISPRi, AAV, Cas12a and CRISPR based technologies

High Resolution Melt Analysis

- 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

Genotyping Services

- Custom RFLP genotyping of mutant and transgenic mice
- Detection of transgene insertion
- Custom HRMA genotyping
- Sequence verification of genome edits

Other Services

- Custom cloning of mammalian and bacterial expression vectors
- Custom cloning of homology directed repair vectors
- Short ssDNA homology directed repair donor design and production
- Long ssDNA homology directed repair design and production
- Production of CRISPR constructs for generating transgenic *D. melanogaster*
- 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)
- Production of mutant *D. rerio* using CRISPR reagents

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

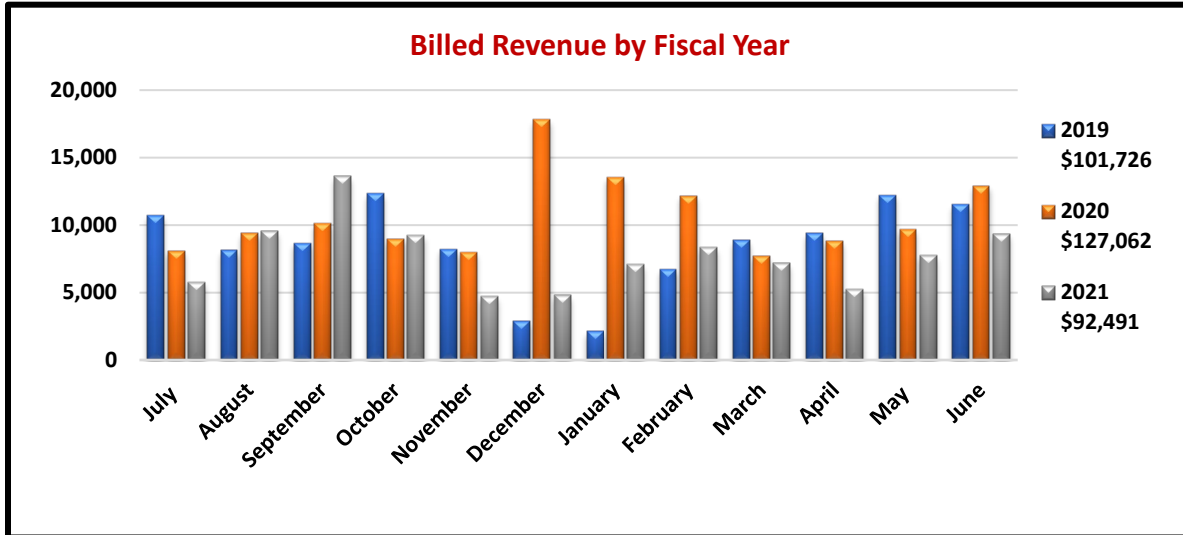
- Crystal Davey, Ph.D., Director
- Lindsay Mortensen, Lab Specialist

Revenue/Expenses

FY21 Expenses: Total \$124,731

FY21 Revenue: Total \$142,491

- VP of Health Sciences Support: \$50,000
- FY21 Revenue generated from services: \$92,491



* Legend displays total annual revenue by year earned.

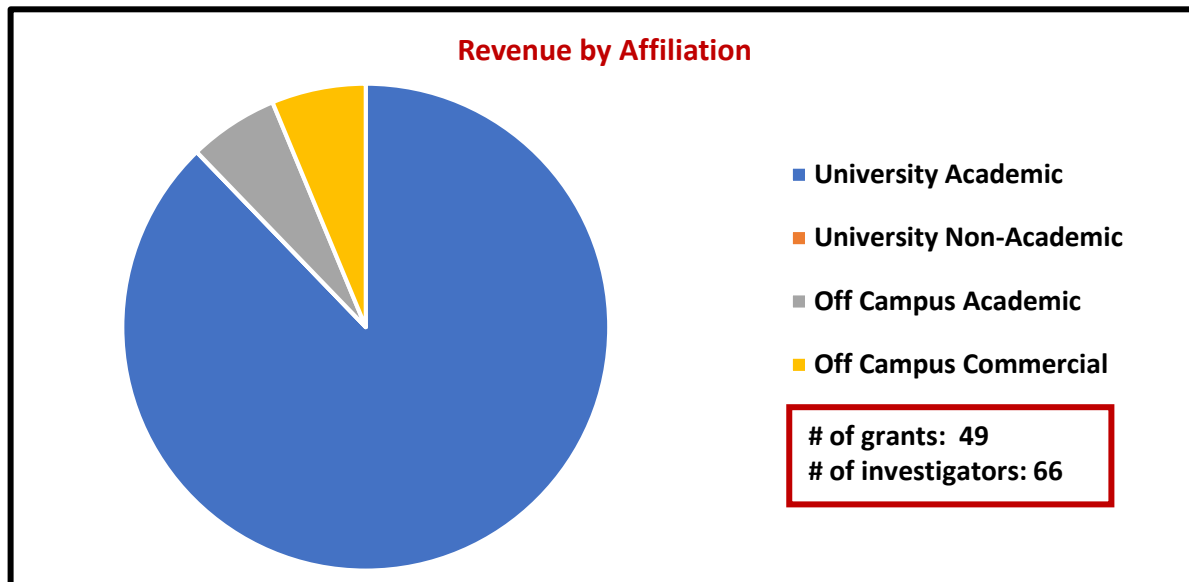
Advisory Board Committee

Last meeting date: July 27, 2021

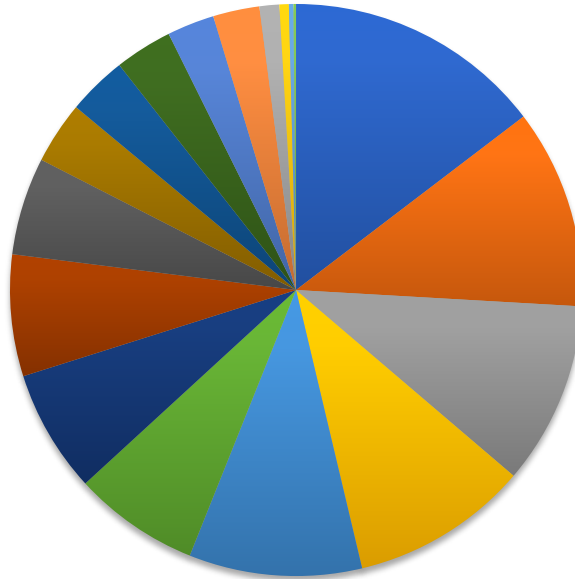
- David Grunwald, Ph.D., Department of Human Genetics (Senior Faculty Advisor)
- Dana Carroll, Ph.D., Department of Biochemistry
- Christopher Gregg, Ph.D., Department of Neurobiology & Anatomy
- Lewis Charles Murtaugh, Ph.D., Department of Human Genetics

**FY21 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Revenue by Department



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

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:

- **DNA Sequencing Facility**
The MGD Core spent \$7,787 with the DNA Sequencing Core in FY21.
- **DNA Peptide Facility**
The MGD Core spent \$6,281 with the DNA/Peptide Synthesis Core in FY21.
- **Drug Discovery Facility**
During FY21 the MGD Core's partnership with the Drug Discovery Facility to produce genetically modified cell lines brought in 3 different projects totaling \$8,000 in chargebacks for that facility.
- **Mouse Transgenic Facility**
During FY21 the MGD Core's partnership with the Mouse Transgenic Facility to produce transgenic mouse models brought in 20 different projects to the Mouse Transgenic Facility totaling \$99,720 in chargebacks for that facility.

Total chargeback impact of the MGD Core on other University Core Research facilities is \$121,788

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

1. Feng, S., S. Lu, W. B. Grueber and R. S. Mann (2021). "Scarless engineering of the Drosophila genome near any site-specific integration site." *Genetics* **217**(3). DOI: 10.1093/genetics/iyab012.
2. Fitzgerald, M., M. Livingston, C. Gibbs and T. L. Deans (2020). "Rosa26 docking sites for investigating genetic circuit silencing in stem cells." *Synth Biol (Oxf)* **5**(1): ysaa014. DOI: 10.1093/synbio/ysaa014.
3. Huffaker, T. B., H. A. Ekiz, C. Barba, S. H. Lee, M. C. Runtsch, M. C. Nelson, K. M. Bauer, W. W. Tang, T. L. Mosbrugger, J. E. Cox, J. L. Round, W. P. Voth and R. M. O'Connell (2021). "A Stat1 bound enhancer promotes Namp1 expression and function within tumor associated macrophages." *Nat Commun* **12**(1): 2620. DOI: 10.1038/s41467-021-22923-5.
4. Hutcheson, D. A., Y. Xie, P. Figueroa and R. I. Dorsky (2020). "A transgene targeted to the zebrafish nkx2.4b locus drives specific green fluorescent protein expression and disrupts thyroid development." *Dev Dyn* **249**(11): 1387-1393. DOI: 10.1002/dvdy.224.
5. Kadmas, J. L., M. C. Beckerle and M. Yoshigi (2020). "Genetic analyses in mouse fibroblast and melanoma cells demonstrate novel roles for PDGF-AB ligand and PDGF receptor alpha." *Sci Rep* **10**(1): 19303. DOI: 10.1038/s41598-020-75774-3.

6. Keefe, M. D., H. E. Soderholm, H. Y. Shih, T. J. Stevenson, K. A. Glaittli, D. M. Bowles, E. Scholl, S. Colby, S. Merchant, E. W. Hsu and J. L. Bonkowsky (2020). "Vanishing white matter disease expression of truncated EIF2B5 activates induced stress response." *Elife* **9**. DOI: 10.7554/eLife.56319.
7. Nowinski, S. M., A. Solmonson, S. F. Rusin, J. A. Maschek, C. L. Bensard, S. Fogarty, M. Y. Jeong, S. Lettlova, J. A. Berg, J. T. Morgan, Y. Ouyang, B. C. Naylor, J. A. Paulo, K. Funai, J. E. Cox, S. P. Gygi, D. R. Winge, R. J. DeBerardinis and J. Rutter (2020). "Mitochondrial fatty acid synthesis coordinates oxidative metabolism in mammalian mitochondria." *Elife* **9**. DOI: 10.7554/eLife.58041.
8. Ruf-Zamojski, F., Z. Zhang, M. Zamojski, G. R. Smith, N. Mendeleev, H. Liu, G. Nudelman, M. Moriwaki, H. Pincas, R. G. Castanon, V. D. Nair, N. Seenarine, M. A. S. Amper, X. Zhou, L. Ongaro, C. Toufaily, G. Schang, J. R. Nery, A. Bartlett, A. Aldridge, N. Jain, G. V. Childs, O. G. Troyanskaya, J. R. Ecker, J. L. Turgeon, C. K. Welt, D. J. Bernard and S. C. Sealfon (2021). "Single nucleus multi-omics regulatory landscape of the murine pituitary." *Nat Commun* **12**(1): 2677. DOI: 10.1038/s41467-021-22859-w.
9. Russell, K. L., J. M. Downie, S. B. Gibson, S. Tsetsou, M. D. Keefe, J. A. Duran, K. P. Figueroa, M. B. Bromberg, L. C. Murtaugh, J. L. Bonkowsky, S. M. Pulst and L. B. Jorde (2021). "Pathogenic effect of TP73 Gene Variants in People With Amyotrophic Lateral Sclerosis." *Neurology*. DOI: 10.1212/WNL.00000000000012285.
10. Saint-Leandre, B., C. Christopher and M. T. Levine (2020). "Adaptive evolution of an essential telomere protein restricts telomeric retrotransposons." *Elife* **9**. DOI: 10.7554/eLife.60987.

Letters of Support

Written and provided to faculty for support of grant applications:

1. LOS for Dr. Alejandra Bosco's grant: "Schlemm's canal targeted-Tie2 knockdown as a mouse model of adult-onset ocular hypertension and glaucoma.", October, 2020
2. LOS for Dr. Diane Ward's proposal to generate a floxed allele of *Lcytb*, October, 2020
3. LOS for Dr. Dean Tantin's proposal to disrupt Oct1 regulation of the *Lgr5* locus, December, 2020
4. LOS for Dr. Sihem Boudina's grant: "Cellular heterogeneity and visceral adipose tissue plasticity in humans and mice.", February, 2021
5. LOS for Dr. Rajeshwary Ghosh's grant: "The role of p62 in the regulation of hypoxia signaling in the heart.", February, 2021
6. LOS for Dr. Chris Gregg's RO1 renewal: "Noncoding Elements Shaping Brain Aging.", February, 2021
7. LOS for Dr. Alexander Pastuszak's RO1: "Validation and Identification of Genetic Variants in Peyronie's and Dupuytren's Disease that Predispose to Fibrosis and Inflammation.", March, 2021
8. LOS for Dr. Jonathan Constance's NIH K22 grant: "Opioid-induced changes to chemotherapeutic activity in blood cancer"., March, 2021
9. LOS for Dr. Dean Tantin's proposal to disrupt the *POU2F1* gene in human ESCs, June, 2021
10. LOS for Dr. Elizabeth Leibold's proposal to generate a conditional *Ireb2* S157A mutation, June, 2021

Nuclear Magnetic Resonance Core Facility

Overview

The NMR core provides services for the University of Utah research community and for local for-profit companies. Researchers have access to several high field NMR spectrometers located at the University of Utah Health Sciences Campus (Varian 400, 500 and 600 MHz instruments) and at the University of Colorado Anschutz Medical Campus (Varian 900 MHz instrument). The 600 and 900 spectrometers are equipped with high sensitivity cryogenic HCN probes ideal for protein and natural products research while the 400 and 500 are used for routine small molecule and natural products characterization. Data collection at the Colorado 900 is performed using a secure network portal. Data processing and analysis is performed using software installed on NMR core computers (CentOS workstations) and at the University of Utah Center for High Performance Computing (CHPC).

Core staff have significant expertise in characterizing biological molecules – natural products, nucleic acids, peptides and proteins using NMR. Our business model stresses user acquired data collection and analysis and thus we provide practical NMR training for individuals and groups on an as needed basis and occasionally offer formal NMR spectroscopy courses.

