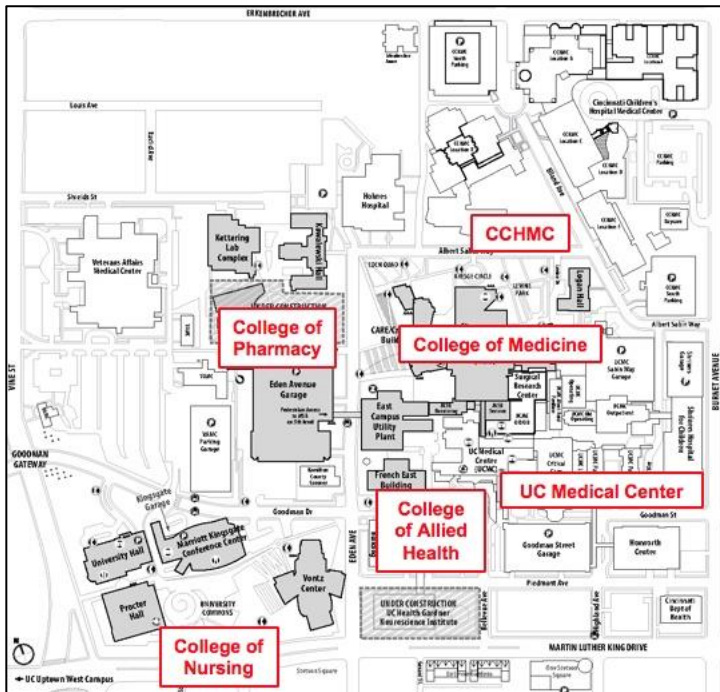


FACILITIES AND OTHER RESOURCES OF CCTST AND AFFILIATES



A. OVERVIEW

A robust cadre of investigators, trainees, and staff from each of the CCTST affiliate institutions are actively involved in CCTST programs and/or directly derive benefit from it. A representative example of high-impact publications from University of Cincinnati (UC) and its affiliates demonstrates the quality of ongoing research at our institutions (see **Overall**). The geographic proximity (six square blocks) of the Academic Health Center (AHC) institutions (shown in figure) promotes team science and collaboration. All of the partners are committed to the success of the CCTST. UC is classified as a “highest research activity” institution by the Carnegie Commission and is ranked 54th in total R&D expenditures among all colleges and universities (n=901) by the National Science Foundation. From all sources, **UC and its affiliates** received \$423 million in sponsored program funding in FY 2018. Of this total, \$107 million was for the AHC. In 2018, nearly 88% of the \$201 million in UC research awards (excluding

affiliates) was from federal sources, including \$72 million from the NIH. Full-time, part-time, and adjunct/volunteer/visiting faculty at the College of Medicine (COM) (excluding pediatrics) number 946, distributed among five basic science and 18 clinical departments. *Cincinnati Children's Hospital Medical Center (CCHMC)*, home to faculty of the UC Department of Pediatrics, has 982 full- and part-time faculty and is a strength of the AHC and CCTST, having received \$222 million in total research funding in FY 2018, with \$144 million from the NIH, the second-largest total for a pediatric center nationally. Research efforts were supplemented by \$60 million from CCHMC and Cincinnati Children's Research Foundation (CCRF) endowment funding. The Department of Pediatrics has 54 research divisions. The *James L. Winkle College of Pharmacy* has 35 faculty. The College's research-intensive MS/PhD program has 40 students across three disciplines: Biomembrane Sciences, Drug Development, and Social and Administrative Sciences. The College has 375 students in its four-year PharmD program and 150 graduate students enrolled in online Master's programs. The *College of Nursing* is ranked 45th among 527 ranked U.S. Nursing schools and 10th among 179 online MSN programs by *U.S. News & World Report*. The College has 73 faculty, and 2018-19 enrollment included 3,124 undergraduate and graduate students. The 28 PhD students focus on specific research interests and methods under the direction of faculty nurse scientists. The *College of Allied Health Sciences* has 287 faculty and 2,912 students, including Master's and doctoral students. The College houses Departments of Clinical and Health Information Sciences, Communication Sciences and Disorders, Rehabilitation, Exercise, and Nutrition Sciences, and the School of Social Work. Faculty/trainees from the UC undergraduate campus (a short shuttle ride from the AHC), which includes the Colleges of Design, Architecture, Art and Planning (DAAP, routinely ranked among the top design schools in the world), Engineering and Applied Sciences (CEAS), Business, Arts and Sciences, Law, and Education, Criminal Justice and Human Services (CECH), support CCTST services or obtain support from it.

UC Health, established in 2009, is an integrated academic health system serving the Cincinnati region. UC Health includes UC Medical Center (UMC), West Chester Hospital, Daniel Drake Center for Post-Acute Care, Bridgeway Pointe Assisted Living, UC Physicians, Lindner Center of HOPE and several specialized institutes. Many UC Health locations have received national recognition for outstanding quality and patient satisfaction. In FY 2018, UC Health served more than 437,000 unique patients through 1.8 million encounters across four inpatient campuses and 58 outpatient locations. UC Health's emergency departments received 125,000 visits.

CCHMC is a 700-bed non-profit organization serving as the AHC's pediatric teaching facility and as the only children's hospital in the Cincinnati metropolitan area. CCHMC ranked 2nd on the 2018-19 Honor Roll of America's Best Children's Hospitals compiled by *U.S. News & World Report*. CCHMC offers 16 patient care

sites throughout the region, the area's only Level I pediatric trauma center and pediatric cardiac ICU, and a satellite campus for psychiatric services. In FY 2018, CCHMC had 1,034,596 outpatient visits, 32,326 admissions, 173,023 emergency department and urgent care visits, and 34,295 surgical procedures, serving patients from all 50 states and 51 countries.

Sponsored program awards for the **Cincinnati Children's Research Foundation** (CCRF), home to faculty of the UC Department of Pediatrics, totaled \$222 million in FY 2018. Of this total, 65% (\$144 million) was NIH-funded. Overall, 73% of sponsored CCRF research (\$163 million) was federally funded. Industry, foundation and other non-federal support was 27% of total sponsored funding, or \$59 million. CCRF efforts were supplemented by internal funding for laboratory and applied research costs. The CCRF has 54 research divisions and 982 faculty, 895 of whom have full-time appointments. The Department of Pediatrics accounts for 753 of the faculty total (704 are full-time). In FY 2018, CCHMC trained 272 clinical fellows, covering nearly all of the sub-specialty areas; 181 research post-doctoral fellows; and 200 pediatric residents. All told, CCRF research resulted in the publication of more than 2,300 peer-reviewed articles in FY 2018.

The AHC campus includes 16 buildings spanning nearly 2.5 million gross sq. ft. on 56 acres in the central Cincinnati neighborhoods of Avondale and Corryville. The Medical Sciences Building (MSB), at the center of the AHC, comprises 917,000 gross sq. ft., with 200 research laboratories totaling over 210,000 sq. ft., as well as all the preclinical and clinical departments of the COM (except Pediatrics), the Health Sciences Library, classrooms, teaching laboratories, and animal facilities. The MSB, which opened in 1974, is physically joined to UC Medical Center (formerly University Hospital), described below. The attached 9 story, 240,000 gross sq. ft. Center for Academic & Research Excellence (CARE)-Crawley wing, which opened in September 2008, encompasses over 70,000 sq. ft. of laboratories as well as library, administrative, meeting and recreational space. These upgrades foster the continued growth of the AHC's biomedical research grants and contracts, just as the addition of the MSB, the Cardiovascular Center (1996), the free-standing Vontz Center for Molecular Studies (1999), and the Reading Campus/Metabolic Diseases Institute (2001) have done. Formerly known as the Genome Research Institute (GRI), the Reading Campus is located 8 miles north of the AHC and is comprised of 10 buildings containing over 382,000 gross sq. ft. of laboratory and office space on a 25-acre campus. This Campus houses research faculty in the Metabolic Diseases Institute, focusing on diabetes and obesity, lipids and arteriosclerosis, and cancer metabolism. The Campus includes about 30 principal investigators and over 300 staff.

The **Department of Internal Medicine** is home to 305 faculty from 9 divisions, 121 residents, 80 fellows and 374 staff. Administratively, it is divided into 4 areas: educational, clinical, research and veterans affairs. Physicians within the Department are part of the UC Health University of Cincinnati Physicians group practice, providing comprehensive clinical services in primary care and all medical subspecialties. New clinical practice programs include a diabetes center, sleep center and heart and vascular center. The Department is deeply committed to its research mission and to the training of future clinical investigators and researchers in foundational, clinical, translational, outcomes and other health care-associated research areas. Faculty research is often interdisciplinary and collaborative between clinical and basic scientists, including projects with investigators at Cincinnati Children's Hospital Medical Center, the Cincinnati VA Medical Center, the James L. Winkle College of Pharmacy, and the College of Education, Criminal Justice and Human Services. The Department has particular research strengths in: cancer, with numerous collaborators across the Academic Health Center, including the CCHMC Hematology Oncology Unit; cardiovascular health, including a Cardiovascular Center of Excellence; digestive diseases, including the Hepatology Research Group, one of the premier research groups involved in the study of HCV and HBV co-infections in the context of HIV; diabetes and obesity; infectious diseases, including the AIDS Clinical Trial Unit; outcomes research; rare lung diseases including LAM and pulmonary alveolar proteinosis; and sickle cell disease, including participation in national clinical trials of the Sickle Cell Research Network.

University of Cincinnati Gardner Neuroscience Institute: The UC Gardner Neuroscience Institute (UCGNI) offers its patients unparalleled access to cutting-edge research, world-class clinical trials, the most advanced technology and the latest innovations in medical treatment and care. We are also home to the nation's first teaching hospital, educating the next generation of healthcare professionals. UCGNI includes the region's only Comprehensive Stroke Center, Level IV (highest) Epilepsy Center, and Level I (highest) Trauma Center and Neurocritical Care facility. We are the national coordinating center for StrokeNet, a member of the Network for Excellence in Neuroscience Clinical Trials, Cincinnati's hub for the Cancer Genome Atlas Research Network,

and founding member of the National Network of Depression Centers. UCGNI is made up of more than 125 faculty members representing 15 clinical specialties. In the past year, UCGNI has performed more than 2,500 surgeries, appeared in over 100 published articles in peer-reviewed academic journals, and had 67 corporate studies and 49 University of Cincinnati studies in neurology.

Centers of Excellence: Through its 2007-2008 strategic planning process, the CoM identified 4 Centers of Excellence: cancer, cardiovascular disease, neuroscience, and diabetes and obesity. These are areas in which the CoM has recognized quality, a track record of success, opportunities for funding, and an ability to advance translational research and deliver high-quality personalized care. The CoM will also continue to develop programs in gastrointestinal disorders, immunology, inflammation and infectious diseases. Broad themes for the Centers include women's health, diseases across the life cycle, multidisciplinary critical care services, innovative technology and environmental and urban health care. The Centers are a focal point of UC's \$1 billion fundraising campaign.

