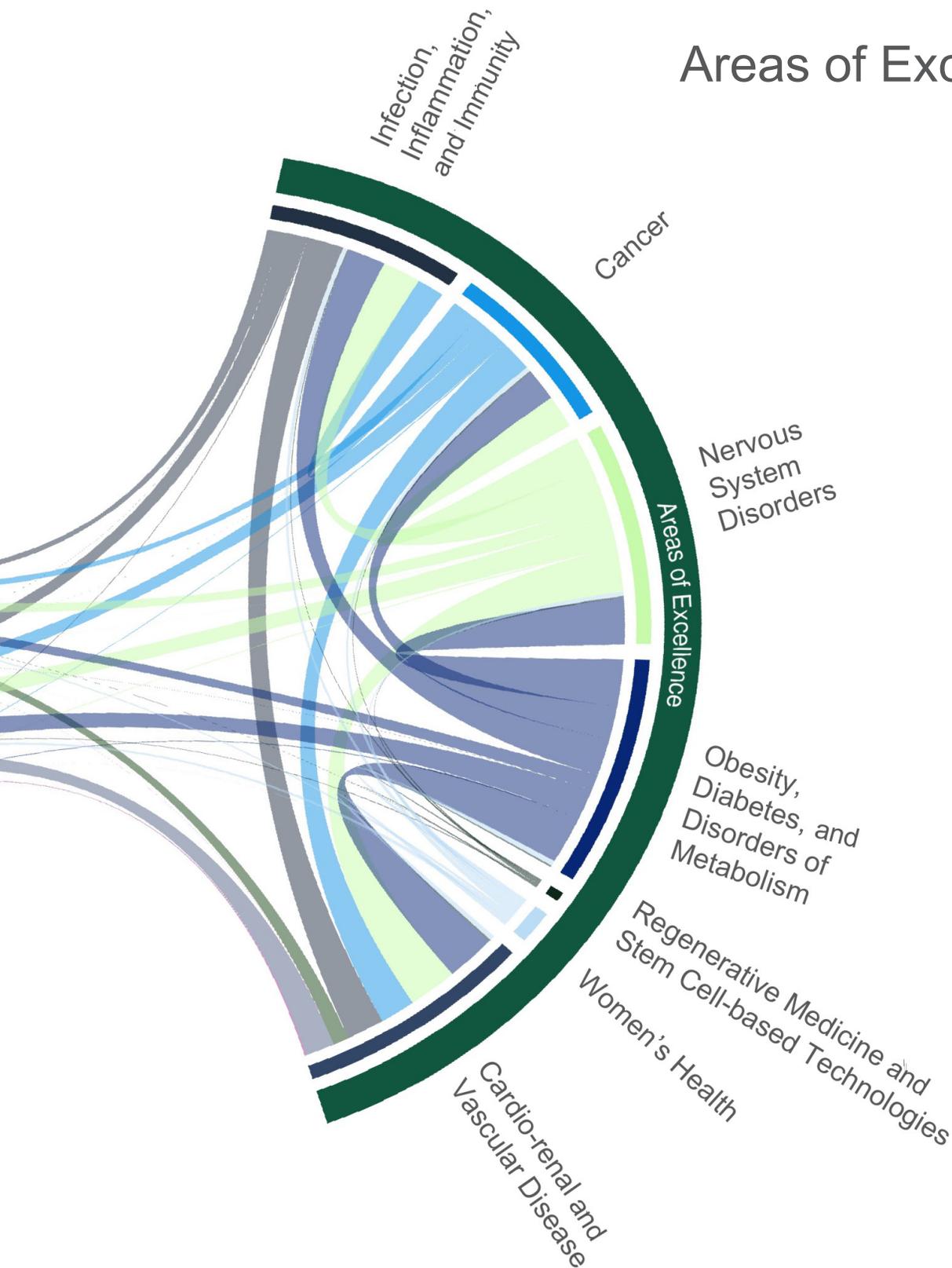


OPERATIONAL STRATEGIC PLAN FOR RESEARCH 2021 - 2026

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LIST OF ABBREVIATIONS AND ACRONYMS