Services

- Consultation
- 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)
- Varian DD2 900 MHz NMR with HCN cryogenic probe (University of Colorado-Denver)

Personnel

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

2021 Annual Update

New Equipment

- New turbo and scroll pumps on 600 cryogenic system.
- Installation of openVnmrJ (open source software) on all three spectrometers.

New Services

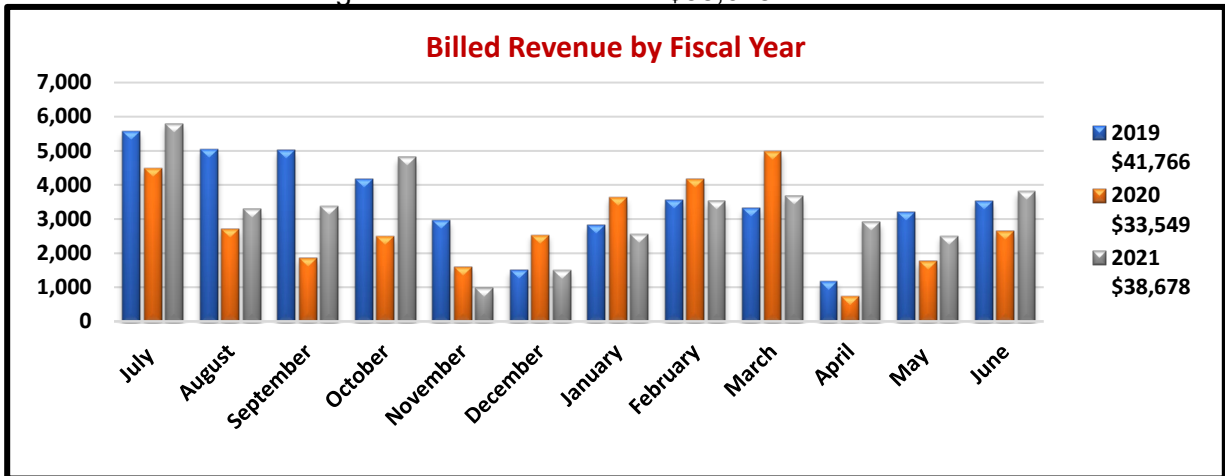
- The NMR Facility did not implement additional services in FY21

Revenues/Expenses

FY21 Expenses: Total \$108,444

FY21 Revenue: Total 108,678

- VP of Health Sciences Support: \$70,000
- FY21 Revenue generated from services: \$38,678



* Legend displays total annual revenue by year earned.

Advisory Board Committee

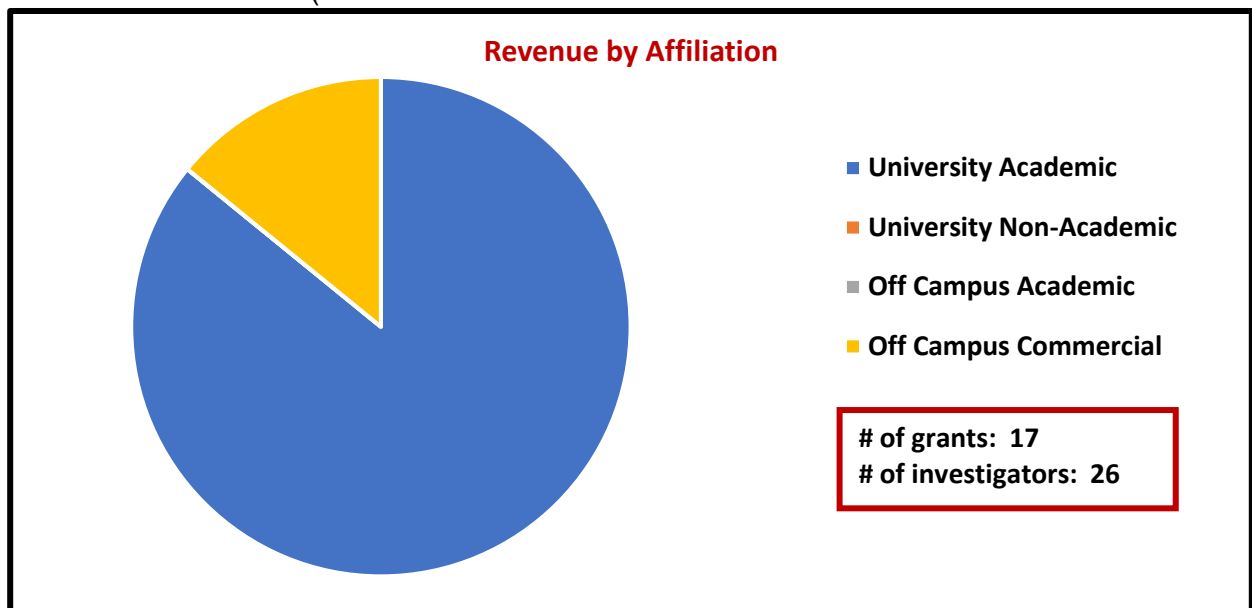
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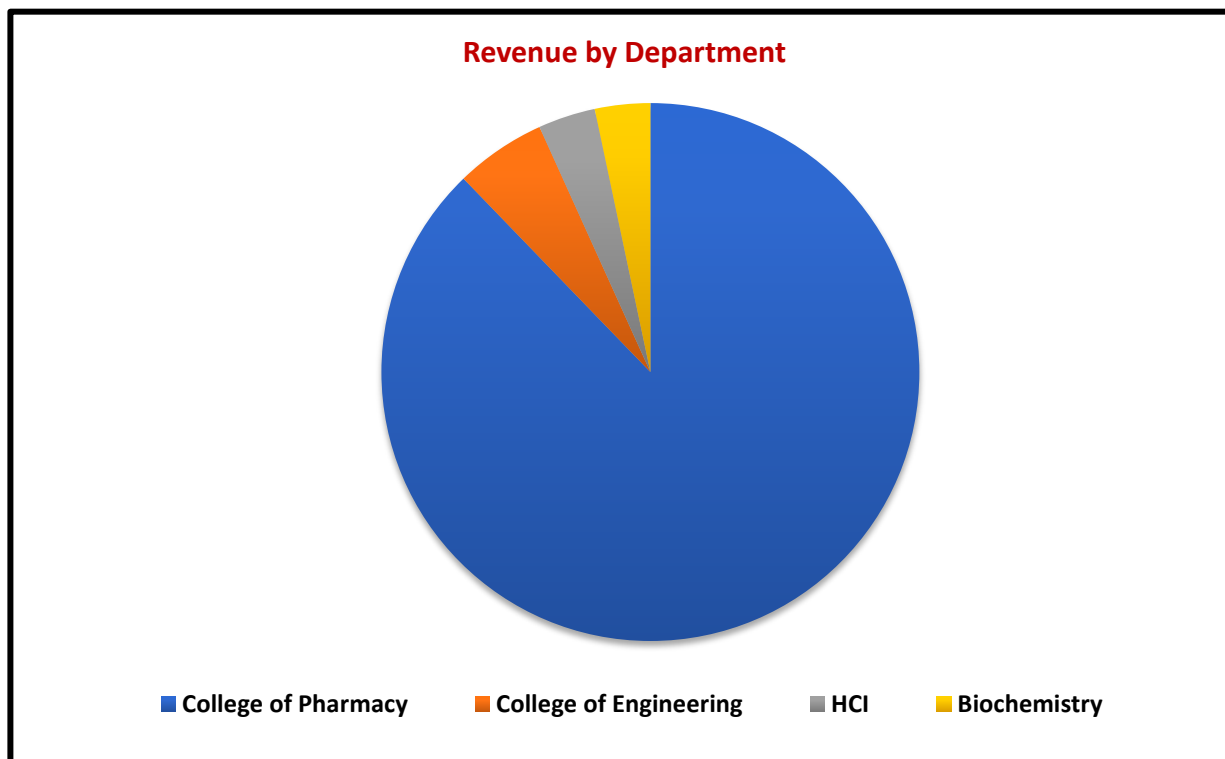
- Darrell Davis, Eric Schmidt and Jaclyn Winter, Department of Medicinal Chemistry
- Wesley Sundquist, Department of Biochemistry
- Jessica Kramer, Department of Bioengineering

FY21 Scientific Impact

Research Support

Revenue Generated: (see charts)





Top Users

1	Schmidt, Eric	US Army Medical Research
2	Davis, Darrell	Department, State of Utah
3	Barrios, Amy	Department, NIH, NSF
4	Echelon Biosciences	Commercial
5	Franzini, Raphael	Department, NIH
6	Vaporsens, Inc.	Commercial
7	Vankayalapati, Hari	Department
8	Haygood, Margo	Department, NIH
9	Winter, Jaclyn	Department, Gordon & Betty Moore FTD
10	Sundquist, Wesley	Department

Publications

- Barrios, A. M. (2020). "PTPs: Degrading the Undruggable." *J Med Chem* **63**(14): 7508-7509. DOI: 10.1021/acs.jmedchem.0c01000.
- Deb, T., J. Tu and R. M. Franzini (2021). "Mechanisms and Substituent Effects of Metal-Free Bioorthogonal Reactions." *Chem Rev* **121**(12): 6850-6914. DOI: 10.1021/acs.chemrev.0c01013.
- Franzini, R. M., J. Tu and M. Xu (2020). "A Stable Precursor for Bioorthogonally Removable 3-Isocyanopropoxyloxycarbonyl (ICPrC) Protecting Groups." *Synlett* **31**(17): 1701-1706. DOI: 10.1055/s-0040-1707220.
- Heard, S. C., G. Wu and J. M. Winter (2020). "Discovery and characterization of a cytochalasan biosynthetic cluster from the marine-derived fungus *Aspergillus flavipes* CNL-338." *J Antibiot (Tokyo)* **73**(11): 803-807. DOI: 10.1038/s41429-020-00368-0.
- Heard, S. C., G. Wu and J. M. Winter (2021). "Antifungal natural products." *Curr Opin Biotechnol* **69**: 232-241. DOI: 10.1016/j.copbio.2021.02.001.
- Kim, M. C., J. M. Winter, R. N. Asolkar, C. Boonlarpradab, R. Cullum and W. Fenical (2021). "Marinoterpins A-C: Rare Linear Merosesterterpenoids from Marine-Derived Actinomycete Bacteria of the Family Streptomycetaceae." *J Org Chem* **86**(16): 11140-11148. DOI: 10.1021/acs.joc.1c00262.

7. Kim, M. C., J. M. Winter, R. Cullum, Z. Li and W. Fenical (2020). "Complementary Genomic, Bioinformatics, and Chemical Approaches Facilitate the Absolute Structure Assignment of Ionostatin, a Linear Polyketide from a Rare Marine-Derived Actinomycete." *ACS Chem Biol* **15**(9): 2507-2515. DOI: 10.1021/acscchembio.0c00526.
8. Lacerna, N. M., C. M. V. Ramones, J. M. D. Robes, M. R. D. Picart, J. O. Tun, B. W. Miller, M. G. Haygood, E. W. Schmidt, L. A. Salvador-Reyes and G. P. Concepcion (2020). "Inhibition of Biofilm Formation by Modified Oxylipins from the Shipworm Symbiont *Teredinibacter turnerae*." *Marine Drugs* **18**(12): 656. DOI: 10.3390/md18120656.
9. Lin, Z., J. P. Torres, M. Watkins, N. Paguigan, C. Niu, J. S. Imperial, J. Tun, H. Safavi-Hemami, R. K. Finol-Urdaneta, J. L. B. Neves, S. Espino, M. Karthikeyan, B. M. Olivera and E. W. Schmidt (2021). "Non-Peptidic Small Molecule Components from Cone Snail Venoms." *Front Pharmacol* **12**: 655981. DOI: 10.3389/fphar.2021.655981.
10. McCullough, B. S. and A. M. Barrios (2020). "In Vitro Assays for Measuring Protein Histidine Phosphatase Activity." *Methods Mol Biol* **2077**: 109-120. DOI: 10.1007/978-1-4939-9884-5_8.
11. Miller, B. W., A. L. Lim, Z. Lin, J. Bailey, K. L. Aoyagi, M. A. Fisher, L. R. Barrows, C. Manoil, E. W. Schmidt and M. G. Haygood (2021). "Shipworm symbiosis ecology-guided discovery of an antibiotic that kills colistin-resistant *Acinetobacter*." *Cell Chem Biol*. DOI: 10.1016/j.chembiol.2021.05.003.
12. Niu, C., L. S. Leavitt, Z. Lin, N. D. Paguigan, L. Sun, J. Zhang, J. P. Torres, S. Raghuraman, K. Chase, R. Cadeddu, M. Karthikeyan, M. Bortolato, C. A. Reilly, R. W. Hughen, A. R. Light, B. M. Olivera and E. W. Schmidt (2021). "Neuroactive Type-A gamma-Aminobutyric Acid Receptor Allosteric Modulator Steroids from the Hypobranchial Gland of Marine Mollusk, *Conus geographus*." *J Med Chem* **64**(10): 7033-7043. DOI: 10.1021/acs.jmedchem.1c00562.
13. Pritz, M. B., L. C. Ziegler, T. N. Thompson and E. W. Hsu (2020). "Magnetic resonance diffusion tensor tractography of a midbrain auditory circuit in Alligator." *Neurosci Lett* **738**: 135251. DOI: 10.1016/j.neulet.2020.135251.
14. Purushothaman, M., S. Sarkar, M. Morita, M. Gugger, E. W. Schmidt and B. I. Morinaka (2021). "Genome-Mining-Based Discovery of the Cyclic Peptide Tolypamide and TolF, a Ser/Thr Forward O-Prenyltransferase." *Angew Chem Int Ed Engl* **60**(15): 8460-8465. DOI: 10.1002/anie.202015975.
15. Shin, Y. H., Y. H. Ban, J. Shin, I. W. Park, S. Yoon, K. Ko, J. Shin, S. J. Nam, J. M. Winter, Y. Kim, Y. J. Yoon and D. C. Oh (2021). "Azetidine-Bearing Non-Ribosomal Peptides, Bonnevillamides D and E, Isolated from a Carrion Beetle-Associated Actinomycete." *J Org Chem* **86**(16): 11149-11159. DOI: 10.1021/acs.joc.1c00360.
16. Torres, J. P., Z. Lin, M. Watkins, P. F. Salcedo, R. P. Baskin, S. Elhabian, H. Safavi-Hemami, D. Taylor, J. Tun, G. P. Concepcion, N. Saguil, A. A. Yanagihara, Y. Fang, J. R. McArthur, H. S. Tae, R. K. Finol-Urdaneta, B. D. Ozpolat, B. M. Olivera and E. W. Schmidt (2021). "Small-molecule mimicry hunting strategy in the imperial cone snail, *Conus imperialis*." *Sci Adv* **7**(11). DOI: 10.1126/sciadv.abf2704.
17. Winter, J. M. (2021). "A Community Effort: Combining Functional Amplicon Sequencing and Metagenomics Reveals Potential Biosynthetic Gene Clusters Associated with Protective Phenotypes in Rhizosphere Microbiomes." *mSystems* **6**(3): e0058721. DOI: 10.1128/mSystems.00587-21.
18. Wu, G., B. T. M. Dentinger, J. R. Nielson, R. T. Peterson and J. M. Winter (2021). "Emerimicins V-X, 15-Residue Peptaibols Discovered from an *Acremonium* sp. through Integrated Genomic and Chemical Approaches." *J Nat Prod* **84**(4): 1113-1126. DOI: 10.1021/acs.jnatprod.0c01186.