James L. Winkle College of Pharmacy, the first west of the Alleghenies, was established in 1850 as a private, independent college of pharmacy and joined UC in 1954. It assumed its current name in 2007 to recognize a \$10 million gift to fund scholarships, research and faculty recruitment. The College has 35 faculty members. The College's research-intensive MS/PhD program has 40 students across three disciplines: Biomembrane Sciences, Drug Development, and Social and Administrative Sciences. The College has 375 students in its 4-year PharmD program, offered since 2000, and 150 graduate students. Extramural faculty research funding was over \$9.7 million in FY 2018, 115% more than 2014. Areas of interest include pharmacoeconomics, cancer, dermatology, drug penetration, drug delivery technology, cosmetic science, cardiovascular disease, infectious disease, and neuropharmacology.

Founded in 1889, the **College of Nursing** is ranked among the top U.S. Nursing schools by *U.S. News & World Report*. The first college to offer a baccalaureate degree in nursing (1916), it has offered a doctorate program since 1990, the same year in which a Center for Nursing Research, now the Institute for Nursing Research and Scholarship, was developed. Additional programs include an RN to BSN online program, an accelerated program, and a master of science in nursing program with a spectrum of online and onsite specialties available. In 2003, it became the first college of nursing in Ohio to offer a cooperative education program, which now includes University of Cincinnati Medical Center and Cincinnati Children's Hospital Medical Center. The College's 73 faculty received \$2.1 million in extramural funding in 2018. Programs and research are supported by organizations such as the Midwest Nursing Research Society, Sigma Theta Tau, the Transcultural Nurses Society and various federal agencies within the U.S. Department of HHS including the CDC and HRSA. Research areas include nursing education innovations, interpersonal violence, vulnerable populations and health disparities, aging, and co-morbid conditions. Enrollment includes 3,124 undergraduate and graduate students. The 28 PhD students focus on specific research interests and methodologies, under the direction of senior faculty nurse scientists. Established in Fall 2010 with CCTST/CTSA support, the Doctorate of Nursing Practice (DNP) program emphasizes the advanced practice of nursing, utilizing best evidence in the delivery of nursing practice and leadership in complex health care systems. The College is a leader in leveraging technology in health care education and in providing diverse educational opportunities for nurses, including nurse scientists and nurse educators.

Formed in 1998, the **College of Allied Health Sciences** has 287 faculty and 2,912 students, including Master's and doctoral students. The College houses the Departments of Clinical and Health Information Sciences, Communication Sciences and Disorders, Rehabilitation, Exercise, and Nutrition Sciences, and the School of Social Work. Research areas of interest are specific to each program and include child language development, traumatic brain injury, stroke, maternal, childhood and adolescent nutrition, and deafness. Faculty extramural research support in FY2018 was nearly \$3.2 million. The College offers a 5 year MD/MS in Nutrition dual degree program with the College of Medicine, which allows medical students to develop a comprehensive knowledge of human nutrition as well as skills in research design and implementation.

Commitment to Diversity: UC recognizes a very broad and inclusive concept of diversity that includes commonly recognized considerations such as race, ethnicity, gender, age, disability status, socioeconomic status, gender identity and expression, sexual identity, sexual orientation, religion, and regional or national origin. A 5-year diversity plan was adopted in 2011 which included as major goals: 1) attract, retain and graduate academically prepared, diverse students; 2) attract, retain and promote an increased number of

historically underrepresented and other diverse faculty in tenure and clinical track positions; and 3) develop/strengthen partnerships with diverse communities and groups locally, nationally and internationally. A university-wide system of accountability and assessment will evaluate and quantify institutional progress. The diversity plan may be viewed at

The AHC has 2 core facilities offering services in epidemiology and biostatistics:

1) The **Center for Biostatistical Services (CBS)** is housed within the Department of Environmental Health of the CoM. Its mission is to leverage grant funding by providing first-rate biostatistical assistance with proposals during their pre-award and post-award phases. The Center is staffed by 7 biostatistics faculty plus several Master's level biostatisticians and graduate students. Services include assistance in formulating and phrasing hypotheses; devising appropriate study designs; calculating sample size and power; and managing and analyzing data. CBS faculty also teach a course in biostatistics consulting.

2) Services of the **Division of Biostatistics and Epidemiology (DBE)** at CCHMC include guidance and assistance in developing study designs and protocols, creating data collection instruments and databases, developing data management protocols, and crafting analysis plans. The DBE also provides input on grant applications and complete data analysis services. In addition to these core services, DBE faculty conduct their own research, focusing on research methodologies and population-based investigation of disease etiology and prevention strategies.

The **Center for Surgical Innovation (CSI)** was established by the Department of Surgery in 2003 to develop, assess, and disseminate new technologies in biomedical and surgical care through partnerships and collaborations across the university and nationally with industry, government and other academic health centers. Made possible by philanthropic and industry donations, and operated in partnership with the Departments of Emergency Medicine and Biomedical Engineering and CCHMC, this core facility is a 3,700 square foot state-of-the-art laboratory in the MSB that supports a variety of activities including research, teaching, training, and product evaluation and validation. The Center includes a sterile surgical suite with the latest technology, 7 workstations, videoconferencing and telemedicine capability, and a conferencing facility. Both animate (animal) and inanimate (cadaver) models can be used for teaching, training and research.

The **UC Reading Campus and Metabolic Diseases Institute** were created to foster excellence in biomedical research—from basic science to translational medicine—and facilitate collaboration among academic and industrial researchers. The Campus houses world-class scientists, more than 350,000 square feet of state-of-the-art laboratories, and cutting-edge technology, core laboratories, and animal housing facilities. Formerly known as the Genome Research Institute (GRI), the Reading Campus became part of UC in 2001 through a major property gift from Aventis Pharmaceuticals, which included 10 buildings situated on a 25 acre campus. UC and the State of Ohio provided approximately \$50 million to finance renovation of the research buildings and construction of a new power plant. Funds were also committed for the recruitment of new faculty, facility management and administration, and day-to-day operations. Today, the GRI employs approx. 30 principal investigators and over 300 research and support personnel. The Metabolic Diseases Institute focuses research efforts on diabetes and obesity, lipids and arteriosclerosis, and cancer metabolism. The interdisciplinary research program at GRI features core facilities for drug discovery, proteomics, structural biology, protein production, and animal phenotype analysis.

B. TRAINING PROGRAMS

Master of Science and Certificate in Clinical and Translational Research: Designed for clinical professionals with terminal degrees (MD, PhD, PharmD, etc.) seeking to become independent clinical or translational investigators, the MS in Clinical Research program was established in 2005 to provide training to translate scientific advances into applications for improved clinical practice and human health

(<http://med.uc.edu/eh/divisions/epi/programs/ms-clinical-translational-research>). The program combines didactic course work, seminars, and individual mentoring to enable clinicians to develop the analytic and quantitative skills necessary to conduct research within their own specialty area. Students must complete 30 graduate credit hours and thesis research and select one of 5 concentrations: Clinical Epidemiology/Clinical Effectiveness; Molecular Epidemiology; Clinical Trials; Translational Research; or Biomedical Informatics. A 10 credit hour Certificate program was added in 2009, which may be taken online as of 2011. Faculty are drawn from several departments of the Colleges of Medicine and Pharmacy. All program faculty are actively

engaged in clinical studies. The MS in Clinical Research program is funded in part by the CCTST and by student tuition and institutional support, and is directed by Aimin Chen, PhD and Patrick Ryan, Ph.D Currently 60 students are enrolled in the MS program, and 46 in the Certificate.

Molecular Epidemiology in Children's Environmental Health: This interdisciplinary training program, funded in part by an NIH T32 training grant (Ranjan Deka, PhD, PI) equips predoctoral students, resident/fellow MDs, and postdoctoral PhDs with the knowledge and skills to undertake epidemiological and clinical studies using molecular markers of exposure, effect, and susceptibility. Housed within the Department of Environmental Health, the program also involves faculty from the Departments of Pediatrics and Molecular Genetics, Biochemistry and Microbiology. Training consists of didactic course and laboratory experience utilizing state-of-the-art methodology in molecular methods. Students participate in health studies examining the impact of environmental exposures on complex diseases and disorders, such as obesity, allergy and asthma, diabetes, cardiovascular disorders, neurological disorders, and juvenile arthritis. Full tuition and an annual stipend are provided.

MS and PhD in Epidemiology: Offered through the Department of Environmental Health, the MS requires 1 year of full-time graduate study or its equivalent, and a minimum of 30 graduate credits in addition to a written thesis. The PhD requires 3 years of full-time graduate study or its equivalent, and a minimum of 90 graduate credits, 60 of which must be from didactic course work, in addition to the dissertation. Courses required of both degrees include Environmental Health Seminar, Epidemiology and Biostatistics Seminar, Ethics in Research, Introduction to Biostatistics, Introduction to Epidemiology, Introduction to SAS Programming, Design & Management of Field Studies in Epidemiology, and Molecular Epidemiology. Additional course requirements of the PhD include Advanced Physiology, Regression Analysis, Experimental Design, and Categorical Data Analysis (Rates & Proportions).

MS in Drug Development: A unique collaboration between academia, industry and government, the MS in Pharmaceutical Sciences with Specialization in Drug Development is offered through the College of Pharmacy and designed as a 2-year part-time curriculum primarily intended for full-time employees in the Cincinnati metropolitan region. Established in 2004, the program is open to individuals holding post-baccalaureate degrees in pharmacy, nursing, medicine and other related biomedical sciences. Courses include Global Drug Development, Pre-clinical Product Development, Regulatory Affairs, Clinical Trials Design, Project Management, Drug Delivery Devices, Pharmacovigilance, and Pharmacoeconomics. A total of 30 credit hours are required for the degree. The program was developed through close collaborations between the College of Pharmacy and other units of the AHC, regional pharmaceutical companies, and clinical research organizations. **Master of Public Health:** The UC MPH program was approved by the Ohio Board of Regents in December 2007 and began enrolling students in September 2008. Housed in the Department of Environmental Health (described above), its mission is to prepare students for leadership in public health practice and research by generating, evaluating, and applying evidence to improve the public's health. This education will be provided from a multidisciplinary perspective, employing active-learning strategies, and in collaboration with the full array of community institutions and organizations involved in the health of the public. The UC MPH program is one of the first public health training programs in the nation to emphasize an evidence-based approach to safeguarding and improving the public's health. In cooperation with the Health Promotion and Education Program of the Division of Human Services, the MPH is also offered with a concentration in Health Education. This is primarily a practitioner's degree for those desiring to work as public health educators in departments of public health, voluntary agencies and other community health organizations. In cooperation with Environmental Health faculty, concentrations in environmental public health and biostatistics were added in 2012. The UC MPH program became a founding member of the Association of Schools and Programs of Public Health (ASPPH) in 2013.

MD/MS in Nutrition Program: Offered jointly by the Colleges of Medicine and Allied Health Sciences, the MD/MS in Nutrition dual-degree program is completed over 5 years, with core courses and guided electives for the MS typically completed between the 3rd and 4th years of medical school. The required master's thesis is completed during the 4th year of medical school. The program provides medical students with: 1) a comprehensive knowledge in the biochemical and physiological aspects of human nutrition; 2) knowledge of methodologies used in nutrition research and nutrition intervention and 3) skills in research design, implementation, evaluation, and interpretation. The combined knowledge of nutrition and medical principles

encourages multidisciplinary approaches to investigative efforts of major public health problems such as diabetes, obesity, cardiovascular disease and cancer, and improves the ability of the practitioner to use behavioral strategies to enhance patient compliance with lifestyle recommendations.

MD/MBA Program: Offered jointly by the UC CoM and Carl H. Lindner College of Business, this dual degree program is designed for highly qualified students who desire to complement their standard medical education with a greater understanding of the economics, finance, marketing and management of the health care system. Students apply during their second or third year of medical school. The program typically takes 5 years to complete via one of 3 curriculum pathways. Graduates have expanded career options including management positions in major health care organizations.

Graduate Programs in Biomedical Sciences

CoM programs included 549 graduate students with 64 MD/PhD students and 261 postdoctoral fellows in 2018-19.

Biomedical Informatics: The Doctor of Philosophy in Biomedical Informatics Program at the University of Cincinnati, which commenced in 2015, provides an in-depth knowledge of the key analytical concepts that underlie applications of informatics and data science to biomedical research. The program leverages partnerships between the CoM, CCHMC, and the UC College of Engineering and Applied Sciences in order to provide a framework of transdisciplinary educational opportunities. The program has assembled a group of 36 informatics faculty spanning three Colleges, five College of Medicine Departments, and ten CCHMC Divisions. Coursework and fields of study span topics of computer and decision science, computational and systems biology, bioinformatics, clinical informatics, public health informatics, and biostatistics. The program currently includes 17 students, including MDs and MD/PhD students. Coursework is individualized by adapting to student background and prior proficiency. An environment of professionalism and collaboration among world-class research groups, faculty, and students is the foundation to educating the next generation of biomedical data scientists. In addition, the Department dually operates a graduate certificate program in biomedical informatics with the UC School of Engineering, and closely coordinates with Engineering's computer science (bioinformatics track) PhD program. The Department also works closely with other area organizations on pipeline programs (e.g., UC and Northern Kentucky University undergraduate and graduate programs; COM's Summer Undergraduate Research Fellowship program) for student recruitment, and various relevant UC-based PhD and MSTP programs for informatics cross-training opportunities for these students. Courses for these programs are shared when possible. The Department also commenced a pediatric medical residency program in clinical informatics in the Fall of 2016.

Cancer and Cell Biology: The Interdisciplinary Graduate Program in Cancer and Cell Biology is a large, interdepartmental graduate program with expertise in many critical areas of modern cancer and cell biology. The Program involves more than 75 faculty from 12 Departments in the UC CoM and CCHMC and is administered from the Department of Cancer and Cell Biology. Faculty selected to join the program are recognized leaders in their fields, and provide excellence and dedication in graduate training. As a consequence, the Program's graduate students excel in research and are highly successful in their scientific careers. Successful completion of the Program typically involves 4 to 5 years beyond the bachelor's degree, varying according to background and special interests. The Program's philosophy is that PhD training must be intellectually stimulating, congenial, and geared toward a successful career in modern research. Requirements include 90 credit hours (30 of which are coursework), successful completion of the Doctoral Qualifying Examination in the Program's second year, and thesis.

Environmental Health: For decades, one of the top-funded academic units of its type in the country, the Department of Environmental Health (DEH) has the largest graduate program in the CoM, offering training in epidemiology and biostatistics, environmental genetics and molecular toxicology, industrial and occupational hygiene, occupational and environmental medicine, and public health. Research centers housed in the DEH include the NIEHS-funded Center for Environmental Genetics (CEG), whose mission is to promote integrative research among basic and applied scientists, epidemiologists and clinicians to develop an understanding of the complex relationship between genetic predisposition factors and environmental exposures. Training programs include the interdisciplinary Molecular Epidemiology in Children's Environmental Health, funded in part by an NIH T32 grant, which equips predoctoral students, resident/fellow MDs, and postdoctoral PhDs with the knowledge and skills to undertake epidemiological and clinical studies

using molecular markers of exposure, effect, and susceptibility. The DEH also houses the MS and Certificate in Clinical and Translational Research described in CCTST section 7 above, which require 30 and 10 semester credit hours respectively, offered in multiple tracks.

Immunology: Study of the immune system in health and disease, from the molecular level to that of whole organisms, has become a major focus of biomedical research over the last decade. The Immunology Graduate Program at UC and CCHMC aims to provide unparalleled training for the next generation of forward-thinking and innovative immunologists. The program offers rigorous coursework and practical training in some of the world's most outstanding immunology laboratories. The top-notch faculty's extensive experience in teaching and expertise in all areas of immunology provides the student with a well-rounded immunology training experience and preparedness for a post-graduate career path in immunology. The Program provides access to outstanding core facilities including state-of-the-art flow cytometry and cell sorting, 2-photon imaging, gene targeting and transgenic mouse core, bioinformatics core, gene expression core, pluripotent stem cell facility, laser capture microdissection core, viral vector core, and many others. All PhD students accepted to the program receive full tuition remission, a nationally competitive stipend and a health insurance plan. The Immunology Graduate Program also offers full-time and part-time tracks leading to the MS degree.

Molecular and Developmental Biology: Based at CCHMC, the Molecular and Developmental Biology Graduate Program offers world-renowned faculty leading research teams integrating basic research in model organisms with translational research into disorders and diseases in children. Major research areas include cancer biology, cardiovascular biology, gastrointestinal development, genetics/gene therapy, genomics/bioinformatics, hematopoietic system, immunology, molecular embryology, neurobiology, other organ systems, pulmonary biology, reproductive biology, stem cell biology, and visual systems. The musculoskeletal, urogenital, auditory, and integumentary systems are also studied. All students must complete required courses in developmental biology, graduate-level biochemistry, molecular biology and cell biology. As students prepare to enter their second year, they initiate their research and spend more time in the lab and less time in the classroom. The average time to obtain a PhD degree in the MDB Program is 5 years, well below the national average of 6-1/2 years. Most students can fulfill their course requirements in the first 18 months, freeing them to focus on laboratory research and the completion of thesis-related experiments. Students participate in laboratory rotations during the first year to gain insight into areas of interest before choosing a faculty advisor and developing a dissertation project. Students are encouraged and expected to publish their contributions in peer-reviewed scientific journals. Unlike some graduate school programs, students are not required to hold teaching assistantships to help pay for their financial aid, so more time can be spent in the lab conducting research. In addition, students in the Program have many opportunities to share their research findings and polish their presentation skills via an annual symposium of student research presentations, university-wide poster presentation contest, attendance at national meetings, weekly journal clubs, and informal lunches with top scientists from around the world.

Molecular, Cellular and Biochemical Pharmacology Program: Based in the Department of Pharmacology and Cell Biophysics, the Program is designed to provide training for the next generation of scientists, innovators, and leaders in pharmacology. Students engage in a contemporary curriculum including thesis research training in faculty mentored research programs. Thesis research involves novel therapeutic target discovery and adding new knowledge to existing chemical and biological molecular entities. Completion of the Program leads to successful careers in academia and in pharmaceutical and governmental organizations. Students complete a series of laboratory research rotations and build their knowledge foundation by completing basic and advanced courses in cell and molecular biology, receptor pharmacology, advanced topics in pharmacology, laboratory research methods, experimental design (including biostatistics, data analysis and interpretation), biotechnology, seminar presentations and "hot papers" journal club. Classes and research activities require a full-time, year-round commitment. PhD degree requirements can be completed in 4 years. Thesis research areas involve mechanistic and quantitative aspects of potential and established drug targets and development of new biotechnologies for high impact disease interventions through the use of state-of-the-art biotechnology and pharmacological methods. A variety of experimental diseases in transgenic and gene ablated/suppressed models from single molecules to entire organisms are used in research. Students conduct thesis research supported by faculty, department, and institutional state-of-the-art biotechnology laboratory resources including numerous core facilities, high throughput screening for drug targets and drug

entities, genomics, proteomics, gene array, bioinformatics, transgenics, MRI, ultrasound and confocal, imaging, and fluorescent cell sorting. The doctoral program has a 1:1 student to faculty ratio assuring personal mentoring and interactions to closely advise and guide the professional development of each student to a career pathway tailored to his/her interests and strengths.

Molecular Genetics: The Department of Molecular Genetics, Biochemistry and Microbiology currently includes 19 primary faculty, 23 affiliate faculty and 45 graduate students, along with a significant population of postdoctoral fellows, all supported by numerous research and administrative staff. The Graduate Program provides a collegial atmosphere that fosters top quality research combined with in- depth course work, seminars, and journal clubs. In this environment, students learn to apply the latest scientific technology to research areas including gene and chromosome structure, regulation of gene expression, protein chemistry and engineering, structural biology, membrane structure and function, intracellular trafficking, signal transduction pathways, oncogenes and growth factors, and pathogenic mechanisms. For many of these studies, a variety of genetic systems are employed, including human, mouse, *Drosophila* and yeast. In addition to well-equipped faculty laboratories, the department houses several core laboratories to facilitate the research process, including DNA sequencing, synthesis and genotyping, mouse transgenic and gene targeting facilities, and state of the art NMR and X ray crystallographic facilities. Furthermore, students have access to the CoM's extensive genomics, proteomics and bioinformatics cores, providing the tools to capitalize on the human and other genome projects. While there is no requirement (or expectation) for graduate students to teach, a certificate program entitled Preparing Future Faculty (PFF) is available, which exposes students already embarked on a graduate degree to a series of seminars on effective teaching practices and conducting an academic job search, while providing internship opportunities in local undergraduate institutions where faculty roles and duties can be experienced via a "shadowing" program with an individual faculty member.

Neuroscience: The aim of the Graduate Program in Neuroscience is for PhD students to develop technical expertise, communication skills and critical thinking skills essential for successful research careers in academia or industry. Critical ingredients include classroom training, rich exposure to a broad base of basic and translational neuroscience seminars and presentations, and research training that emphasizes modern approaches to understanding nervous system function. The Program supports study in a wide range of research areas, including but not limited to neural development; neurobiology of addiction; biology of neurological diseases and neurodegeneration; neuroimaging; neuroendocrinology of stress, obesity and diabetes; and cognitive neuroscience. The Program includes over 90 faculty in multiple departments in the Colleges of Medicine, Arts & Sciences, Engineering, Pharmacy, and Allied Health, as well as CCHMC. All students have access to a full range of core facilities, including genomics, proteomics, functional MRI, confocal microscopy and rodent behavioral and metabolic phenotyping. There are currently over 30 students in the Program, supported by training grants from NINDS, NIDDK and NIBIB and generous gifts from the Daniel L. Kline fund.