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

Personnel

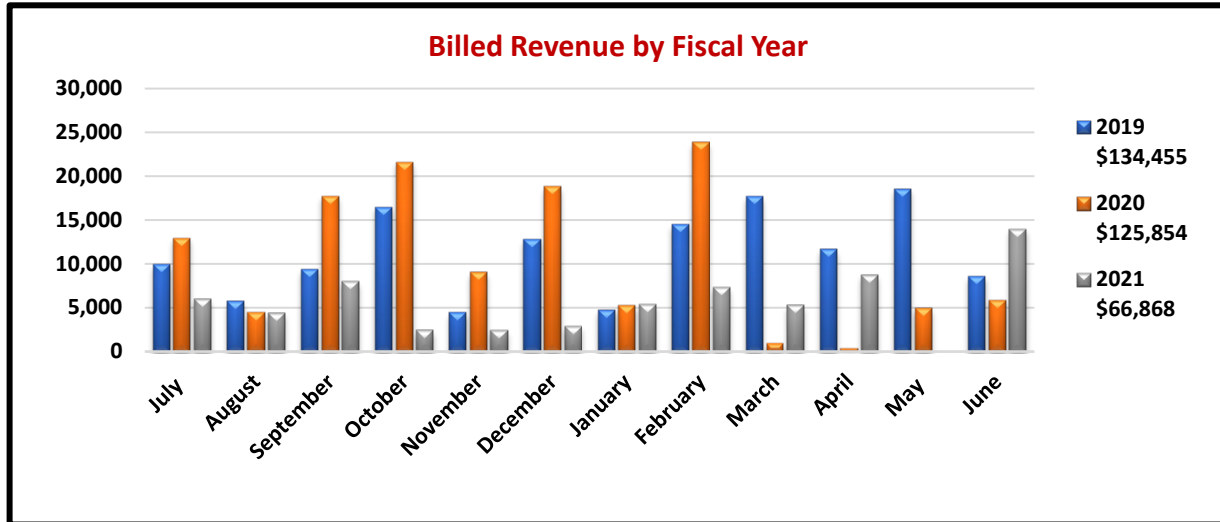
- Edward Hsu, Ph.D., Director
- Samer Merchant, M.S., Manager
- Tyler Thompson, Research Assistant
- Tyler Slater, Research Assistant

**2021 Annual Update
Revenue/Expenses**

FY21 Expenses: Total \$207,159

FY21 Revenue: Total \$176,868

- VP of Health Sciences Support: \$50,000
- VP of Research Support: \$60,000
- FY21 Revenue generated from services: \$66,868



* Legend displays total annual revenue by year earned.

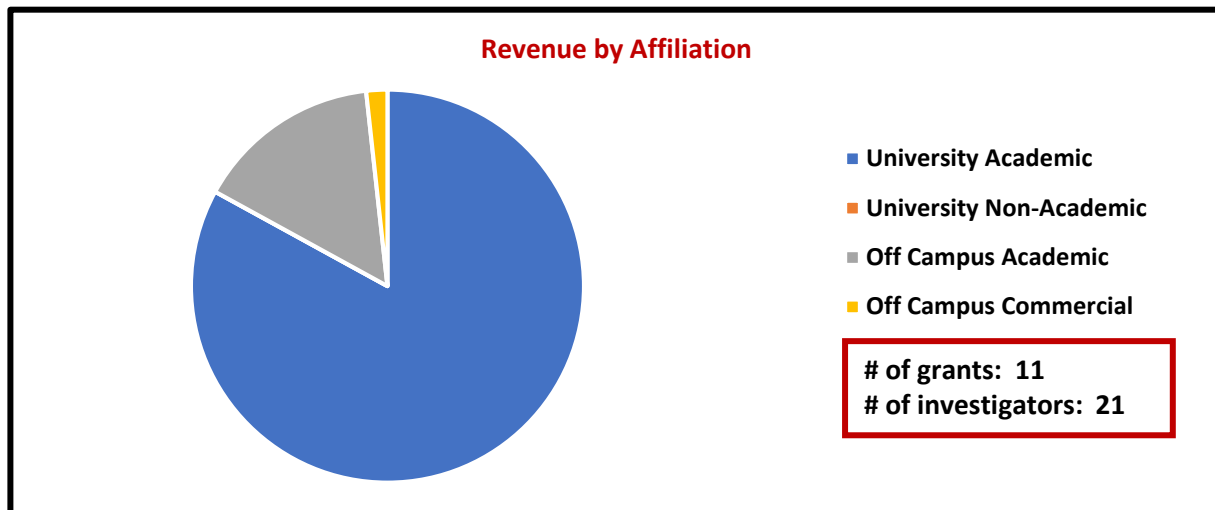
Advisory Board Committee

Last meeting date: April 1, 2018

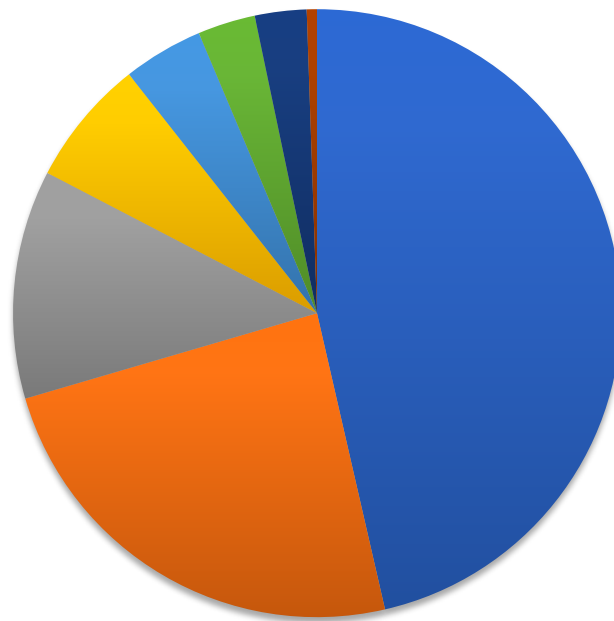
- Rob MacLeod, Professor, Bioengineering/SCI/CVRTI
- John Phillips, Professor, Hematology
- Edward DiBella, Professor, Radiology
- Donna Cross, Associate Professor, Radiology

**FY21 Scientific Impact
Research Support**

Revenue Generated (see charts following):



Revenue by Department



- Internal Medicine
- College of Science
- Radiology
- CVRTI
- School of Dentistry
- Orthopaedics
- College of Engineering
- Pathology

Top Users

1	Ranjan, Ravi	NIH
2	Shapiro, Michael	NIH
3	Utah State University	Off Campus Educational
4	Minoshima, Satoshi	Department
5	Colorado State University Pueblo	Off Campus Educational
6	Phillips, John	NIH
7	MacLeod, Rob	Nora Eccles Treadwell FTD
8	Jia, Shihai	NIH
9	Jeong, Eun-Kee	Department
10	Jones, Kevin	NIH

Publications

- Bastiaans, D., J. J. F. Kroll, D. Cornelissen, J. W. M. Jagt and A. S. Schulp (2020). "Cranial palaeopathologies in a Late Cretaceous mosasaur from the Netherlands." Cretaceous Research **112**: 104425. DOI: 10.1016/j.cretres.2020.104425.

2. Boer, E. F., H. F. Van Hollebeke, C. Holt, M. Yandell and M. D. Shapiro (2021). A ROR2 coding variant is associated with craniofacial variation in domestic pigeons, Cold Spring Harbor Laboratory. DOI: 10.1101/2021.03.15.435542.
 3. Li, D. S., R. Avazmohammadi, C. B. Rodell, E. W. Hsu, J. A. Burdick, J. H. Gorman, 3rd, R. C. Gorman and M. S. Sacks (2020). "How hydrogel inclusions modulate the local mechanical response in early and fully formed post-infarcted myocardium." *Acta Biomater* **114**: 296-306. DOI: 10.1016/j.actbio.2020.07.046.
 4. Pritz, M. B., L. C. Ziegler, T. N. Thompson and E. W. Hsu (2020). "Magnetic resonance diffusion tensor tractography of a midbrain auditory circuit in Alligator." *Neurosci Lett* **738**: 135251. DOI: 10.1016/j.neulet.2020.135251.
- Rubio, J. E., M. Skotak, E. Alay, A. Sundaramurthy, D. R. Subramaniam, V. B. Kote, S. Yeoh, K. Monson, N. Chandra, G. Unnikrishnan and J. Reifman (2020). "Does Blast Exposure to the Torso Cause a Blood Surge to the Brain?" *Front Bioeng Biotechnol* **8**: 573647. DOI: 10.3389/fbioe.2020.573647.

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
- Tiehua Chen, Laboratory Technician

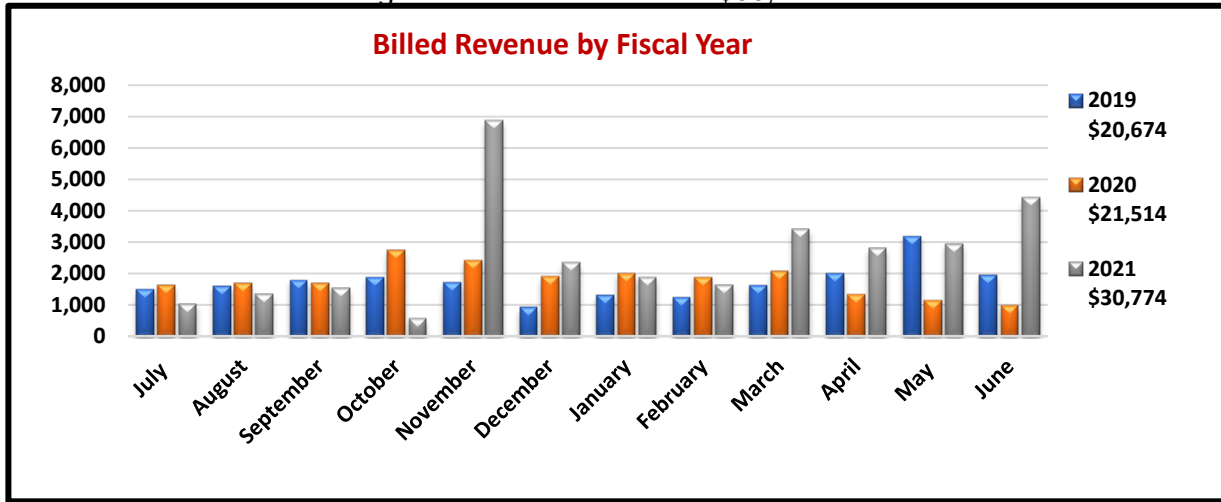
2021 Annual Update

Revenue/Expenses

FY21 Expenses: Total \$20,262

FY21 Revenue: Total \$40,774

- VP of Health Sciences Support: \$10,000
- FY21 revenue generated from services: \$30,774



* Legend displays total annual revenue by year earned.

Advisory Board Committee

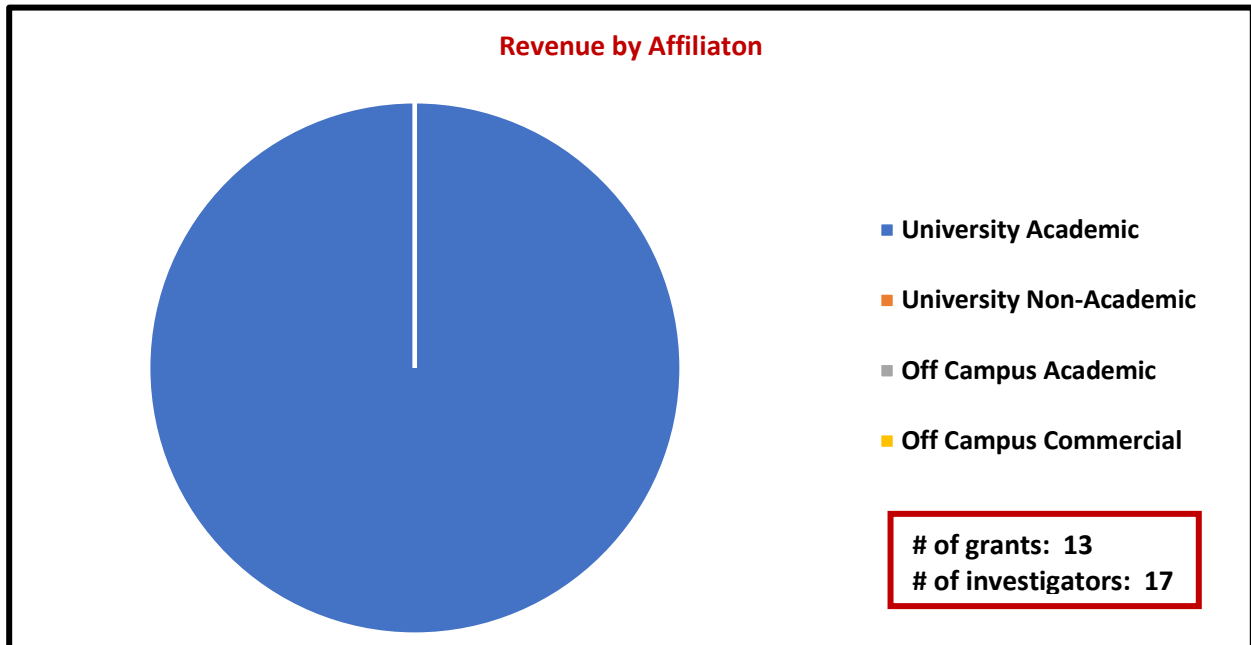
Last meeting date: April 15, 2013.