Pathobiology and Molecular Medicine: The Graduate Program in Pathobiology & Molecular Medicine is administered by 2 clinical departments: Pathology and Internal Medicine. Doctoral students in the Program are exposed to each of these disciplines in a program of study that unites contemporary investigative research in biomedical sciences with an understanding of human disease and the challenges that face effective treatment. All students participate in a core curriculum of academic courses for the first year, comprised of a series of lectures and laboratories that encompass basic molecular and cellular biology and the molecular mechanisms of human disease. Additional elective coursework and 2 to 3 research laboratory rotations are tailored to the student's individual research interests. The student also has the option of participating in an industrial or government research entity. At the beginning of the second year, students select from approximately 41 participating faculty laboratories and begin work on their independent research project. General focus areas are cardiovascular and lipid disorders; digestive and kidney disease; endocrine, metabolic, and bone disorders; hematologic and oncologic disease; and immunology and infectious diseases. The completion of all requirements for the PhD degree generally takes 5 years.

Systems Biology and Physiology: The PhD program in Systems Biology and Physiology is focused on research training, and includes opportunities for academic course work that supports the development of each student's research competence and confidence. Research in the program employs a wide range of classical and modern experimental methods including molecular biology, electrophysiology, genetic technology,

bioinformatics and functional genomics, proteomics, and advanced imaging methods. Researchers work in the fields of cardiovascular, epithelial, pulmonary and renal physiology, neurobiology, endocrinology, membrane biophysics, and cellular signal transduction. Students and faculty from a variety of different backgrounds and expertise are brought together to approach research questions using experimental, theoretical, and computational approaches. In this way teams of researchers help students discover new solutions to physiological questions. A combination of introductory lab experiences, core and advanced courses, seminars and journal clubs provide foundations on which to build a dissertation research project. Prior to graduation, all students must publish their research in major scientific journals. Students are provided financial support to present their findings at national scientific meetings, and compete for research fellowship awards. On average, students in this program finish the PhD in about 5 years.

Medical Scientist Training Program: The Medical Scientist Training Program (MSTP) is the combined MD/PhD program of UC COM. Students typically complete their first 2 years of medical school and then shift their study to graduate school training in one of the College's 11 graduate programs. Upon successful completion of a PhD thesis, students then return to medical school and complete their final 2 years of clinical training. During these 2 years, students complete 5 required core clinical clerkships: internal medicine, surgery, obstetrics and gynecology, psychiatry, and pediatrics; 2 acting internships; and several primary care or specialty electives. During their final year, students are required to complete a senior research project that may be in the field of medicine that the student has chosen to pursue in the future, or may be a continuation of the student's thesis work. MSTP students are recruited from a national pool of outstanding individuals at top undergraduate schools. About 190 applications are accepted annually for 9 positions. MSTP graduates typically go on to residency and fellowship training in major academic medical centers; many are now faculty members directing their own research programs in leading medical schools.

C. HEALTH CARE FACILITIES

University of Cincinnati Medical Center (UCMC), part of **UC Health**, traces its origins to the Commercial Hospital and Lunatic Asylum founded in 1821, the first hospital built in the U.S. primarily for teaching purposes. The hospital was later renamed Cincinnati General Hospital. In 1969, a new facility was constructed on the AHC campus. The institution was renamed University Hospital in 1982, and in 2009 established a more collaborative partnership with the University of Cincinnati and UC Physicians known as UC Health. The hospital was renamed UC Medical Center in December 2012. Many UC Health locations have received national recognition for outstanding quality and patient satisfaction. It's over 700 beds make it the largest hospital in the Cincinnati region. UCMC's unique services include: the UC Cancer, Cardiovascular and Neuroscience Institutes; the Burn Center, one of the few nationally-certified major adult burn treatment centers in the US; and the region's best-equipped and busiest Level I Trauma Center. Its residency program in emergency medicine was the nation's first, established in 1970. UCMC's Transplant Center performs kidney, liver, and pancreas transplants. UCMC is the first hospital in the OH-KY-IN tri-state region to receive Advanced Disease-Specific Care Certification for Ventricular Assist Device (VAD) by the Joint Commission. The Medical Center's Cincinnati Center for Sustainment of Trauma and Readiness Skills (CSTARS), a joint initiative with the U.S. Air Force, is one of only 5 collaborative military/academic hospital training centers of excellence in the country. In 2013, UCMC was certified by the Joint Commission as an Advanced Comprehensive Stroke Center, a new level of certification reserved for institutions with specific abilities to receive and treat the most complex stroke cases. There is no higher stroke certification.

In 2007, UC, CCHMC and University Hospital (now UCMC) agreed to establish a **Joint Cancer Center**, together committing \$60 million to build and upgrade facilities and new clinical programs, attract world-class faculty and accelerate research findings. The development of shared clinical facilities will allow continuous monitoring of pediatric cancer survivors into adulthood and beyond. Now known as the Cincinnati Cancer Center (CCC), the collaboration's long-term goal is NCI designation as a Comprehensive Cancer Center. The adult cancer clinic recently completed a \$4 million renovation, which includes an all-digital mammography center, updated infusion therapy suite, advanced radiation oncology delivery system (Trilogy) and upgrades to patient clinics. Leadership of the University of Cincinnati is working closely with an administrative team and research program leaders to develop cross-institutional and cross-departmental research teams and to ensure alignment with the NCI's guidelines for research programs and initiatives.

Complementing its partnership in the CCC with other AHC institutions, CCHMC established its third interdisciplinary institute, the **Cancer and Blood Diseases Institute**, in 2009. As with the Heart and Perinatal Institutes previously formed, its goal is to closely integrate research and clinical care with institutional support in order to advance knowledge and deliver better outcomes, experiences and value for patients and their families. The institute structure strengthens CCHMC's ability to coordinate care delivery; foster collaboration among researchers, clinicians and educators; compete for extramural funding; recruit outstanding faculty; and better utilize organizational resources. The Cancer and Blood Diseases Institute is expected to further bolster the CCC's efforts to achieve NCI designation as a Comprehensive Cancer Center.

Cincinnati Children's Hospital Medical Center (CCHMC) is a not-for-profit hospital and research center pioneering breakthrough treatments, providing outstanding family-centered patient care and training health care professionals for the future. CCHMC was founded in 1883 and relocated in 1926 to its present site across the street from the University of Cincinnati College of Medicine (COM). William Cooper Procter, a benefactor of the hospital, established the Cincinnati Children's Research Foundation (CCRF) with a building devoted to research in children's diseases that opened in 1931, and included a \$2.7 million endowment. Today the CCRF endowment is valued at ~\$2 billion. Mr. Procter established that income from the endowment would support research and development, a principle that continues to form the philosophical approach to supporting research. CCHMC and UC COM facilities share a rich history of collaboration, provide an exceptional environment encompassing an extensive and diverse array of institutional and collaborative clinical, research, and training facilities and resources. In 2001, a formal agreement between CCHMC and UC COM was signed, whereby CCHMC acts as the Department of Pediatrics for COM, and UC and its Board of Trustees are responsible for academic activities, including faculty appointments and promotions, and conferring degrees. CCHMC and its Board are responsible for appointment of CCHMC medical staff, patient care, training and research at CCHMC. The CCHMC-COM leadership structure reflects a close bond: Dr. Margaret Hostetter is Chair of the Department of Pediatrics at COM, and serves as Chief Medical Officer of CCHMC and Director of CCRF. Appointment of the Chair requires approval by both the CEO of CCHMC and the Dean of UC COM and is subject to approval by both Boards of Trustees. All CCHMC Chiefs of Service must be full time faculty at COM.

Faculty at CCHMC include the Departments of Pediatrics (Hostetter, Chair, 43 divisions, 753 faculty members), Surgery (von Allmen, Chair, 11 divisions, 98 faculty members), Anesthesia (McAuliffe, Chair, 70 faculty members), Radiology (Coley, Chair, 48 faculty members), Patient Services (13 faculty members), three large integrated clinical and research institutes (Cancer & Blood Diseases Institute, Heart Institute, and Perinatal Institute), and multiple interdisciplinary Centers of Excellence. CCHMC has a long and rich history of research focused on diseases of children and young adults, with expertise in genetic, environmental, and developmental origins of disease. Research breakthroughs have included the Sabin oral polio vaccine, rotavirus vaccine (Rotarix®), the first practical heart-lung machine, and the first successful bone marrow transplant for sickle cell disease.

Today, CCHMC is a 700-bed non-profit organization serving as the AHC's major teaching facility for pediatrics and as the only children's hospital in the Cincinnati metropolitan area (population 2.3 million). With operations totaling more than \$2.1 billion annually, CCHMC employs >15,000 individuals with 6 million square feet of facilities and eleven off-site neighborhood facilities. In FY 2018, CCHMC had 1,034,596 outpatient visits, 32,326 admissions, 173,023 emergency department and urgent care visits, and 34,295 surgical procedures, serving patients from all 50 states and 51 countries. Amongst all pediatric institutions in the nation, CCHMC ranks second in NIH funding after Boston Children's Hospital.

For the past 5 years, CCHMC has consistently ranked in the top three pediatric hospitals by *U.S. News & World Report*, and continues to be on the Honor Roll, ranking in the top 10 for all 10 pediatric specialties in 2017. CCHMC offers 16 patient care sites throughout the region, the area's only Level I pediatric trauma center and pediatric cardiac ICU, and a satellite campus (College Hill) providing acute inpatient, outpatient, and residential psychiatric services.

The **Cincinnati VAMC**, located within the AHC complex, has 116 general medical, surgical, and acute mental health beds and serves veterans within a 50-mile radius of Cincinnati and beyond, encompassing 17 counties in Ohio, Kentucky and Indiana. It is accredited by the Joint Commission on Accreditation of Health Care

Organizations (JCAHO). Its major clinical disciplines include Medicine, Neurology, Surgery, Psychiatry, Ambulatory Care, and Dentistry. Most of the University of Cincinnati house staff rotate through the VAMC. During fiscal year 2018, the hospital served 7,709 inpatients, who were provided 72,873 bed days of care, performed 4,037 surgical procedures, and had 600,491 outpatient visits. The VAMC also supports 6 community-based outpatient clinics and 1 health care access site in Fort Thomas, Kentucky. The Research Service supports a variety of research projects that are funded by VA Central Office, Department of Defense (DOD), National Institutes of Health (NIH), private foundations, and pharmaceutical industry. In fiscal year 2018, Cincinnati VAMC investigators received \$3.9 million in VA funding and \$4.6 million in extramural federal funding (\$4.3 million from DOD), which supported 60 active investigators in 85 research projects. There are ongoing projects in infectious disease, immunology, oncology, psychiatry, psychology, substance abuse, cardiology, endocrinology, pulmonary medicine, nephrology, and neurology. Cincinnati VAMC faculty and staff are actively involved in clinical and basic science research. The Cincinnati Education and Research for Veterans (CERV) foundation is based at the VAMC.

Center for Health Systems Excellence at CCHMC is dedicated to improving the health of children and clinical outcomes through the generation of knowledge and the application of research into practice. Named in honor of the former President and CEO of Cincinnati Children's, the Anderson Center builds on our existing strength in quality improvement by creating a structured approach to accelerate the integration of health systems research and bedside application. It is committed to decreasing the time it takes for new knowledge to be put into practice and to teaching the next generation of experts who can spread health systems excellence here and elsewhere. The Anderson Center is a unique scientific resource for this project because of its extensive capacity and expertise as a local, state, and national resource for improving care in large networks of clinical sites. Anderson Center faculty have led over 60 learning collaboratives and supported the creation of nine state-wide and national pediatric sub-specialty networks: GI- inflammatory bowel disease, (ImproveCareNow), cardiology (National Pediatric Cardiology – Quality Improvement Collaborative), juvenile inflammatory arthritis (Pediatric Rheumatology Collaborative Innovation Network, PR-COIN), perinatology (Ohio Perinatal Quality Collaborative), and safety (Solutions for Patient Safety). These networks serve as improvement and research laboratories, providing the population base and sample size required to understand what works best to improve care.

The **Center for Health Care Quality** at CCHMC is a resource for health care providers throughout the world to make the highest-quality care a reality for children, adolescents and their families. Its goals are to: support projects to transform health care delivery systems in Cincinnati, the nation and the world; provide education in quality improvement methods and advanced experimental design to build capacity to advance the field of quality improvement in medicine; undertake research to design and test novel approaches to health care delivery and translate new knowledge rapidly into practice; and to work in partnership with professional and quality improvement organizations to disseminate quality improvement methods. Co-directed by Carole Lannon, MD, MPH and Peter Margolis, MD, PhD, the Center is currently working on several improvement initiatives related to preventive and developmental services, chronic illness care, office access and efficiency, patient safety, and hospital care.

INNOVATIONS in Community Research is a community-collaborative program through which clinical psychologists work with community groups and non-profit agencies to enhance outcomes for underserved children, adolescents, and families in the Cincinnati community. As clinicians and researchers, co-directors Lori Crosby, PsyD and Monica Mitchell, PhD of the [Division of Behavioral Medicine and Clinical Psychology](#) at CCHMC have experience and expertise in a broad range of topics related to health disparities and community issues including violence prevention, teen pregnancy, premature birth, and community-based assessment and intervention. In addition, **INNOVATIONS** team members are proficient in qualitative and quantitative research design and methods, including survey development and focus group conduct, program evaluation and refinement, including implementing relationship- and developmentally-based models of care, and cultural competence training.

The **Cincinnati Digestive Health Center** (DHC), established as an NIH “mini-center” in 2003, is now one of 17 Digestive Disease Research Core Centers funded by NIDDK. The only DHC dedicated to pediatric digestive diseases research, it has grown since inception from 34 to 105 investigators, spread across 20 divisions of Cincinnati Children's and 8 departments of the UC CoM. Funding has nearly tripled from

\$12.5 million to \$35.6 million. The Center's research is focused in 4 areas: 1) chronic liver disease, 2) inflammatory and diarrheal diseases (especially inflammatory bowel disease and eosinophilic gastrointestinal disorders), 3) obesity and the digestive system and 4) development and digestive diseases. Interrelated research cores in gene and protein expression, bioinformatics, pluripotent stem cell and organoid, and integrative morphology provide support for researchers and encourage collaboration. Center accomplishments to date include programming inducible pluripotent stem cells to give rise to intestinal organoids that display cellular phenotypes and 3-dimensional features of the small intestine, development of the first gene chip for use in the early diagnosis of at least 5 hereditary liver diseases and detection of genetic causes of jaundice in children and adults, as well as the discovery of the first gene associated with eosinophilic esophagitis.

The **Center for Closing the Health Gap in Greater Cincinnati** was established in 2003 with the vision of "a healthier region for all." A non-profit corporation, its mission is to lead efforts to eliminate racial and ethnic health disparities in Greater Cincinnati through advocacy, education, and community outreach. Led by President & CEO Dwight Tillery, a former Cincinnati Mayor, the Center also works collaboratively with health institutions and other stakeholders to promote health and disease prevention.

Hoxworth Blood Center, located on the AHC campus, is the only facility of its kind for the Greater Cincinnati region. Serving a 17-county area in Ohio, Kentucky and Indiana, Hoxworth collects, tests, processes, and distributes over 270,000 units of blood and blood components annually to 28 hospitals and medical centers. Hoxworth, a member of America's Blood Centers, is licensed and regulated by the U.S. Food and Drug Administration and accredited by the American Association of Blood Banks. Founded by Dr. Paul I. Hoxworth in 1938, the Blood Center has grown to be an internationally recognized leader in transfusion medicine. The Center has 9 neighborhood donor centers, more than 250 full- and part-time employees in 26 departments (including apheresis, transplantation immunology, cellular therapy, reference and research), and a complement of over 300 volunteers. Hoxworth's Research Laboratory is leader in coordinating research projects in transfusion medicine, including clinical trials for transfusion medicine-related products. Its goal is to link basic research with clinical care, leading to improved methods that ensure the quality, safety, and efficacy of the blood and hematopoietic supply. Sponsored research support was over \$1.3 million in FY2018. The Center offers a fellowship program for physicians interested in blood center or hospital transfusion service careers, and through the College of Allied Health Sciences, offers a 2-year Master of Science in Transfusion and Transplantation Sciences, with tracks in blood transfusion medicine and cellular therapies.

The **UC Cancer Institute** was established in 2010 to encompass all cancer patient care, research and education missions within the CoM and throughout patient care settings in UC Health, including the Barrett Cancer Center, which has a long-standing reputation for providing the most advanced and complete range of cancer services available in the region. The Institute provides screening, diagnosis, and treatment for all types of cancer, and serves as a cancer education resource for patients, physicians, health professionals and the general community. Cancer Institute physicians, who are faculty of UC COM, are joined by a team of nurses, pharmacists, dietitians, social workers, occupational and physical therapists, and financial counselors. Its faculty and staff conduct innovative clinical research, with over 140 active protocols sponsored by cooperative programs through the National Cancer Institute and pharmaceutical companies. In 2007, the Barrett Center was designated a Breast Imaging Center of Excellence by the American College of Radiology, the only facility in Greater Cincinnati to receive this recognition. In 2011, the Institute launched an adult bone marrow transplant service as a new component of its hematologic malignancies program, based at University Hospital, and in collaboration with the UC Neuroscience Institute established the UC Brain Tumor Molecular Therapeutics Program, the first comprehensive brain metastasis translational research program in the US. In 2013, the Institute's Comprehensive Breast Cancer Center was recognized as a "Certified Quality Breast Center of Excellence" in the National Quality Measures for Breast Centers (NQMBC) Program—the highest distinction for excellence given by the NQMBC. This is the only Greater Cincinnati tristate program and only one of 42 centers nationally to gain this distinction.

Through a strategic planning process, the UC Cancer Institute identified 5 comprehensive cancer centers to serve as the initial focus of its efforts: breast, brain, gastrointestinal, head and neck, and lung. Each center includes multidisciplinary clinicians as well as scientists working in basic, clinical and population sciences. The institute is working to integrate faculty from the UC College of Nursing and James L. Winkle College of

Pharmacy and other UC colleges into the disease-based centers. The Institute's infrastructure was designed to complement efforts of the Cincinnati Cancer Center, a collaborative initiative of the COM, UC Health and CCHMC (see description above).

D. PATIENT RESOURCES AVAILABLE FOR RESEARCH

With over 700 registered beds and 5,254 employees, University of Cincinnati Medical Center (UCMC) is the largest hospital in the region and is the major referral center for many programs and therapeutic modalities not available elsewhere in the metropolitan area. In FY 2018, physicians at UC Health served more than 437,000 unique patients through 1.8 million encounters across four inpatient campuses and 58 outpatient locations. UC Health's emergency departments received 125,000 visits. UCMC, West Chester Hospital, Drake Center for Post-Acute Care, Lindner Center of HOPE (behavioral care), numerous outpatient care facilities throughout the region and UC Physicians (UCP), the practice group for 820 clinical faculty members at the UC College of Medicine (also 81 faculty CRNAs, 311 advance Practice Providers), together comprise UC Health. Clinical services are provided in an array of different specialties including family medicine, surgery, internal medicine, emergency medicine, oncology, urology, cardiology, neurology, neurosurgery, otolaryngology, dermatology, rehabilitation, pain management, anesthesiology, orthopedics, obstetrics-gynecology, ophthalmology, radiology, radiation oncology, pathology and psychiatry.

CCHMC is the largest pediatric facility in the U.S. in terms of inpatient beds, annual admissions, total surgical procedures, outpatient surgical procedures, and emergency department visits. CCHMC is a not-for-profit children's hospital, licensed for 670 beds, and as the only children's hospital in the Cincinnati metropolitan area (population >2 million) serves UCCOM as the major teaching facility for Pediatrics. With operations totaling \$2.3 billion annually, CCHMC employs >15,000 individuals working in ~6 million square feet of facilities, and offers 16 patient care sites throughout the region, as well as the area's only Level I pediatric trauma center and pediatric cardiac ICU, and a satellite campus (College Hill) providing acute inpatient, outpatient, and residential psychiatric services. In FY2018, CCHMC had approximately 1.2 million patient encounters, including over 89,000 Emergency Department visits, 34,000 surgical procedures and 18,800 admissions. While focused on providing primary, tertiary, and quaternary care for the population in our tri-state, patients came from 51 countries and all 50 states, as well as Washington, DC, and Puerto Rico.

E. INSTITUTIONAL ASSETS FOR RESEARCH TRAINING

The Academic Health Center is the region's center of medical education. The COM currently (2018-9) trains 708 medical students, 549 MS and PhD students with 64 MD/PhD students, 660 residents and clinical fellows, and 261 postdoctoral fellows. CCHMC had 458 residents, 263 clinical fellows and 176 research postdoctoral fellows; postdoctoral fellow training is funded largely by institutional funds of the Cincinnati Children's Research Foundation and by federal training grants. The James L. Winkle College of Pharmacy has 364 students, including the PharmD and MS/PhD programs. The College of Nursing has 3,090 undergraduate and graduate students. The College of Allied Health Sciences has 2,912 undergraduate and graduate students. The AHC held 23 NIH training grants in 2018.

F. INFORMATICS INFRASTRUCTURE

Department of Biomedical Informatics: Biomedical Informatics (BMI) was established in 2000 as both an academic Division of the Department of Pediatrics and a component of the Cincinnati Children's Research Foundation (CCRF). In 2014, a Department of Biomedical Informatics was established at UC COM to integrate informatics academic, educational, service, and infrastructure efforts across UC and CCHMC. Associate Director Peter White was recruited at that time as founding Chair of the Department. BMI currently includes 18 primary faculty, 18 secondary faculty, and over 100 trainees and staff. Together, the group operates both at UC COM and directly across the street on the 10th floor of CCHMC's "S" building in a combined assemblage of 16,000 square feet of contiguous space. The CCHMC space is directly adjacent to the Division of Biostatistics and Epidemiology, while the UC-COM space is next to the Department of Internal Medicine, a major collaborator. BMI faculty conduct both collaborative and independent research in bioinformatics and clinical informatics, with particular focus in the areas of comparative/functional genomics, systems biology, and proteomics; natural language processing; genome-wide association studies of diseases; learning networks and distributed research networks; the use of data from electronic health records; and high-performance computing. BMI also maintains the IT infrastructure that supports research programs at CCRF, provides high end informatics resources across the UC College of Medicine, conducts research, and educates both focused

trainees and the local research community, through a “community of practice” approach that aims to raise literacy for data science across the organization.