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

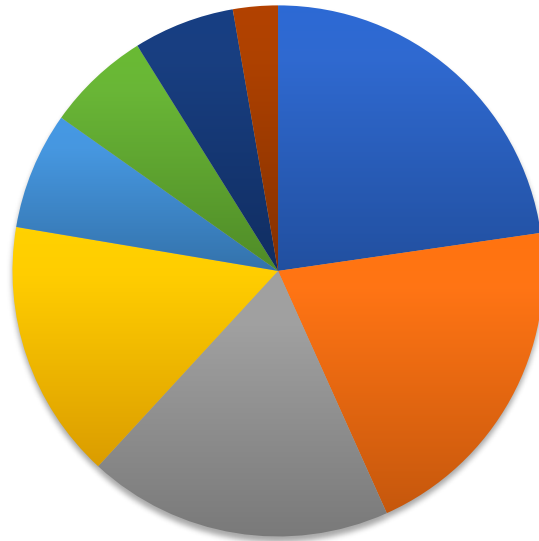
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Molecular Medicine
- CVRTI
- College of Health
- Internal Medicine
- Surgery
- College of Pharmacy
- Pediatrics
- Biochemistry

Top Users

1	Selzman, Craig	NIH
2	Lai, Kent	Department
3	Yost, Joseph	NIH
4	Chaudhuri, Dipayan	Department
5	Rutter, Jared	Department, NIH, Warren Alpert FTD
6	Ramkumar, Nirupama	NIH
7	Donato, Anthony	Mayo Clinic
8	Warren, Junko	Department
9	Lesniewski, Lisa	NIH
10	Whitehead, Kevin	Department

Publications

No known publications acknowledged this facility in FY 21.

Transgenic & Gene Targeting

Overview

The goal of the Transgenic & Gene Targeting (TGT) Core Facility is to provide state of the art service and assistance in the field of mouse transgenesis and gene targeting. The TGT core develops gene targeting technology, possesses state of the art equipment, provides project consultation 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 generate transgenic and gene targeted mouse models for researchers. The TGT core uses CRISPR technology to generate knockout, knockin, and conditionally targeted alleles in mice. This method allows for the efficient and relatively inexpensive 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, the TGT core has expertise in mouse research procedures including embryo and sperm cryopreservation, *in vitro* fertilization (IVF), 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, a surgery area, and a mouse room for housing and breeding. The TGT core staff has 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

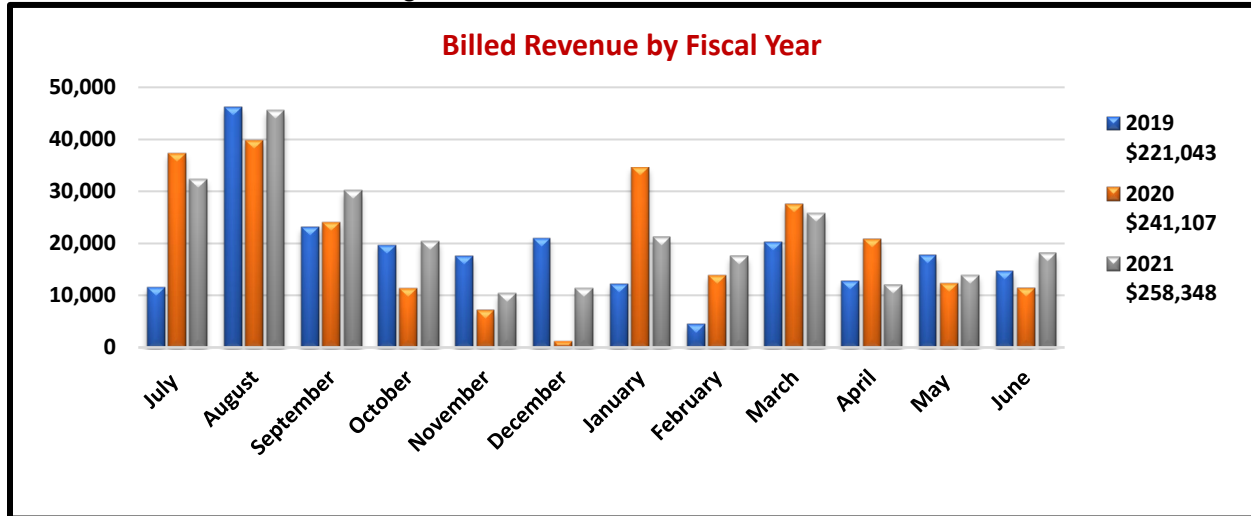
- Crystal Davey, Ph.D., Co-Director
- Kyle O'Connor, B.S., Co-Director
- He Lan, Ph.D., Senior Lab Specialist
- Nick Black, Lab Specialist

Revenue/Expenses

FY21 Expenses: Total \$544,892

FY21 Revenue: Total \$692,951

- VP of Health Sciences Support: \$434,603
- FY21 Revenue generated from services: \$258,348



* Legend displays total annual revenue by year earned.

Advisory Board Committee

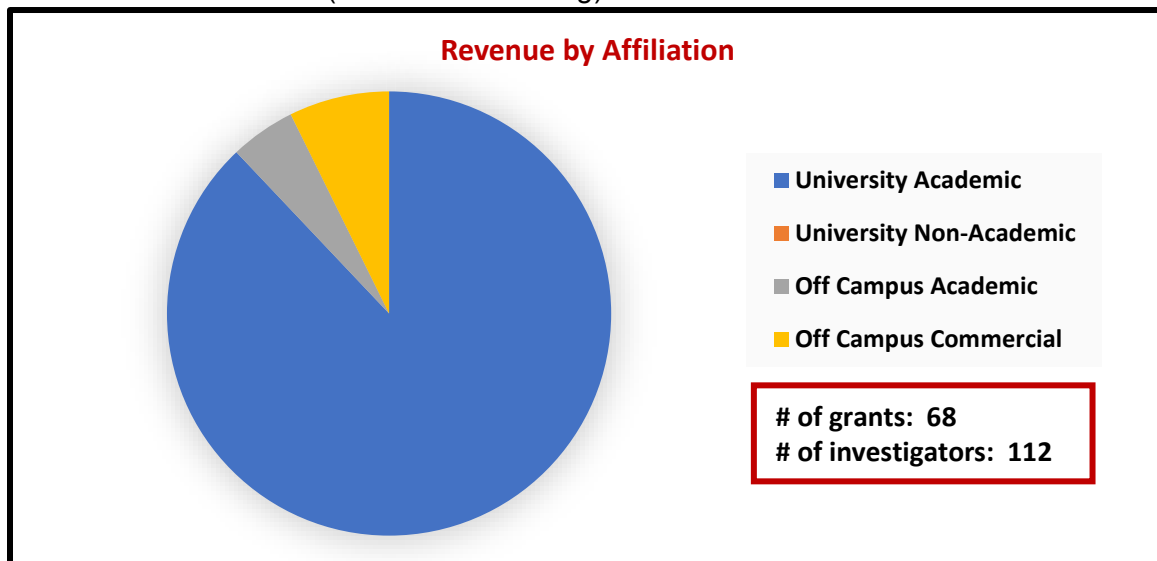
Last meeting date: August, 2021

- Lewis Charles Murtaugh, Ph.D., Department of Human Genetics (Sr. Faculty Advisor)
- Christopher Gregg, Ph.D., Department of Neurobiology & Anatomy
- Kevin B. Jones, MD, Huntsman Cancer Institute
- Dean Tantin, Ph.D., Department of Pathology

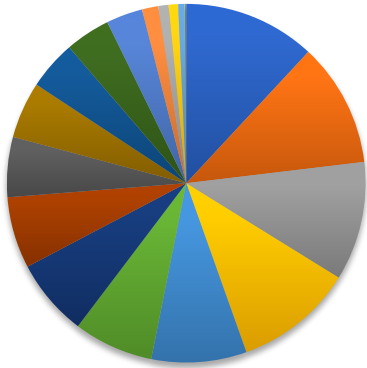
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



- Biochemistry
- Orthopaedics
- Human Genetics
- College of Health
- Surgery
- Pediatrics
- Nephrology
- Neurology
- Anesthesiology
- Plastic Surgery
- Psychiatry
- CVRTI
- Molecular Medicine
- Oncological Sciences
- College of Pharmacy
- Pathology
- HCI
- Ophthalmology & Visual Sciences
- College of Science
- Neurosurgery
- Radiation Oncology

Top Users

1	Sundquist, Wesley	NIH
2	Funai, Katsuhiko	Department, NIH
3	Science Exchange	Commercial
4	Jones, Kevin B.	NIH
5	Boudina, Sihem	Department
6	Yang, Tianxin	NIH
7	Park, Sungjin	Department, NIH
8	Capecchi, Mario	Department
9	Phillips, John	NIH
10	Warren, Junko	Nora Eccles Treadwell Foundation, The Medical Foundation

FY21 Publications

1. Dahl, T. M., M. Reed, C. D. Gerstner, G. Ying and W. Baehr (2021). "Effect of conditional deletion of cytoplasmic dynein heavy chain DYNC1H1 on postnatal photoreceptors." PLoS One **16**(3): e0248354. DOI: 10.1371/journal.pone.0248354.

Letters of Support for grant applications:

1. Dr. Mary Harnett's R01, "Endothelial transmigration in neovascular age-related macular degeneration". September, 2020
2. Dr. Dean Tantin's NCI PPG project to generate mouse lines with disruptions in regulatory sites in the *Lgr5* locus, December, 2021
3. Dr. Michael Deininger's R01: "MS4A3 as a regulator of quiescence in chronic myeloid leukemia stem cells.", February, 2021
4. Dr. Chris Gregg's RO1 renewal: "Noncoding Elements Shaping Brain Aging.", February, 2021

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 2336 CPU cores and 4.1 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 expertise for massively scalable data processing 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.
- Data transfer, storage, and management for large NGS datasets
- Facilitate return of sequencing data from ARUP laboratories (both short read Illumina and long read PacBio sequencing available to researchers)

Personnel

- Carson Holt, UCGD Core Director
- Barry Moore, Project Director
- Shawn Rynearson, Software Developer
- Bushra Gorski, Research Analyst
- Steven Boyden, Director of Research and Science

2021 Annual Update

Grant Support – UCGD Core supported the following grant submissions in FY21:

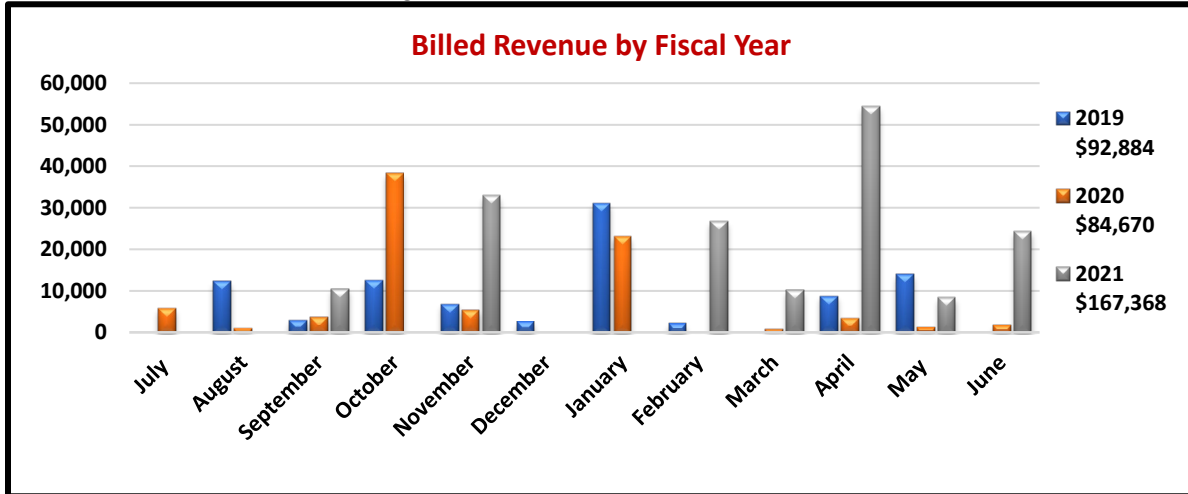
- *Implementation of Intelligent Assisted Support in Pediatric Primary Care to Shorten the Rare Disease Diagnostic Odyssey (UG3/UH3)*. PI: Luca Brunelli.
- *A comprehensive de novo mutation discovery tool (R01)*. PI: Gabor Marth.
- *A unified software platform for comprehensive somatic cancer mutation detection (U24)*. PI: Gabor Marth.
- *Validation and Identification of Genetic Variants in Peyronie's and Dupuytren's Disease that Predispose to Fibrosis and Inflammation (R01)*. PI: Alexander Pastuszak.
- *A web software system supporting genetic counseling in the age of genomic medicine (R01)*. PI: Gabor Marth.
- *Utah/Rady Mendelian Genomics Research Center (U01)*. PI: Aaron Quinlan.
- *Organization and exploration of longitudinal data (STTR)*. COO: Alistair Ward.

Revenue/Expenses

FY21 Expenses: Total \$704,023

FY21 Revenue: Total \$807,022

- VP of Health Sciences Support: \$639,654
- FY21 Revenue generated from services: \$167,368



*Legend displays total annual revenue by year earned.