In 2015, BMI faculty and key senior staff participated in a strategic planning process to guide the future growth of the Department. Through that process, BMI established a vision “to be the leader in the development and application of innovative computational methods to produce actionable biomedical knowledge, more fully understand disease, and improve health.” BMI’s mission is to drive the next generation of understanding and discovery of disease causes and cures through data sciences and to broadly empower multiple communities to improve human health. The goals laid out in the strategic plan are to: 1) develop excellence and recognition for computational models of biological systems, for informatics to collect, process, share and interpret data across research enterprises and health care systems, and to integrate data and knowledge to transform pediatric and adult health; 2) to lead the implementation of a cross-institutional collaborative culture of data sciences; 3) to increase participation and visibility in the national and global biomedical informatics research communities; and 4) to sustain and grow both degree-granting and institutionally-focused educational programs. In the past year, BMI faculty and staff participated in 50 external grants and contracts, plus an additional 30 that were based in BMI (BMI faculty as PI). In FY17, BMI faculty and staff contributed to 64 scientific articles with a mean Impact factor of >8.

resources and services to investigators at Cincinnati Children's and the University of Cincinnati College of Medicine

Biomedical Informatics Services. BMI offers resources and services to investigators at Cincinnati Children's and the University of Cincinnati College of Medicine through four linked Shared Facilities encompassing approximately 50 staff: Research IT, Clinical Data Services, Technology Development, and Health care Analytics (see below). CCHMC Research IT operates independently from—and maintains a computational architecture distinct from—CCHMC Hospital IS. However, the two groups have a long history of tightly coordinated cooperation to support research, with a highly granular matrix of responsibilities, and shared use of network, data security, and policy/procedural infrastructures (see letter of support from CCHMC Chief Information Officer Marianne James). More details are provided in the Research IT section below, and specific details on particular capabilities can be found in the Data Analysis Core Facilities and Resources section.

The Research IT group is dedicated to supporting the diverse mix of technology and infrastructure needed to sustain the efforts of a dynamic medical and biological research environment. Research IT is comprised of approximately 25 staff and includes systems and database administrators, systems programmers and IT support staff, with Michal Kouril as faculty advisor and under advisement of a faculty steering committee. The group provides support for the hardware infrastructure of CCRF (e.g., physical and virtual servers, a high-performance computing cluster, terabyte-scale storage facility, application and database servers, authentication and identity management, etc.). In order to facilitate collaboration with external institutions, BMI has worked over the past several years to build a dedicated research network with separate secure segments for data storage, data management systems, and applications. BMI closely collaborates with Information Security staff in UC and CCHMC Information Services as well as legal and compliance departments to provide an environment compliant with local and federal requirements. Aside from the day-to-day responsibilities needed to maintain the operation and functionality of this infrastructure, the group also handles requests for service from end users. Generally, capacity includes:

- Servers running Windows and Linux operating systems for production, testing and development environments as well as to provide backup and redundant services
- A 1000+ CPU Linux cluster for parallel computation, including multi-core AMD Opteron and Intel Xeon based servers, with 4-64 GB or memory per single or aggregated processor
- A VMWare cluster of 150+ virtual machines running Windows and Linux operating systems for testing and development environments as well as to provide backup and redundant services
- Dedicated Oracle, MySQL, MS SQL, Oracle, PostgreSQL, and several NoSQL-based database servers
- A terabyte-scale storage facility, with currently over 1.8 PB usable space, with daily incremental and weekly full backups in designated directories and volumes
- Centralized authentication (LDAP) servers, serving unique usernames and passwords to all investigators
- Basic developer tools (compilers, debuggers, graphical development environments) and parallel computing software (MPI, PVM)

- Dedicated redundant web servers, principally employing Apache, Tomcat, or JBoss
- A Highly redundant core network for data exchange
- A farm of Microsoft Windows servers and workstations
- Dedicated redundant web servers
- Online tools to facilitate collaborative data authoring and sharing, and data exchange (e.g., Aspera, Xythos)
- Centralized identity management services providing streamlined access to local investigators as well as external collaborators
- Basic developer tools (e.g., compilers, debuggers, graphical development environments) and parallel computing software

The Research Data Storage (RDS) system in the Data Center was designed to provide data storage for all research divisions. RDS provides centralized, backed-up storage and has staff on-site 24x7. Several types of storage are available: Institutionally supported enterprise storage—i.e., personal, divisional shared and project drives; Web-based storage systems for specific research data types (e.g., genomic, functional genomic, imaging). Other specialized storage includes the mega-i2b2 Clinical Research Data Warehouse hosted on Oracle, storage for VMWare and VDI clusters, High Performance Cluster storage space, project and home directories for segregated research network systems. BMI offers centralized administration of >100 software packages, licensed and open-source. Examples include:

- *Data capture and storage.* InfoPath/SharePoint, REDCap, OpenClinica, Oracle, FileMaker Pro, MS SQL Server, PostgreSQL, MySQL, Toad, Hadoop, SPARK, MongoDB, hbase, Phoenix
- *Statistical computing and numerical analysis.* SAS, PSPP, JMP, JMP Genomics, Matlab, Nquery, SPSS, R, SUDAAN, GraphPad Prism, SigmaPlot
- *Genome analysis tools.* dprime, snpgwa, dandelion, IMPUTE and other GWA tools, Plink/gPlink, Progeny, SOLAR,
- *RNA sequence analysis tools.* STAR, Bowtie2, BWA, DESeq2, AltAnalyze, BioWardrobe, Kallisto, RSEM, Cell Ranger, ICGS, Seurat, Sincera, SLICE, SIMLR, Monocle2, ToppGene, GO-Elite, Cytoscape
- Machine learning: ILOG/CPLEX, Weka
- Bioinformatics research software: GeneSpringTM; GCG, Affymetrix MicroArray Suite, Vector NTI, DNASTar, MacVector, Ingenuity, Golden Helix
- Additional general software: Adobe Acrobat, Adobe Photoshop Elements, Adobe LifeCycle Designer, BTM Biomaterials Tracking and Management, CERF, Prism

In order to facilitate collaboration with external institutions, BMI has built a dedicated research network with separate segments for data storage, data management systems, and applications. BMI closely collaborates with UC, UC Health, and CCHMC IS as well as legal and compliance departments to provide an environment compliant with local and federal requirements, including HIPAA (the Health Insurance Portability and Accountability Act), FISMA (the Federal Information Security Management Act), and 21 CFR Part 11 (U.S. Food and Drug Administration regulations on electronic records and electronic signatures). BMI provides consultations for faculty and staff on best IT practices and help facilitate data use agreements with partner institutions for a wide range of projects. BMI has developed annual System Security Plans and data use agreements as required by a number of regulations, including through its role as a FISMA-compliant data coordinating center for several NIH consortia.

UC and CCHMC Information Services maintain 7 x 24 x 365 Data Center operations with operators continually onsite. All servers are backed up with daily incremental backups, weekly full backups, and monthly offsite vaults as needed. In the event of a power outage, the Data Centers rely on redundant power systems, distributed power distribution units, and a number of backup generators.

The Research Data Center for high-performance computing and virtualized servers that is available to all CCTST investigator projects is operated by BMI and is housed in a portion of CCHMC's state-of-the-art 15,000 square foot, highly secure, institutional data center that meets Tier 4 standards for reliability (redundant power and cooling systems, remote site backup, etc.) and provides redundant, high bandwidth, fiber connectivity between the University of Cincinnati and CCHMC networks, as well as with Internet2. The secure environment permits compliance with numerous federal and state regulations (e.g., FISMA, HIPAA,

NIH, DOD) as well as with security requirements attached to many data access agreements. It has scalable storage capacity, which is essential because of the regulatory requirements governing the length of time data must be retained/archived. State of the art firewalls and systems for identity management and access control are incorporated into management of the Data Center, including interfaces between Hospital and Research IT networks and equipment.

Technology Development. BMI's Technology Development group is a faculty-supported collaborative service and development unit with expertise in a number of different areas that operates across CCHMC and UC. The group is overseen by Associate Director Peter White. Staff members include experts in web- and mobile-based software development, networking, system administration and maintenance, and database programming. Staff are accustomed to working within a unique environment that facilitates realization of complex projects with significant programming and outreach extensions. Services offered include:

- Developing customized software applications in a wide variety of programming languages, (e.g., Python, Perl, Java/J2EE, iOS, and .NET)
- Evaluating, hosting and customizing licensed and open-source research software
- Designing and hosting research databases, datamarts, and registries
- Developing customized research web sites and web services compliant with industry and corporate standards
- Hosting content management systems and web portals based on SharePoint and Drupal

BMI application developers have extensive experience in designing and implementing web servers for prediction and analytical methods developed in BMI investigator laboratories. In addition to interactive web-interfaces involving JavaScript, Java applets, PHP, Perl, and HTML5 graphics, the following web and computing technologies have been acquired and are frequently utilized by BMI application developers for ongoing projects: asynchronous JavaScript and XML (AJAX) client-server communication; automated queries to both local (MySQL- and SQLite-based) and external databases (with HTML, FTP, or REST interfaces); scheduling jobs on the BMI computational cluster; dynamic data analysis and visualization; automated email communication and data file exchange. BMI application developers have experience handling large user request traffic, integration of servers and databases, and creating automated workflows for data distribution and analysis.

Data Services. BMI Data Services is a group of approximately 30 staff members who operate both at UC and CCHMC and is co-led by co-investigators Harnett (UC) and Marsolo (CCHMC). This group specializes in complex extractions of data from the electronic health record (EHR) and other primary sources for research purposes, the transformation of these data into common data models for use in distributed research networks, the development and implementation of standards and infrastructure to support learning health systems and other data and improvement networks. BMI Data Services oversees the development and implementation of the respective UC and CCHMC-based research data warehouses and develop data collection and reporting systems to support registries and multicenter learning networks. The research data warehouses are also used to support UC/CCHMC participation in several distributed data sharing networks, including the Electronic Medical Records and Genomics (eMERGE) Network, the National Patient-Centered Clinical Research Network (PCORnet) and the Accrual for Clinical Trials (ACT) Network. CCHMC was involved in three projects during PCORnet Phase 1 (SCILHS and PEDSnet Clinical Data Research Networks (CDRNs) and the PCORnet Patient-Powered Research Network (PPRN)), and is part of two awards in PCORnet Phase 2 (PEDSnet CDRN and ImproveCareNow PPRN). UC and CCHMC share a node on the ACT Network. Through these projects, staff in BMI Data Services have gained tremendous experience extracting data from the EHR and developing transformations into many of the most popular Common Data Models (CDMs), such OHDSI/OMOP, i2b2, and the PCORnet CDM. They have also gained experience with the analytical tools that are associated with each model.