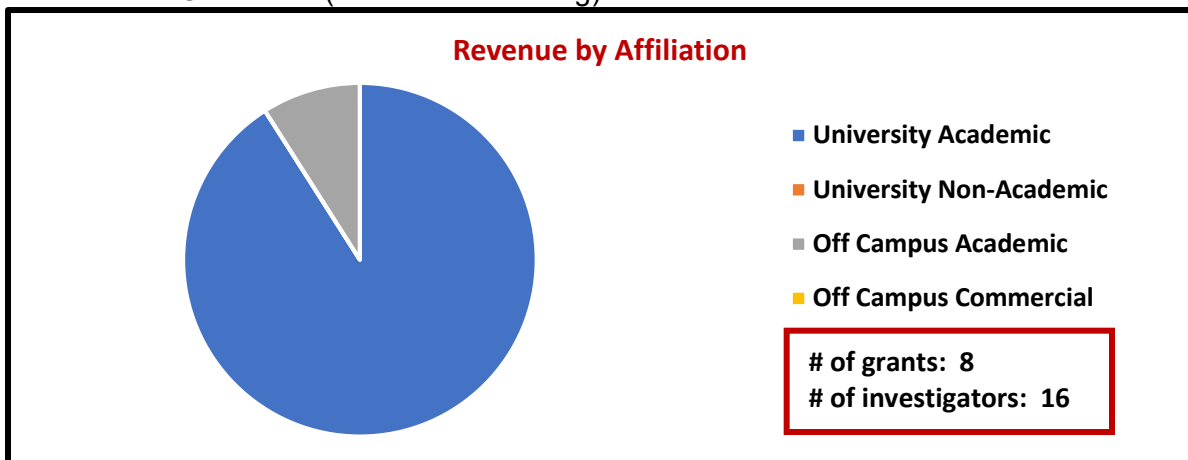
Advisory Board Committee

- Mark Yandell, PhD, Professor of Human Genetics
- Gabor Marth, DSc, Professor of Human Genetics
- Aaron Quinlan, PhD, Professor of Human Genetics
- Joseph Yost, PhD, Professor and Vice Chairman for Basic Science Research, Department of Pediatrics
- Ryan O'Connell, PhD, Professor of Pathology
- Daniel Leung, MD/MSc, Associate Professor of Internal Medicine

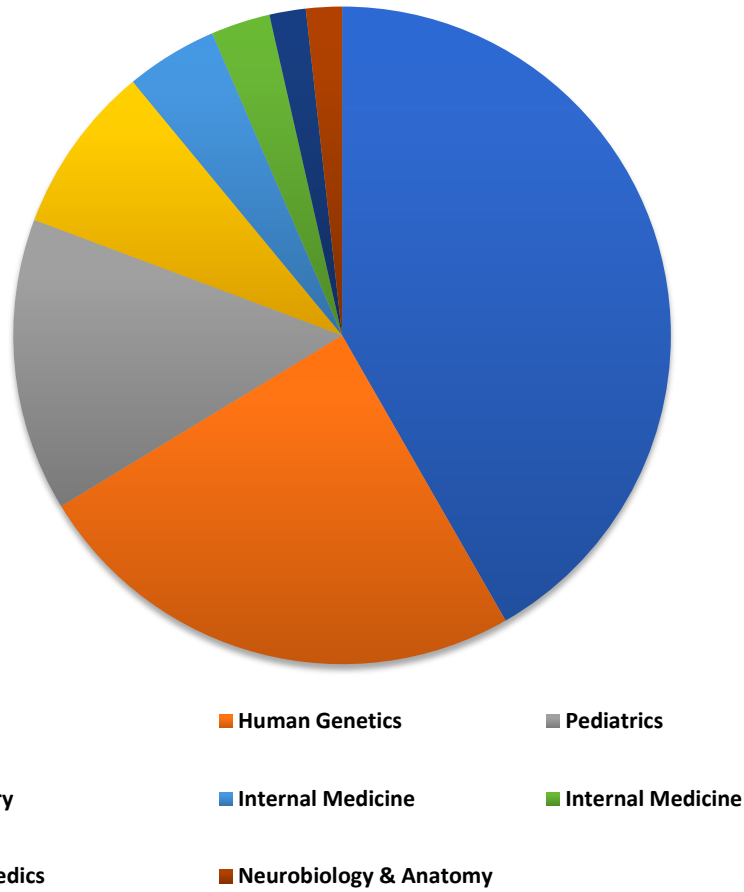
FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):



Revenue by Department



Top Users

1	Dere, Willard	Department
2	Quinlan, Aaron	Department
3	Oregon Health & Science Univ	Off- Campus Academic
4	Coon, Hilary	Department
5	Tristani-Firouzi, Martin	NIH
6	Al-Rabadi, Laith	National Kidney Foundation
7	Botto, Lorenzo	Department, NIH
8	Guthery, Stephen	NIH
9	Yandell, Mark	Department
10	Phillips, John	NIH

Publications:

1. Belyeu, J. R., H. Brand, H. Wang, X. Zhao, B. S. Pedersen, J. Feusier, M. Gupta, T. J. Nicholas, J. Brown, L. Baird, B. Devlin, S. J. Sanders, L. B. Jorde, M. E. Talkowski and A. R. Quinlan (2021). "De novo structural mutation rates and gamete-of-origin biases revealed through genome sequencing of 2,396 families." Am J Hum Genet **108**(4): 597-607. DOI: 10.1016/j.ajhg.2021.02.012.
2. Bogenschutz, E. L., Z. D. Fox, A. Farrell, J. Wynn, B. Moore, L. Yu, G. Aspelund, G. Marth, M. Yandell, Y. Shen, W. K. Chung and G. Kardon (2020). "Deep whole-genome sequencing of multiple proband tissues and parental blood reveals the complex genetic etiology of congenital diaphragmatic hernias." HGG Adv **1**(1). DOI: 10.1016/j.xhgg.2020.100008.
3. Musfee, F. I., A. J. Agopian, E. Goldmuntz, H. Hakonarson, B. E. Morrow, D. M. Taylor, M. Tristani-Firouzi, W. S. Watkins, M. Yandell and L. E. Mitchell (2021). "Common Variation in Cytoskeletal Genes is Associated with Conotruncal Heart Defects." Genes (Basel) **12**(5). DOI: 10.3390/genes12050655.

Patents:

1. Holt, C. H., Yandell, M. (2021). Systems And Methods For Facilitating Rapid Genome Sequence Analysis. US Provisional Patent No. 63/176,744

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.

Anticonvulsant Drug Development (ADD) Program

Overview

The Anticonvulsant Drug Development (ADD) Program is an established laboratory experienced in the preclinical identification and evaluation of investigational compounds for the treatment of epilepsy.

Uniqueness

Current investigators at the program have held multiple contracts with biopharmaceutical and government partners for testing of novel compounds in seizure models. The program has considerable experience in performing efficacy and tolerability assessments of novel and established antiseizure drugs (ASDs) using multiple routes of administration [intraperitoneal (i.p.), intravenous (i.v.), oral (per os, p.o.), subcutaneous (s.c.), intramuscular (i.m.), and intracerebroventricular (i.c.v.)] in models for epilepsy.

Services

The models we offer include maximal electroshock (MES)-induced seizure, 6 Hz seizure (varying stimulus intensities;), corneal kindled seizure test, lamotrigine-resistant amygdala kindled model, and the post kainate-induced status epilepticus (SE) chronically epileptic model. In parallel, our staff routinely evaluates the effect of investigational compounds on motor impairment in the rotorod test, the open field locomotor assay, the minimal motor impairment (MMI) assay, and the modified Functional Observation Battery (FOB, or Irwin test). Our facilities include state-of-the-art multi-channel monitoring units to allow for continuous video-electroencephalographic (v-EEG) monitoring of spontaneous seizures. We also offer chronic administration of any compound to rats or mice using a drug-in-food model. Using our automated feeder system, drugs can be delivered on a fixed schedule, 24/7 for any requested length of time. Food pellets containing compound are formulated either by outsourcing or can be custom made in-house. Prices will be determined based on the requirements of the planned study.

Personnel

- Karen Wilcox, Director
- Cameron Metcalf, Associate Director
- Peter West, Assistant Professor
- Misty Smith, Assistant Professor
- Kristina Johnson, Laboratory Manager
- Elisa Koehler, Project Administrator

2021 Annual Update**Revenue/Expenses- New Service Recharge June 2021****FY21 expenses: 0****FY21 revenue: 0****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 FY21

- Starting Operations
- Reaching out to new users

Behavioral Health Innovation and Dissemination Center

Overview

The mission of the Behavioral Health Innovation and Dissemination Center (BHIDC) at The University of Utah (U of U) is to develop, test, and implement behavioral health interventions as well as to train U of U students to deliver them and make these and other state of the art interventions available to the public. The BHIDC conducts research primarily focused on cognitive-behavioral interventions for adults and couples, and provides low cost, evidence-based treatments to Utah residents. BHIDC staff will also begin conducting training workshops and educational presentations for healthcare providers and the public in FY2021.

Services

BHIDC will offer a range of services including **consulting, training, and psychological treatments** beginning in FY2021. BHIDC did not offer any services during FY2021.

Personnel

- Brian Baucom, PhD, Co-Director
- Feea Leifker, MPH, PhD, Co-Director

2021 Annual Update

Revenue/Expenses

FY21 Expenses: Total \$2,593

FY21 Revenue: Total \$0

Grant Support – N/A

BHIDC was not formally approved until May 5, 2021. BHIDC is replacing the NCVS recharge center.

Advisory Board Committee

- N/A

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 and Conferences

- 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
- Planning and coordinating local and national conferences

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 Designer
- 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
- Jason Harris, AS, Sr. Web Software Developer
- Nathan Holland, BA, Graphic Designer
- Jonny Holmgren, AA, Graphic Designer
- Sheila Homburger, MS, Science Content Manager

- Ann Lambert, PhD, Research Associate
- John Maxwell Kelly, BFA, Multimedia Manager
- Molly Malone, BS, Senior Education Specialist
- Steve Ortiz, MLS, Administrative Program Coordinator
- Ryan Perkins, BFA, Senior Graphic Designer
- Julia Peterson, BFA, Graphic Designer
- Harmony Starr, BS, Senior Media Production Manager
- Jen Taylor, BS, Education Specialist
- Arthur Veenema, BS, Video Producer/Director
- Brooklee Watters, AS, User Experience Developer

FY21 Annual Update

New Services

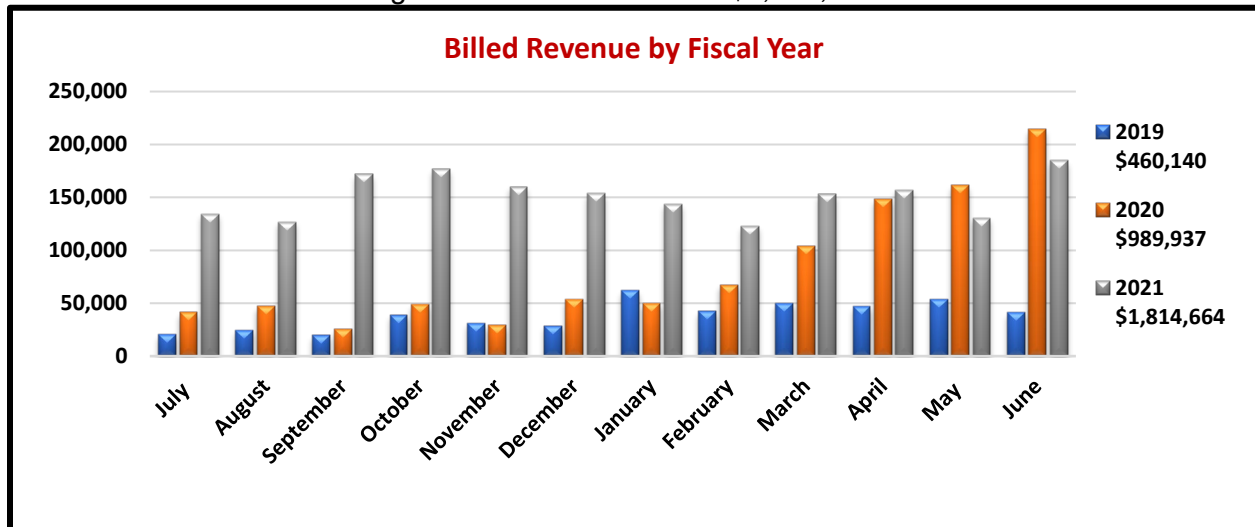
- Conference Planning
- Conference Coordination

Revenue/Expenses

FY21 Expenses: \$1,569,425

FY21 Revenue: \$1,897,848

- Other Revenue Sources: \$83,184
- FY21 revenue generated from services: \$1,814,664



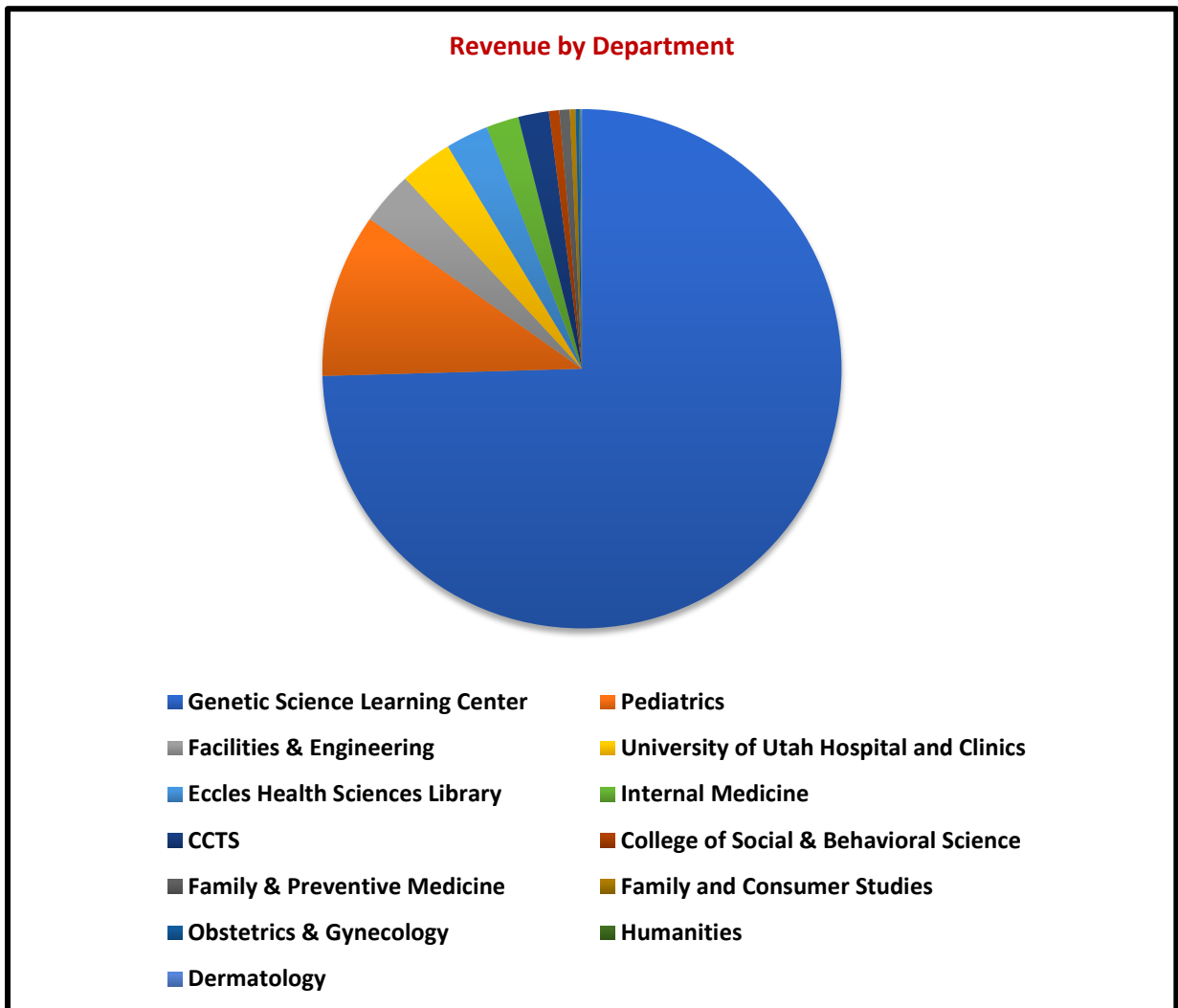
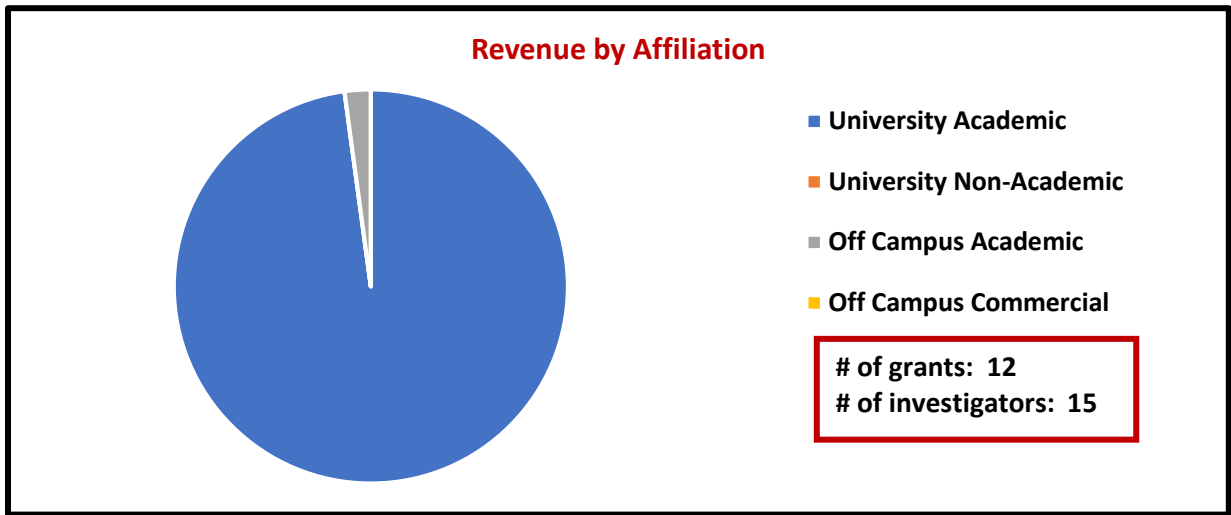
* Legend displays total annual revenue by year earned.

Management Meeting

Last meeting date: August 27, 2021

- 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

**FY21 Scientific Impact
Research Support
Revenue Generated (see charts):**



Top Users

1	Stark, Louisa	NIH, NSF
2	Keenan, Heather	NIH
3	Patterson, Brittany	Department
4	Izzo, Emily	Department
5	Soehner, Catherine	NIH
6	Phillips, John	NIH
7	Krantz, Susan	Department
8	University of Georgia	Off Campus Educational
9	Utz, Rebecca	NIH
10	Okuyemi, Kola	Department

Goals for FY22

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. Delaney, R. K., N. M. Pinto, E. M. Ozanne, H. Brown, L. A. Stark, M. H. Watt, M. Karasawa, A. Patel, M. T. Donofrio, M. M. Steltzer, S. G. Miller, S. L. Zickmund and A. Fagerlin (2021). "Parents' decision-making for their foetus or neonate with a severe congenital heart defect." Cardiology in the young: 1-8. DOI: 10.1017/s1047951121003218.
2. Frost, C. J., E. P. Johnson, B. Witte, L. Stark, J. Botkin and E. Rothwell (2021). "Electronic informed consent information for residual newborn specimen research: findings from focus groups with diverse populations." J Community Genet **12**(1): 199-203. DOI: 10.1007/s12687-020-00496-y.
3. Homburger, S. A., D. Drits-Esser, M. Malone and L. A. Stark (2021). "Building Argumentation Skills in the Biology Classroom: An Evolution Unit That Develops Students' Capacity to Construct Arguments from Evidence." The American Biology Teacher **83**(2): 104-111. DOI: 10.1525/abt.2021.83.2.104.

Educational Modules Published Online

1. Cells in Context [Web]. Available: <https://teach.genetics.utah.edu/content/cells/#item2> and <https://learn.genetics.utah.edu/content/cells/>

Materials Developed for Clinical Trials

1. Decision aid for parents of babies diagnosed with severe, life-threatening congenital heart disease (English and Spanish). PI: Angie Fagerlin, PhD, UU Department of Population Health Science.
2. Online tool to assist caregivers of adults with Alzheimer's Disease and other dementias in planning their respite time. PI: Rebecca Utz, PhD, UU Department of Sociology.
3. Interactive, multimedia educational modules for children and teens who have developed psychological distress after being hospitalized for an injury, and for their parents. PIs: Heather Keenan, MD, PhD, MPH; UU Department of Pediatrics; Linda Ewing-Cobbs, PhD, University of Texas Health Science Center at Houston; Shari Wade, PhD, Cincinnati Children's Hospital.
4. Video series for Hispanic women to normalize discussion with their healthcare providers about pelvic floor issues that can develop after giving birth. PI: Ingrid Nygaard, MD, MS, UU Health Obstetrics and Gynecology.

5. Video and brochure to improve prenatal healthcare delivery by enhancing congenital cytomegalovirus (CMV) awareness, teaching preventative measures, and facilitating neonatal screening (English and Spanish). PI: Marissa Diener, PhD, UU Department of Family and Consumer Studies.
6. Two educational videos for patients aged 10–18 at high risk for developing melanoma. PI: Yelena Wu, PhD, UU Department of Dermatology and Huntsman Cancer Institute.
7. Video to inform potential participants about the ValEAR clinical trial. PI: Albert Park, MD, UU Health Pediatric Otolaryngology.

Evaluation Studies for Training Programs

1. GURU: Graduate and Undergraduate Researchers of UCEER program. PIs: James Tabery, PhD, UU Department of Philosophy, and Erin Rothwell, PhD, UU Department of Obstetrics and Gynecology.
2. Genomics Summer Research for Minorities: A Pathway to Promote Diversity in Science Research. PI: Joseph Yost, PhD, UU Department of Pediatrics.
3. Huntsman Cancer Institute PathMaker Programs for Cancer Research. PIs: Donald Ayer, Huntsman Cancer Institute, and Kolawole Okuyemi, UU Department of Family and Preventive Medicine

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. We specialize in small, biological samples (cells, tissue, blood, urine, feces). We homogenize and measure protein content for sample normalization, unusual for metal analysis centers and important for biological research.

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)
- Sample preparation (cells & tissues) by homogenization, with protein concentration determination

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

Personnel

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

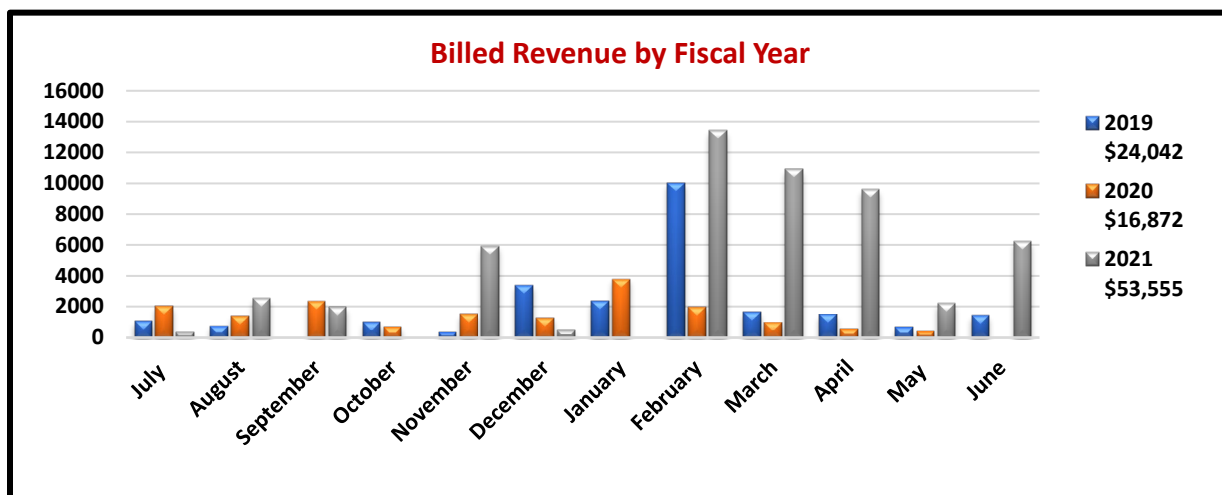
2021 Annual Update

Revenue/Expenses

FY21 Total Expenses: \$22,072

FY21 Total Revenue: \$53,555

- VP of Research Support: \$0
- FY21 Revenue generated from services: \$53,555



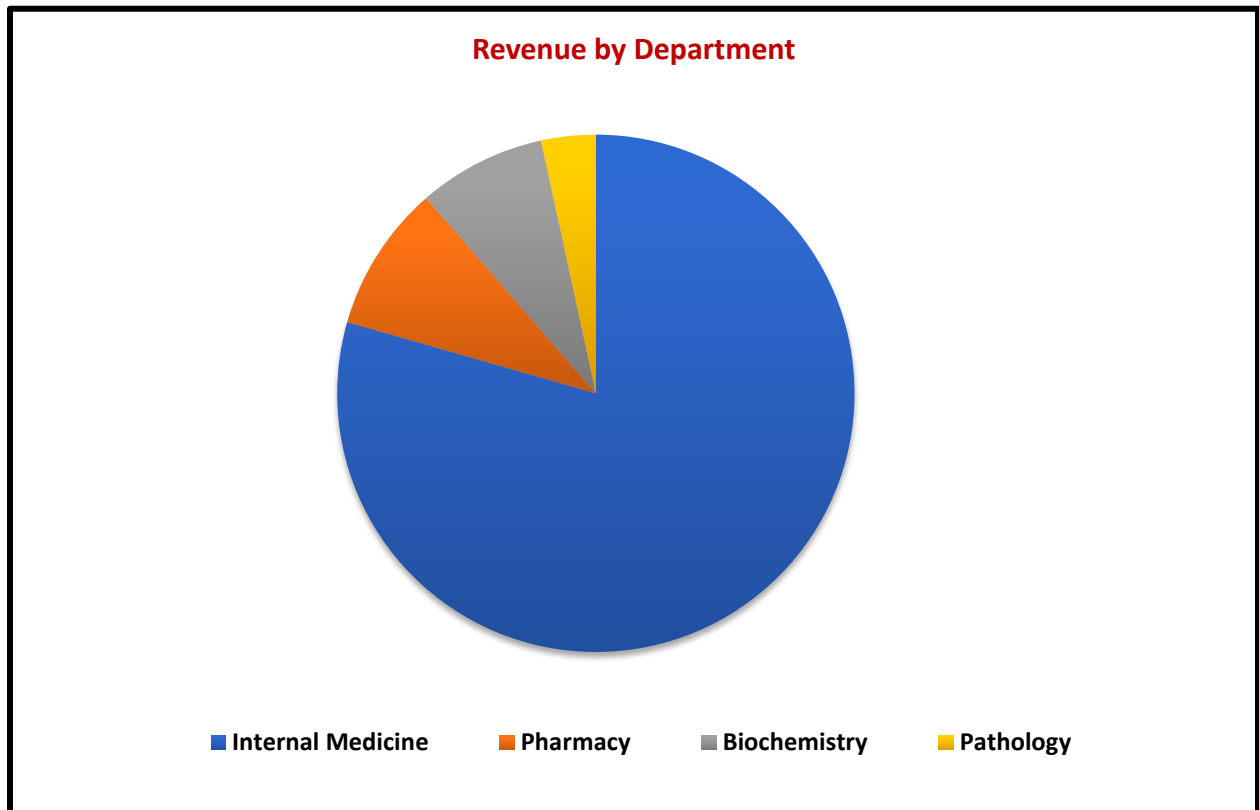
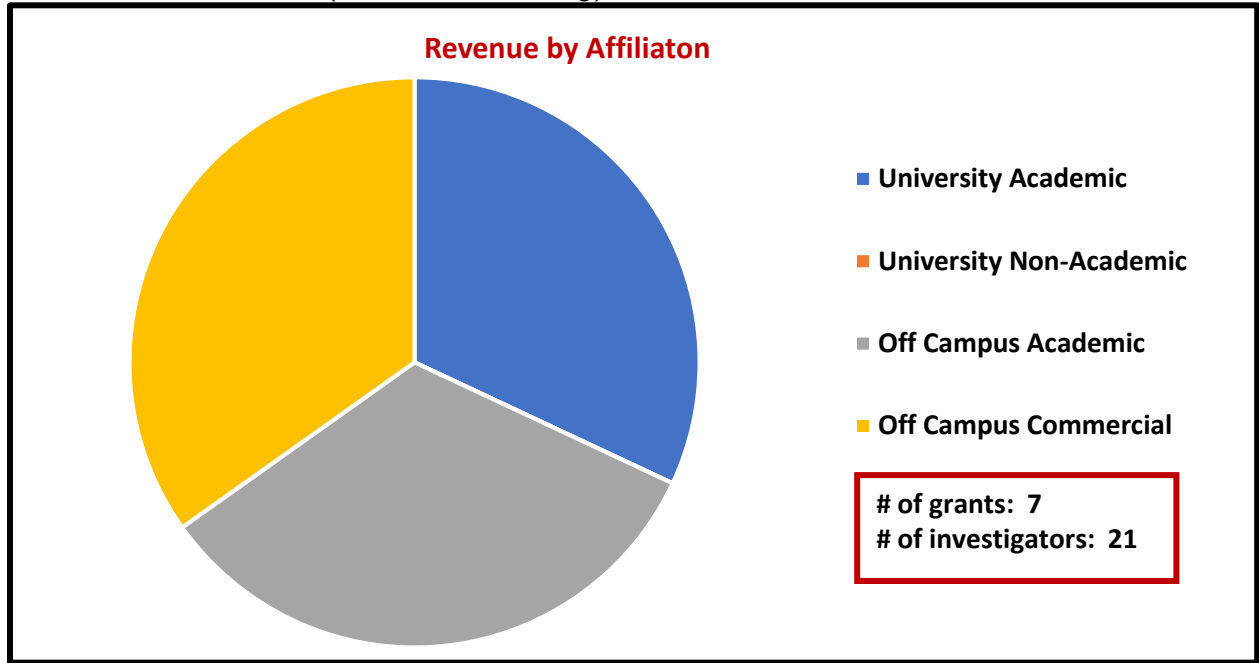
* Legend displays total annual revenue by year earned.