BMI supports Honest Broker services for each institution, which allows the creation of an integrated patient record using data from UC Health and CCHMC's clinical information systems as well as select research systems. This information is de-identified and access is made available through the respective institutional Research Data Warehouses, which consist of a suite of software applications as well as a core data repository that is intended to support translational research. The warehouses are designed with the same core infrastructure (e.g., i2b2 and TriNetX) to maximize efficiency and interoperability across institutions. Each

warehouse contains much of the data stored in UC Health and CCHMC's electronic health records, including demographics, diagnoses, procedures, laboratory results, medication orders, vital signs and allergies. The CCHMC warehouse is also linked to the institutional biorepository, which allows investigators to include sample-related metadata in their search queries. The primary use case of the warehouses is cohort identification, allowing users to perform an enterprise-wide search on a limited data repository to determine the existence of a set of patients meeting certain inclusion or exclusion criteria. Once a cohort has been identified, investigators at UC COM and Cincinnati Children's are able to work with the Honest Broker service to obtain the data needed to complete their research as specified in their Institutional Review Board (IRB) protocol. Investigators can also work with the Honest Broker service directly to obtain the data they need to complete their research study. The research data warehouse is also used to support CCTST participation in several distributed data sharing networks. Data from the relevant warehouse(s) is transformed into the appropriate data model and terminology standards and then exposed in a way that preserves privacy and allows queries for aggregate counts or summary statistics to be broadcast from approved investigators to all network participants. The queries are executed against the data and then the results are sent back to the originating investigator, rapidly lowering the time needed to identify cohorts or validate hypotheses among large, diverse patient populations spread among multiple care centers.

G. LIBRARY AND ELECTRONIC RESOURCES

Donald C. Harrison Health Sciences Library: Reopened in summer 2008 following extensive renovation and expansion, the former Academic Information Technology & Libraries was renamed for benefactor Donald C. Harrison, MD, who served as AHC provost and senior vice president for health affairs from 1986-2002. The Library encompasses nearly 45,000 sq.ft., bridging the existing Medical Sciences Building (MSB) and light-filled atrium of the new CARE/Crawley building. Featuring a 90 seat computer lab, numerous meeting spaces, and over 200,000 print volumes on site, it also provides a full calendar of computing classes and access to over 800 databases, 110,000 electronic journals, and 149,000 e-books. The Health Sciences Library serves the research needs of students, faculty, and staff of all AHC Colleges, affiliates including UCMC, CCHMC and VAMC, the Greater Cincinnati community, and investigators/scholars across the country and globe. The Health Sciences Library is ranked 14th among "the 25 most impressive university medical school libraries in the world" according to the website Best Master's Degrees Reviews and Rankings.

NetWellness: Established in 1995 as one of the first health sites on the internet, NetWellness (www.netwellness.org) is a non-profit service providing health and medical information directly to the public from 3 academic health centers (University of Cincinnati, The Ohio State University, and Case Western Reserve University). NetWellness covers a full range of health topics in an easy to understand format with information for all age groups and diverse populations, including minorities and the underserved. NetWellness provides the knowledge needed to increase prevention, enhance provider/patient communication, and reduce health care costs. In NetWellness, these Ohio universities have created the largest expert network of its kind, providing health information and education to consumers directly from experts who are specialists in their field. NetWellness is non-profit and without commercial advertising, serving the public as an unbiased resource. Over its 19 years of operation, its reputation has grown as a leader in free, accurate health information, garnering numerous national awards for the site. NetWellness has also enjoyed considerable growth, now receiving over 13 million visitors per year, 80% from across the US and North America, for its 55,000+ pages of health information. Over 500 faculty members have volunteered their time to provide state-of-the-art health content, including over 600 articles and an "Ask an Expert" feature that has answered over 68,000 questions to date.

HealthBridge: HealthBridge is a not-for-profit health information exchange serving the Greater Cincinnati OH-KY-IN tri-state area. Created through the Greater Cincinnati Health Collaborative, its mission is to improve the quality and efficiency of health care in the community. To do this HealthBridge serves as a trusted third party working with all participating health care stakeholders to facilitate creation of an integrated and interoperable community health care system. This includes the adoption of community standard technologies and work processes. HealthBridge's Health System participants include 18 hospitals and represent nearly 90% of the community hospital sector activity. HealthBridge also connects thousands of physicians and staff as well as nursing homes, independent labs, radiology centers and others in our health care community. It provides access to over 60 hospital based critical care systems including radiology images, fetal heart monitoring, hospital-based electronic medical records and chart completion, among others. Additionally, it operates the

largest community-based secure clinical messaging system in the country. HealthBridge functions as a complete outsourced solution of results reporting for its hospitals and ancillary facilities. Through its clinical messaging system, it delivers over 1.4 million results (laboratory, radiology, transcription and ADT) to over 4,000 physicians each month.

H. OTHER CORE RESOURCES AT CCHMC AND UC

Animal Behavioral Core (CCHMC)

1. **Purpose:** The Animal Behavioral Collaborative Core facility, located in the Division of Neurology, is available to PIs at CCRF, UC and outside PIs. The core offers a variety of behavioral assays to enable the characterization of CNS dysfunction in mice or rats.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/animal>
3. **Director:** Charles Vorhees, charles.vorhees@cchmc.org, 513-636-8622 and Michael T. Williams michael.williams@cchmc.org, 513-636-8624
4. **Open to:** All CCRF and UC research personnel; other researchers as allowed by core staff.

Biomedical Informatics (UC and CCHMC)

1. **Purpose:** Provides computational resources, services and support to investigators at Cincinnati Children's Research Foundation and the University of Cincinnati College of Medicine; serves as the initial point of contact for all inquiries about hardware, software and other information technology related to research.
2. **Website:** <https://bmi.cchmc.org>
3. **Manager:** Ron Bryson, ron.bryson@cchmc.org, 513-636-0271
4. **Open to:** All CCRF and UC research personnel; other researchers as allowed by core staff.

Data Management and Analysis Center (DMAC), Division of Biostatistics and Epidemiology (DBE) at CCHMC

1. **Purpose:** Provides consultation and/or ongoing support to research at CCHMC and other academic and research institution such as: study design, grant preparation, budgeting & resourcing, database builds, data management planning & documentation, query management, programming for data merges and derived data sets, power and sample-size calculations, statistical analysis and manuscript writing.
2. **Website:** <https://www.cincinnatichildrens.org/research/divisions/b/biostatistics>
3. **Director:** Mekibib Altaye, Mekibib.altaye@cchmc.org
4. **Open to:** All CCHMC and UC research personnel through Research Central.

Cardiovascular Core Imaging (CCHMC)

1. **Purpose:** Provides investigators a wide range of human and animal cardiac and vascular imaging and peripheral vascular non-imaging techniques using state of the art imaging, measurement, and quality control tools.
2. **Website:** <http://www.cincinnatichildrens.org/research/cores/cardio-imaging>
3. **Manager:** Vicky Moore, vicky.moore@cchmc.org, 513-636-7489
4. **Open to:** All CCRF and UC personnel as allowed by core staff.

Cell Manipulations/Processing (CCHMC)

1. **Purpose:** Provides experienced scientists to help develop and scale up ex-vivo gene transfer and cell therapy, clinical trials or simply transfer existing at-scale technology to clean facilities which will enable one to move research to a safe and effective patient treatment plan. The CPC provides stem cells and other tissue samples from normal donor or patient populations such as disease specific repositories or specific research studies requiring sample processing.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/translational-core-laboratory/cell-manipulations-laboratory>
3. **Manager:** Carolyn Lutzko, carolyn.lutzko@cchmc.org, 513-803-2420 and CML_coordinator@cchmc.org, 513-636-6261
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

The James Anderson Center for Health Systems Excellence Purpose (CCHMC)

1. **Purpose:** Develops, translates and communicates evidence to measurably improve child health and well-being and the quality of health care for children. Our partners include community, local, state and national policy makers, program managers and advocates. The Center addresses the most urgent challenges facing children and families.
2. **Website:** <https://www.cincinnatichildrens.org/service/j/anderson-center/health-policy>
3. **Director:** Carole Lannon MD, carole.lannon@cchmc.org, 513-803-8818
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Comprehensive Mouse and Cancer Core (CCHMC)

1. **Purpose:** Provides animals from specific inbred mouse strains primarily used in cancer and hematopoietic research (like the immunocompromised NOD/SCID Gamma C γ C γ and NSG-SGM3 or the immunocompetent CD45.1 Boy J); offers animal and cell irradiation services; cell transplant and hematopoietic cell harvest services mouse bone marrow aspirates and handling of animal cancer model systems involving xenotransplant procedures.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/mouse-core>
3. **Director:** Hartmut Geiger, 513-636-1338
4. **Contacts:** Jeff Bailey, Jeff.Bailey@cchmc.org, 513-803-0495 and Victoria Summey, Victoria.Summey@cchmc.org, 513-636-5879
5. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Confocal Imaging (CCHMC)

1. **Purpose:** Use of state-of-the-art confocal microscopes for your research with access to confocal microscopes, deconvolution microscopes and computer analysis workstations.
2. **Web Site:** <https://research.cchmc.org/cic/>
3. **Manager:** Matthew Kofron, matthew.kofron@cchmc.org, 513-803-9055, or cic@cchmc.org, 513-636-4425
4. **Open to:** All CCRF research personnel and others as allowed by core staff.

Flow Cytometry and Cell Sorting Services (UC and CCHMC)

1. **Purpose:** Offers cell sorting and analysis capability and expertise to the entire clinical and research community.
2. **Website:** CCHMC - <https://www.cincinnatichildrens.org/research/cores/flow-cyto/> and UC - <https://med.uc.edu/molgen/core-facilities/flow-cytometry-core>
3. **Director:** CCHMC - Sherry Thornton, PhD, UC - William Miller, Ph.D
4. **Manager:** CCHMC - Dan Marmer, MS, MT(ASCP) Daniel.Marmer@cchmc.org, 513-636-8614, UC - William Miller at william.miller@uc.edu
5. **Open to:** All clinical and research personnel and other community hospital research investigators.

Genomics and Microarray Laboratory (UC)

1. **Purpose:** The core enhances research in environmental functional genomics (i.e, large scale gene expression data acquisition and analysis in biological systems stimulated by environmental agents) by offering a laboratory with emerging technologies in cDNA microarray technology.
2. **Website:** <https://www.med.uc.edu/eh/centers/ceg/integrative-technologies-support-core/genomics-sequencing-and-microarray-core>
3. **Director:** Shuk-Mei Ho, PhD, shuk-mei.ho@uc.edu, 513-558-3646
4. **Open to:** Open to all UC and CCHMC research personnel.