Advisory Board Committee (CIHD Operations Committee)

Last meeting date: July 2, 2021

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

**FY21 Scientific Impact
Research Support
Revenue Generated (see charts following):**



Top Users

1	Phillips, John	NIH
2	Rockefeller University	Off Campus Academic
3	University Wisconsin-Madison	Off Campus Academic
4	Origimm Biotechnology GmbH	Commercial
5	Keros Therapeutics	Commercial
6	University of Pennsylvania	Off Campus Academic
7	University of Washington	Off Campus Academic
8	Massachusetts General Hospital	Commercial
9	East Carolina University	Off Campus Academic
10	Protagonist Therapeutics	Commercial

Goals for FY2021

- Increase awareness of our services
- Balance core responsibilities with 50% time lab responsibilities for LKJ

Publications

1. Biancur, D. E., K. S. Kapner, K. Yamamoto, R. S. Banh, J. E. Neggers, A. S. W. Sohn, W. Wu, R. T. Manguso, A. Brown, D. E. Root, A. J. Aguirre and A. C. Kimmelman (2021). "Functional Genomics Identifies Metabolic Vulnerabilities in Pancreatic Cancer." *Cell Metab* **33**(1): 199-210 e198. DOI: 10.1016/j.cmet.2020.10.018.
2. Parker, A. C., H. A. Bergonia, N. L. Seals, C. L. Bacchanale and E. R. Rocha (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.
3. Pleinis, J. M., L. Norrell, R. Akella, J. M. Humphreys, H. He, Q. Sun, F. Zhang, J. Sosa-Pagan, D. E. Morrison, J. N. Schellinger, L. K. Jackson, E. J. Goldsmith and A. R. Rodan (2021). "WNKs are potassium-sensitive kinases." *Am J Physiol Cell Physiol* **320**(5): C703-C721. DOI: 10.1152/ajpcell.00456.2020.
4. Shetty, T., K. Sishtla, B. Park, M. J. Repass and T. W. Corson (2020). "Heme Synthesis Inhibition Blocks Angiogenesis via Mitochondrial Dysfunction." *iScience* **23**(8): 101391. DOI: 10.1016/j.isci.2020.101391.

F

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, a scanning electron microscope (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 rheometer/ dynamic mechanical analyzer (DMA), a dilatometer, a helium pycnometer, an Instron mechanical testing system, a physisorption analyzer, a particle size analyzer (PSA), carbon and gold sputter coaters, a compression hot-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. In addition to supporting undergraduate classes, student interns can work for two semesters in the lab to gain experience with the machines and professional communication.

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 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
- TA Instruments HR 20 Discovery Hybrid Rheometer with Dynamic Mechanical Analysis (DMA) mode
- Anter Corporation Work Horse IB Dilatometer
- Anton Paar Ultrapyc 5000 helium pycnometer
- Instron 5969 Dual Column Tabletop Testing System
- Micromeritics 3Flex physisorption analyser for BET surface area and pore size
- Micromeritics FlowPrep 060 Sample Degas System
- Beckman Coulter LS230 particle size analyzer (PSA) with polarized light detectors

Sample Preparation

- Mettler AE100 Analytical Balance
- 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

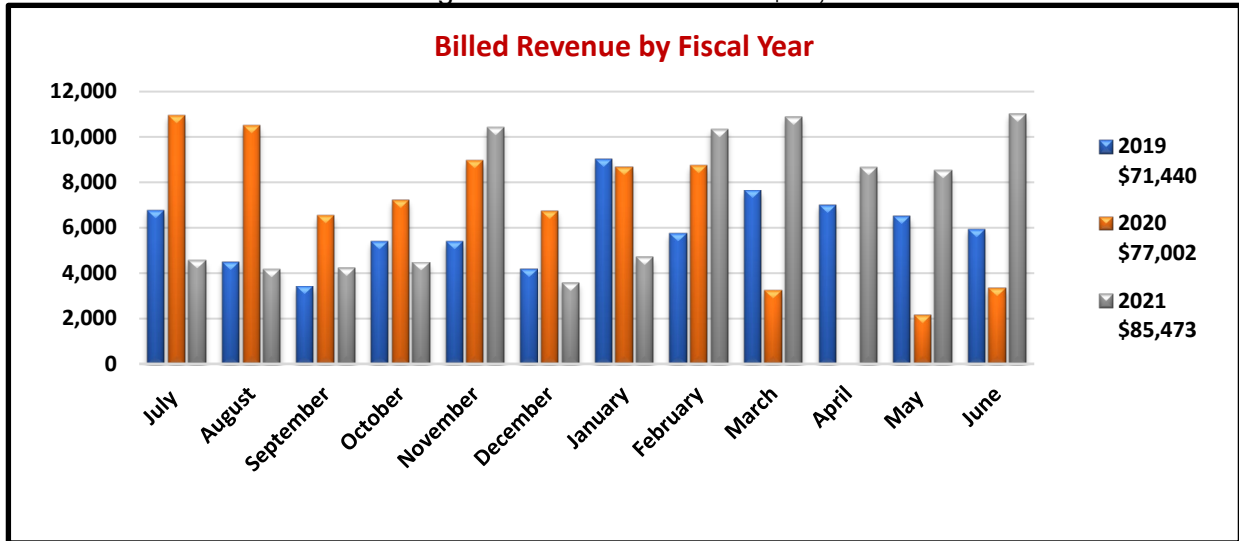
- Angela Nelson, Administrative Officer
- Kimberly Watts, Lab Manager

Revenue/Expenses

FY21 Expenses: Total \$126,438

FY21 Revenue: Total \$85,473

- VP of Research Support: \$ 0
- FY21 Revenue generated from services: \$85,473

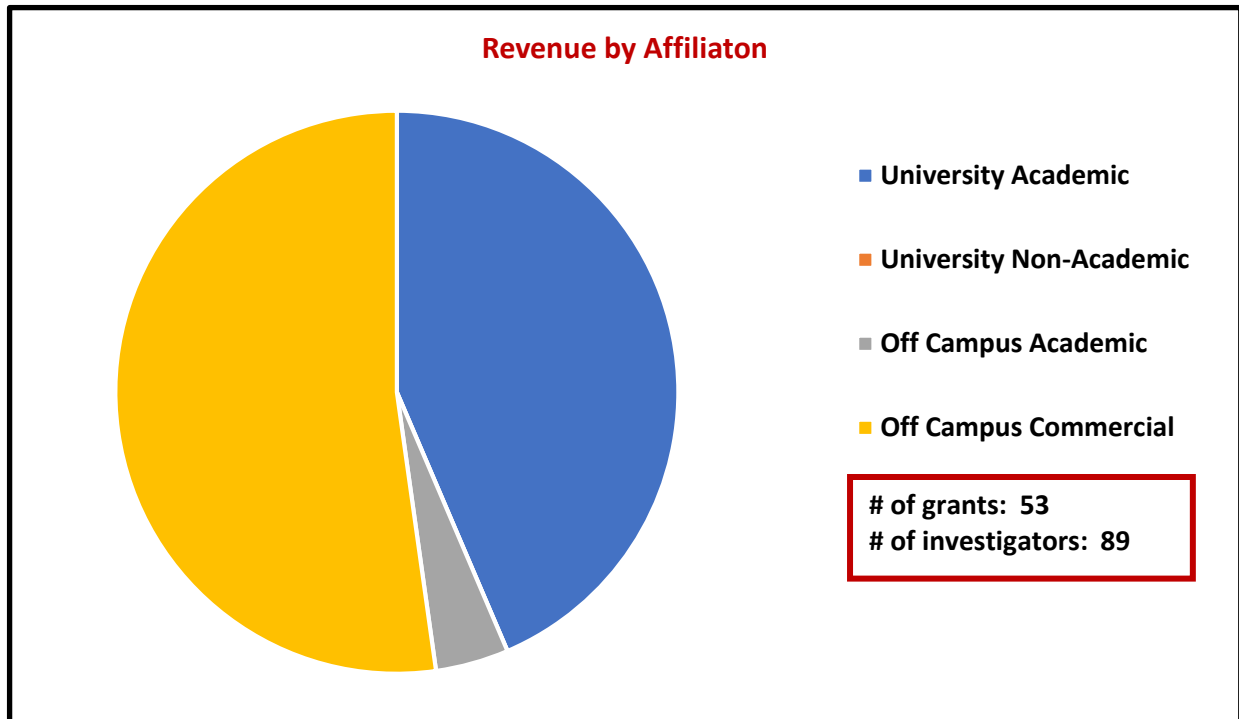


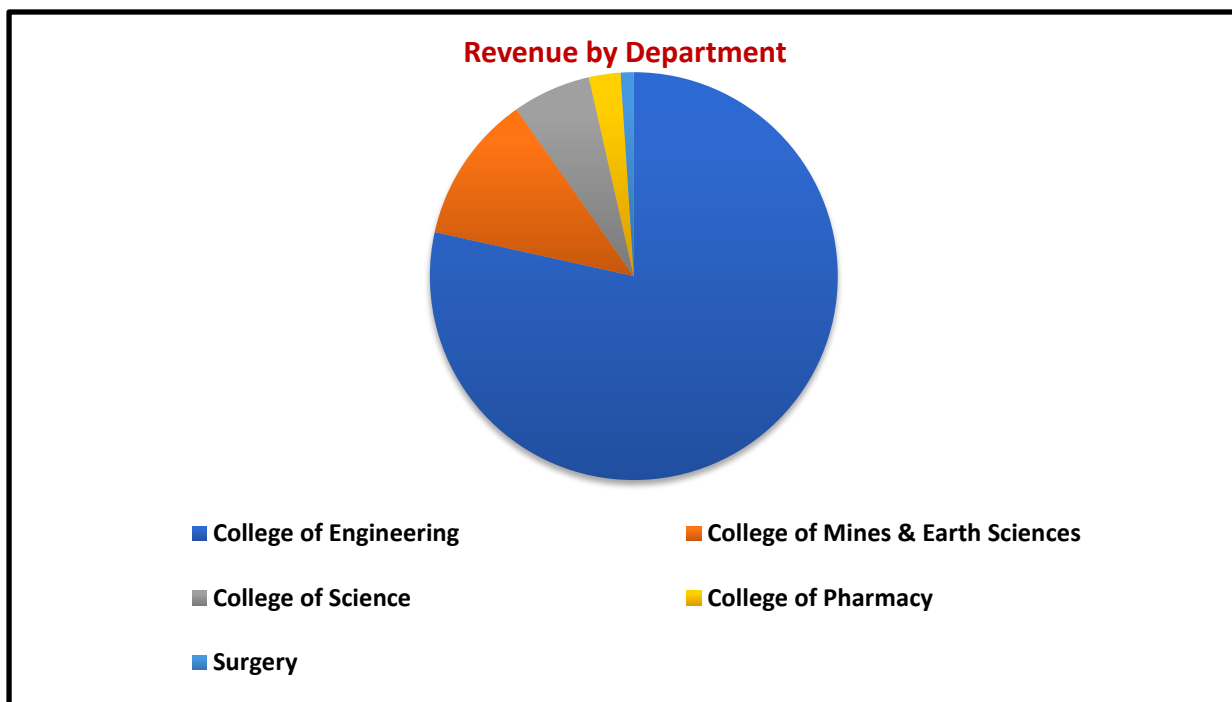
* Legend displays total annual revenue by year earned.