Gene Expression (CCHMC)

1. **Purpose:** Is available at Cincinnati Children's to perform the expression level analyses of thousands of genes in parallel. For most organisms it is now possible to provide a quantitative measure of the expression level of every gene. This powerful technology is becoming increasingly important in the study of developmental and disease processes, enabling scientists to achieve ambitious research goals such as identifying gene expression variation associated with disease and discovering new drug targets.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/affymetrix/>

3. **Director:** S. Steven Potter, PhD, steve.potter@cchmc.org, 513-636-4850
4. **Primary Contacts:** Shawn Smith, genecore@cchmc.org, 513-636-0290 and Hung-Chi Lian, hung.chi.liany@cchmc.org
5. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Hoxworth Cellular Therapies Division Laboratory (UC)

1. **Purpose:** Stem Cell Processing/Cryopreservation and Laboratory support for Transplant Programs
2. **Website:** <https://hoxworth.org/lab-services/cellular-therapies-division.html>
3. **Director:** Tom Leemhuis, PhD
4. **Primary contact:** Teri Crouch MT, ASCP, 513-558-1552
5. **Open to:** Accessible to all bone marrow/solid organ transplant programs.

The Anderson Center (CCHMC)

1. **Purpose:** Provides resources for data management and data analysis, process implementation, data analysis and outcomes research, and additional resources and expertise from health services research investigators in other divisions of the Research Foundation and the University of Cincinnati for research pertaining to improving the health and quality of life of children and their families.
2. **Website:** <https://www.cincinnatichildrens.org/service/j/anderson-center/health-policy>
3. **Director:** Peter Margolis, peter.margolis@cchmc.org, 513-636-0187, and Stephen E. Muething, stephen.muething@cchmc.org, 513-636-2068
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Imaging Research Center (CCHMC)

1. **Purpose:** Provides access to state-of-the-art MRI Research Instrumentation and diagnostic imaging technologies related to the diagnosis and treatment of diseases in children and young adults. An in-vivo microimaging laboratory is available to develop micro and molecular imaging techniques in models of pediatric disease.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/imaging>
3. **Director:** Charles Dumoulin, PhD, charles.dumoulin@cchmc.org, 513-636-7721
4. **Contact:** Kimra Smith, kimra.smith@cchmc.org, 513-636-3495
5. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Mass Spectrometry (CCHMC)

1. **Purpose:** Provides an analytical resource that focuses on the application of mass spectrometry and allied chromatographic approaches to the analysis of complex biological samples.
2. **Website:** <https://www.cincinnatichildrens.org/service/p/pathology/mass-spectrometry/>
3. **Director:** Ken Setchell, PhD, kenneth.setchell@cchmc.org, 513-636-4548, and pathology@cchmc.org, 513-636-4203
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Microscopy/Live Microscopy Core (UC)

1. **Purpose:** The Live Microscopy facility is designed to help investigators perform high resolution imaging with either living or fixed specimens. The facility has two advanced Zeiss confocal laser scanning microscopes for use, including one equipped for multiphoton imaging, as well as a Leica DMI8 widefield microscope system, and various stereo and dissection microscopes. Additional equipment available for use are a Laser Capture Microdissection instrument, multimode plate reader, Real-Time-PCR systems, infrared imager, and cryostat.
2. **Website:** <https://med.uc.edu/research/core-facilities/Index/43/Facility/>
3. **Director:** Christian I. Hong, PhD, hongca@ucmail.uc.edu, 513-558-5093
4. **Manager:** Chet Closson, clossoc@uc.edu, 513-558-4607
5. **Open to:** The facility is self-serve, open 24/7 only to users who have undergone full training so that they can work independently. Training/technical assistance available by appointment.

Nuclear Magnetic Resonance (UC)

1. **Purpose:** To facilitate biochemical research by providing high-resolution chemical NMR capabilities (conventional 1D- and 2D-NMR experiments of liquids to determine structure), magic angle spinning

(MAS) NMR of intact tissue samples, and *in vivo* imaging and spectroscopy of mice and small rats. Conventional NMR experiments can use any NMR-sensitive nucleus; MAS experiments can only be done using proton and carbon-13 nuclei. *In vivo* imaging and spectroscopy data can be acquired using proton, carbon-13, sodium-23, phosphorus-31, and lithium-7 nuclei.

2. **Website:** <https://med.uc.edu/research/core-facilities/Index/196/Facility/>
3. **Director:** Diana Lindquist, PhD, Diana.Lindquist@cchmc.org, 513-636-9268
4. **Primary Contact:** Elizabeth Fugate, Elizabeth.Fugate@cchmc.org, 513-636-9267 or 513-558-3330
5. **Open to:** By Appointment.

Pathology Research (CCHMC)

1. **Purpose:** Tissue trimming, processing and embedding, slide sectioning, H&E staining, special staining, immunohistochemistry, *in situ* hybridization, antibody or probe workup and electron microscopy.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/pathology-core>
3. **Director:** David Witte, MD, PathologyResearchCore@cchmc.org; 513-636-8159 or 513-803-0741
4. **Open to:** Anyone in CCHMC/Research Foundation, training required, technical advice and support available. For individuals outside CHMC, availability depends on collaboration with faculty at CCHMC.

Pediatric Pharmacology Research Unit (CCHMC)

1. **Purpose:** Provides support for both pediatric (Phase I-IV) and adult (Phase I-III) clinical research studies. Provides sponsors and researchers with scientific tools, facilities, and services to conduct effective clinical research studies.
2. **Website:** <https://www.cincinnatichildrens.org/research/divisions/c/pharmacology>
3. **Director:** Alexander Vinks, PhD, sander.vinks@cchmc.org, 513-636-5833
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Pluripotent Stem Cells (CCHMC)

1. **Purpose:** Providing high-quality, well-characterized and reliably archived human embryonic stem cells for distribution to researchers and reagents and expertise for the generation of induced pluripotent stem cells (iPSCs)
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/pluripotent-stem-cell-facility>
3. **Director:** James Wells, PhD, james.wells@cchmc.org, PSCF@cchmc.org
4. **Co-Director:** Chris Mayhew, PhD, christopher.mayhew@cchmc.org, 513-636-3744 and 513-636-9254
5. **Open to:** All CCRF and UC research personnel.

Proteomics (UC)

1. **Purpose:** The UC Proteomics Laboratory (UCPL) is committed to providing collaborative expertise & services in proteomics & biological mass spectrometry to investigators both as fee-for-service and as grant supported partnerships.
2. **Website:** <http://med.uc.edu/research/core-facilities/Index/44/Facility/>
3. **Director:** Ken Greis, PhD, ken.greis@uc.edu, 513-558-7102
4. **Open to:** All CCRF and UC research personnel at the preferred rate; external researchers as allowed by core director.

Office of Research Compliance and Regulatory Affairs (CCHMC)

1. **Purpose:** Assures research compliance of Cincinnati Children's Hospital Medical Center and Research Foundation in following all local, state, and federal regulations governing the use of all biological materials and human subjects.
2. **Website:** <https://www.cincinnatichildrens.org/research/cincinnati/support/orcra>
3. **Director:** Jeremy Corsmo, MPH, CIP, jeremy.Corsmo@cchmc.org, 513-636-5449
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Pyrosequencing (CCHMC)

1. **Purpose:** Full-service or ready-to-run options for or genomic variation studies. DNA extraction, bisulfite treatment, and PCR services in preparation for pyrosequencing.
2. **Web Site:** <http://www.cincinnatichildrens.org/research/cores/pyrosequencing/services>

3. **Director:** Hong Ji, PhD, PyroCore@cchmc.org, 513-803-5055
4. **Open to:** All CCRF research personnel and other researchers as allowed by core staff.

Transgenic Animal and Genome Editing (CCHMC)

1. **Purpose:** Generate genetically altered mice and rats; provide sperm and embryo cryopreservation, IVF and re-derivation.
2. **Website:** <http://www.cincinnatichildrens.org/research/divisions/d/dev-biology/core>
3. **Director:** Yueh Chiang Hu, PhD, Yueh-Chiang.Hu@cchmc.org
4. **Primary Contact:** Sandy Iten, Sandy.Iten@cchmc.org, 513-636-7098
5. **Open to:** All CCRF and UC research personnel; other researchers as allowed by core staff.

Transgenic Animal / Transgenic Mouse Physiology Core (UC)

1. **Purpose:** Analysis of a variety of physiological (cardiac, renal, pulmonary) functions in intact transgenic mice and development of new technologies/instrumentation related thereto.
2. **Website:** <http://www.uc.edu/labs/mmpc.html>
3. **Director:** Patrick Tso, PhD, Patrick.tso@uc.edu
4. **Primary Contact:** Dana Lee, dana.lee@uc.edu, 513-558-2758
5. **Open to:** Accessible to all.

Translational Research (CCHMC)

1. **Purpose:** Stimulates the development of pre-clinical and human translational trials that will improve the care of children with severe diseases. Provides adequate infrastructure that has been developed to insure support for pre-clinical and clinical translational research projects.
2. **Website:** <https://www.cincinnatichildrens.org/research/cincinnati/support/clinical-translational-research>
3. **Director:** Michelle Adams, michelle.adams@cchmc.org, 513-803-4538 and Office for Clinical and Translational Research, OCTR@cchmc.org, 513-636-3232
4. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Translational Research Development and Support Laboratory (CCHMC)

1. **Purpose:** Coordinates and/or performs cellular and molecular testing required to document purity, function, clonal composition, and overall safety of human ex vivo manipulated cell preparations, vector preparations, gene modified cell preparations, and patient molecular and safety monitoring samples, making compiled data accessible to investigators within and outside of Cincinnati Children's Hospital Medical Center.
2. **Website:** <https://www.cincinnatichildrens.org/research/cores/translational-core-laboratory/>
3. **Director:** Scott Witting, PhD, Scott.Witting@cchmc.org, 513-803-1066
4. **Manager:** Shellie Jungkunz, shellie.jungkunz@cchmc.org, 513-803-1070
5. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Veterinary Services (CCHMC)

1. **Purpose:** Provides veterinary support and consultation to the researchers involved in animal research. Ensures the vivarium is in compliance with all Federal, State and Local Regulations and all animals are provided appropriate veterinary care and husbandry, meeting or exceeding the "Guide for the Care and Use of Laboratory Animals."
2. **Director:** Gary Keller, DVM, gary.keller@cchmc.org, 513-636-4441
3. **Open to:** All CCRF research personnel; other researchers as allowed by core staff.

Laboratory Animal Medical Services (UC)

1. **Purpose:** To provide a high-quality laboratory animal care and use program to the University of Cincinnati research and teaching community. To serve as a resource to the medical research community through the provision of education, training and consultative services as it relates to laboratory animal care and use. To provide leadership and direction in response to scientific advancements as it relates to laboratory animal care and use.
2. **Director:** Joanne Tetens-Woodring, tetensje@ucmail.uc.edu, 513-558-5518
3. **Website:** <http://researchcompliance.uc.edu/LAMS/aboutus.aspx> and <https://research.uc.edu/support/offices/ACUP>

4. **Open to:** All CCRF and UC research personnel; other researchers as allowed by core staff.