FY21 Scientific Impact

Research Support

Revenue Generated (see charts following):





Top Users

1	SINTX Technologies	Commercial
2	American Oxygen LLC	Commercial
3	OxEon Energy	Commercial
4	109 Therapeutics	Commercial
5	StoargeEnergy	Commercial
6	Virkar, Anil	DOE, NSF
7	Uplift Aerospace LLC	Commercial
8	Utah Material Research	Commercial
9	Zhang, Huanan	Department, NIH
10	Lipocine Inc.	Commercial

Goals for FY21

- Refurbish room 133a for more effective use of space and to make room for more instrumentation
- Build an online analysis submission program to track user’s training and radiation safety certificates

Publications

1. Khan, F., T. Kowalchik, S. Roundy and R. Warren (2021). "Stretching-induced phase transitions in barium titanate-poly(vinylidene fluoride) flexible composite piezoelectric films." *Scripta Materialia* **193**: 64-70. DOI: <https://doi.org/10.1016/j.scriptamat.2020.10.036>.
2. Lim, T., H. J. Kim, H. Zhang and S. Lee (2021). "Screen-printed conductive pattern on spandex for stretchable electronic textiles." *Smart Materials and Structures* **30**(7): 075006. DOI: 10.1088/1361-665x/abfb7f.
3. Sarswat, P., T. Smith, S. Sarkar, A. Murali and M. Free (2020). "Design and Fabrication of New High Entropy Alloys for Evaluating Titanium Replacements in Additive Manufacturing." *Materials (Basel)* **13**(13). DOI: 10.3390/ma13133001.

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

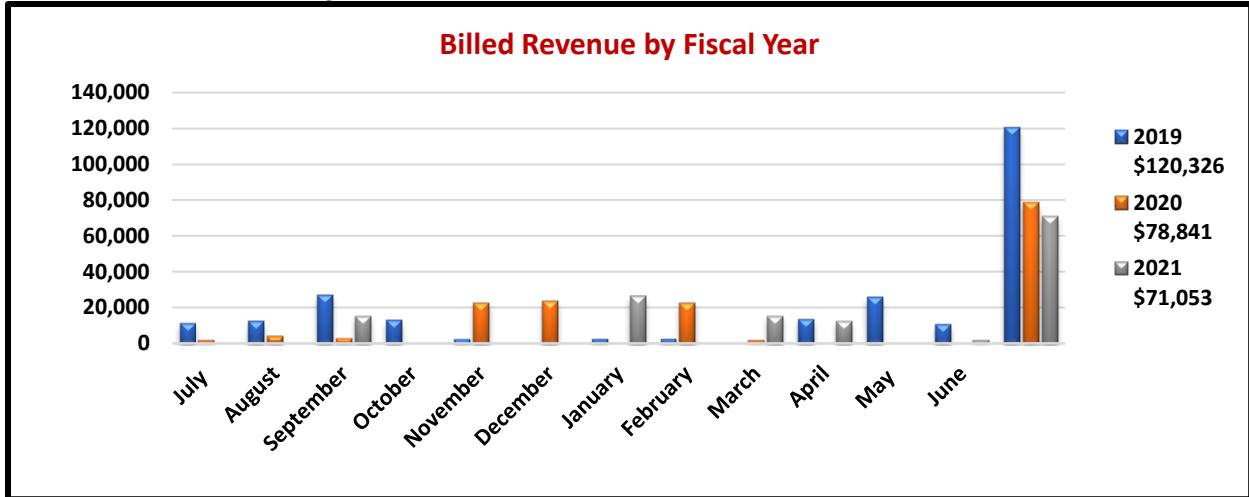
FY21 Annual Update

Revenue/Expenses

FY21 Expenses: \$21,059

FY21 Revenue: \$71,053

- VP of Research Support: \$0
- Revenue generated from services: \$71,053



* Legend displays total annual revenue by fiscal year earned.

Management Meeting

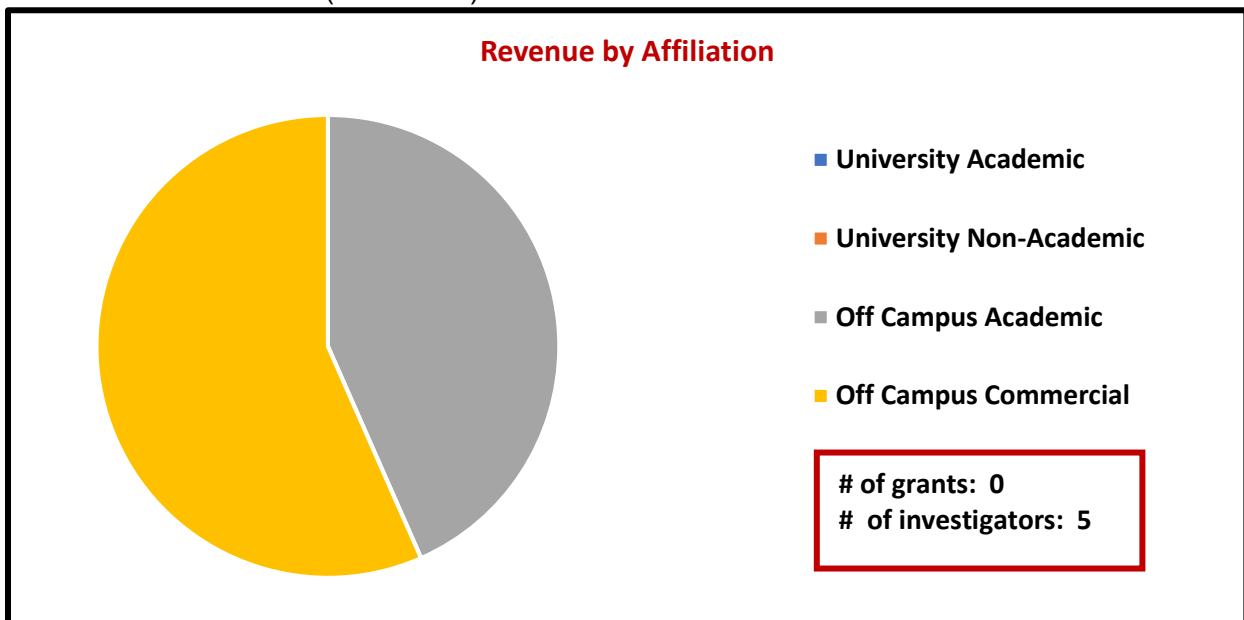
Last meeting date: July 22, 2021

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

FY21 Scientific Impact

Research Support

Revenue Generated (see charts):



Top Users

1	University of Pennsylvania	Off Campus Academic
2	Western Institute for Biomedical Research	Commercial
3	Bedford VA Research Corp, Inc	Commercial
4	Vanderbilt University Medical Center	Commercial

Goals for FY22

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 FY22. We continue to increase the team size and should be able to meet demand across FY22.

Publications

1. Burn, E., S. C. You, A. G. Sena, K. Kostka, H. Abedtash, M. T. F. Abrahao, A. Alberga, H. Alghoul, O. Alser, T. M. Alshammari, M. Aragon, C. Areia, J. M. Banda, J. Cho, A. C. Culhane, A. Davydov, F. J. DeFalco, T. Duarte-Salles, S. DuVall, T. Falconer, S. Fernandez-Bertolin, W. Gao, A. Golozar, J. Hardin, G. Hripcsak, V. Huser, H. Jeon, Y. Jing, C. Y. Jung, B. S. Kaas-Hansen, D. Kaduk, S. Kent, Y. Kim, S. Kolovos, J. C. E. Lane, H. Lee, K. E. Lynch, R. Makadia, M. E. Matheny, P. P. Mehta, D. R. Morales, K. Natarajan, F. Nyberg, A. Ostropelets, R. W. Park, J. Park, J. D. Posada, A. Prats-Urbe, G. Rao, C. Reich, Y. Rho, P. Rijnbeek, L. M. Schilling, M. Schuemie, N. H. Shah, A. Shoaibi, S. Song, M. Spotnitz, M. A. Suchard, J. N. Swerdel, D. Vizcaya, S. Volpe, H. Wen, A. E. Williams, B. B. Yimer, L. Zhang, O. Zhuk, D. Prieto-Alhambra and P. Ryan (2020). "Deep phenotyping of 34,128 adult patients hospitalised with COVID-19 in an international network study." *Nat Commun* **11**(1): 5009. DOI: 10.1038/s41467-020-18849-z.
2. Duarte-Salles, T., D. Vizcaya, A. Pistillo, P. Casajust, A. G. Sena, L. Y. H. Lai, A. Prats-Urbe, W. U. Ahmed, T. M. Alshammari, H. Alghoul, O. Alser, E. Burn, S. C. You, C. Areia, C. Blacketer, S. DuVall, T. Falconer, S. Fernandez-Bertolin, S. Fortin, A. Golozar, M. Gong, E. H. Tan, V. Huser, P. Iveli, D. R. Morales, F. Nyberg, J. D. Posada, M. Recalde, E. Roel, L. M. Schilling, N. H. Shah, K. Shah, M. A. Suchard, L. Zhang, A. E. Williams, C. G. Reich, K. Kostka and D. Prieto-Alhambra (2020). "Baseline characteristics, management, and outcomes of 55,270 children and adolescents diagnosed with COVID-19 and 1,952,693 with influenza in France, Germany, Spain, South Korea and the United States: an international network cohort study." *medRxiv*. DOI: 10.1101/2020.10.29.20222083.
3. Gaziano, L., C. Giambartolomei, A. C. Pereira, A. Gaulton, D. C. Posner, S. A. Swanson, Y. L. Ho, S. K. Iyengar, N. M. Kosik, M. Vujkovic, D. R. Gagnon, A. P. Bento, I. Barrio-Hernandez, L. Ronnblom, N. Hagberg, C. Lundtoft, C. Langenberg, M. Pietzner, D. Valentine, S. Gustincich, G. G. Tartaglia, E. Allara, P. Surendran, S. Burgess, J. H. Zhao, J. E. Peters, B. P. Prins, E. D. Angelantonio, P. Devineni, Y. Shi, K. E. Lynch, S. L. DuVall, H. Garcon, L. O. Thomann, J. J. Zhou, B. R. Gorman, J. E. Huffman, C. J. O'Donnell, P. S. Tsao, J. C. Beckham, S. Pyarajan, S. Muralidhar, G. D. Huang, R. Ramoni, P. Beltrao, J. Danesh, A. M. Hung, K. M. Chang, Y. V. Sun, J. Joseph, A. R. Leach, T. L. Edwards, K. Cho, J. M. Gaziano, A. S. Butterworth, J. P. Casas and V. A. M. V. P. C.-S. Initiative (2021). "Actionable druggable genome-wide Mendelian randomization identifies repurposing opportunities for COVID-19." *Nat Med* **27**(4): 668-676. DOI: 10.1038/s41591-021-01310-z.
4. Klarin, D., S. S. Verma, R. Judy, O. Dikilitas, B. N. Wolford, I. Paranjpe, M. G. Levin, C. Pan, C. Tcheandjieu, J. M. Spin, J. Lynch, T. L. Assimes, L. Aldstedt Nyronning, E. Mattsson, T. L. Edwards, J. Denny, E. Larson, M. T. M. Lee, D. Carrell, Y. Zhang, G. P. Jarvik, A. G. Gharavi, J. Harley, F. Mentch, J. A. Pacheco, H. Hakonarson, A. H. Skogholt, L. Thomas, M. E. Gabrielsen, K. Hveem, J. B. Nielsen, W. Zhou, L. Fritsche, J. Huang, P. Natarajan, Y. V. Sun, S. L. DuVall, D. J. Rader, K. Cho, K. M. Chang, P. W. F. Wilson, C. J. O'Donnell, S. Kathiresan, S. T. Scali, S. A. Berceci, C. Willer, G. T. Jones, M. J. Bown, G. Nadkarni, I. J. Kullo, M. Ritchie, S. M. Damrauer, P. S. Tsao and P. Veterans Affairs Million Veteran (2020). "Genetic Architecture of Abdominal Aortic Aneurysm in the Million Veteran Program." *Circulation* **142**(17): 1633-1646. DOI: 10.1161/CIRCULATIONAHA.120.047544.
5. Lane, J. C. E., J. Weaver, K. Kostka, T. Duarte-Salles, M. T. F. Abrahao, H. Alghoul, O. Alser, T. M. Alshammari, P. Biedermann, J. M. Banda, E. Burn, P. Casajust, M. M. Conover, A. C. Culhane, A. Davydov, S. L. DuVall, D. Dymshyts, S. Fernandez-Bertolin, K. Fister, J. Hardin, L. Hester, G. Hripcsak, B. S. Kaas-Hansen, S. Kent, S. Khosla, S. Kolovos, C. G. Lambert, J. van der Lei, K. E. Lynch, R. Makadia, A. V. Margulis, M. E. Matheny, P. Mehta, D. R. Morales, H. Morgan-Stewart, M. Mosseveld, D. Newby, F. Nyberg,

- A. Ostropolets, R. W. Park, A. Prats-Uribe, G. A. Rao, C. Reich, J. Reys, P. Rijnbeek, S. M. K. Sathappan, M. Schuemie, S. Seager, A. G. Sena, A. Shoaibi, M. Spotnitz, M. A. Suchard, C. O. Torre, D. Vizcaya, H. Wen, M. de Wilde, J. Xie, S. C. You, L. Zhang, O. Zhuk, P. Ryan, D. Prieto-Alhambra and O.-C.-. consortium (2020). "Risk of hydroxychloroquine alone and in combination with azithromycin in the treatment of rheumatoid arthritis: a multinational, retrospective study." *Lancet Rheumatol* **2**(11): e698-e711. DOI: 10.1016/S2665-9913(20)30276-9.
6. Lynch, K. E., P. R. Alba, O. V. Patterson, B. Viernes, G. Coronado and S. L. DuVall (2020). "The Utility of Clinical Notes for Sexual Minority Health Research." *Am J Prev Med* **59**(5): 755-763. DOI: 10.1016/j.amepre.2020.05.026.
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