AAALAC	Association for Assessment and Accreditation of Laboratory Animal Care International
AAAS	American Association for the Advancement of Science
AAHRPP	Association for the Accreditation of Human Research Protection Programs
AALAS	American Association of Laboratory Animals Science
ABB	American Board of Bioanalysis
AD	Alzheimer's disease
ADME	Absorption, distribution, metabolism, elimination
ADR	Associate Dean of Research
AoE	Area(s) of Excellence
AI	Artificial intelligence
AIC	Advanced Imaging Core
AIMP	Artificial Intelligence for Precision Medicine
ANVC	Advanced Neurovascular Practitioner
APRN	Advanced practice registered nurse
ARM	Advanced RISC Machines
ASCP	American Society for Clinical Pathology
AVCR	Associate Vice Chancellor for Research
AVCR-BD	Associate Vice Chancellor for Research and Business Development
AVCR-E	Associate Vice Chancellor for Research and Entrepreneurship
AVCR-GP	Associate Vice Chancellor for Research and Global Partnerships
AVCR-OSP	Associate Vice Chancellor for Research and Sponsored Programs
BBD	Behavior and brain diseases
BC	Board of certification
BF	Bridge Funding
BIG	Biorepository of Integrated Genomics
BioLINCC	Biologic Specimen and Data Repository Information Coordinating Center
BMHC	Baptist Memorial Health Care
BSL-2 or -3	Biosafety level-2 or 3
CAB	Community Advisory Board
CANDLE	Conditions Affecting Neurocognitive Development and Learning in Early Childhood
CAR	Chimeric antigen receptor
Cas9	CRISPR-associated protein 9
CBMI	Center for Biomedical Informatics
CCHS	Christ Community Health Services
CCRN	Certified in critical care nursing
CCP	Cross-cutting platform(s)
CCSG	Cancer Center Support Grant
CFRI	Children's Foundation Research Foundation
CGHS	College of Graduate Health Sciences
CIHER	Center for Innovation in Health Equity Research
CMGH	Center for Multicultural and Global Health
CM ² N	Center for Muscle Metabolism and Neuropathology
CMS	Centers for Medicare and Medicaid Service
CNS	Central nervous system
COD	College of Dentistry
COHP	College of Health Professions
COM	College of Medicine
CON	College of Nursing
COP	College of Pharmacy
COPD	Chronic obstructive pulmonary disease
CORNET	Collaborative Research Network
CoV	Coronavirus
COVID-19	Coronavirus disease 2019

CPET	Center of Excellence for Pediatric Experimental Therapeutics
CPU	Central processing unit
CRISPR	Clustered regularly interspaced short palindromic repeats
CRM	Cardiovascular, renal, and metabolic
Cryo-EM	Cryo-electron microscopy
CT	Computerized tomography
CTGB	Clinical Trials Governance Board
CTIAC	Clinical Trial Industry Advisory Committee
CTN2	Clinical Trials Network of Tennessee
CTR	Clinical and translational research
D3	Drug Discovery and Development
DbGaP	Database of Genotypes and Phenotypes
DDC	Drug Discovery Center
DDHS	Department of Diagnostic Health Sciences
DDS	Doctor of Dental Surgery
DMD	Doctor of Dental Medicine or Doctor of Medicine in Dentistry
DNA	Deoxyribonucleic Acid
DO	Doctor of Osteopathic Medicine
DOC	U.S. Department of Commerce
DSc	Doctor of Science
DUA	Data use agreement
DVM	Doctor of Veterinary Medicine
EDGE	Economic Development Growth Engine
EDW	Enterprise data warehouse
EHR	Electronic health record
ETSU	Eastern Tennessee State University
FAAN	Fellow of the American Academy of Nursing
FAANP	Fellow of the American Association of Nurse Practitioners
FAAP	Fellow of the American Academy of Pediatrics
FAAPS	Fellow of the American Academy of Orthopaedic Surgeons
FACP	Fellow of the American College of Physicians
FACS	Fellow of the American College of Surgeons
FACSM	Fellow of the American College of Sports Medicine
FAGD	Fellow in the Academy of General Dentistry
FAHA	Fellow of the American Heart Association
FARVO	Fellow of the Association for Research in Vision and Ophthalmology
FASB	Financial Accounting Standards Board
FASD	Fetal alcohol spectrum disorders
FASN	Fellow of the American Society for Nephrology
FI	Funding Institutional
FCCS	Flow Cytometry and Flow Sorting Core
FCP	Fellow of the College of Clinical Pharmacology
FNP	Family nurse practitioner
FTE	Full-time equivalent
FY	Fiscal year
GASB	Governmental Accounting Standards Board
GLP	Good laboratory practice
GMP	Good manufacturing practice
GPU	Graphics processing unit
GRA	Grants and Research Agreements
GWAS	Genome-wide association studies
HCA	Hospital Corporation of America
HCLD	High-complexity Clinical Laboratory Director
HIIM	Health Informatics and Information Management
HIPAA	Health Insurance Portability and Accountability Act

HIV	Human immunodeficiency virus
HPC	High performance computing
HR	Human Resources
HRP	Human Research Protection
HRSA	Health Resources and Services Administration
HSE	Health Sciences Entrepreneurship
IAB	Industry Advisory Board
IACUC	Institutional Animal Care and Use Committee
IBC	Institutional Biosafety Committee
III	Infection, immunity, and inflammation
IND	Investigational new drug
IOP	International Outreach Program
IP	Intellectual property
IRB	Institutional Review Board
IRR	InfoReady Review
ISAAC	Infrastructure for Scientific Applications, and Advanced Computing
ISHPS	Institute for the Study of Host Pathogen Systems
IT	Information technology
ITS	Information Technology Services
IUGR	Intrauterine growth restriction
JD	Juris Doctor
LACU	Lab Animal Care Unit
LBCH	Le Bonheur Children's Hospital
LEADS	Launching Entrepreneurial Activities and Discovery in Science
MA	Master of Arts
MAGD	Master of the Academy of General Dentistry
MB	Molecular Biology
MBA	Master of Business Administration
MBIO	Molecular Bioinformatics Core
MCC	Medicinal Chemistry Core
MD	Doctor of Medicine
MEMPHI-SYS	Memphis Pandemic Health Informatics System
MIRM	Memphis Institute of Regenerative Medicine
ML	Machine Learning
MLBH	Methodist Le Bonheur Healthcare
MLS	Medical Laboratory Scientist
MMHI	Memphis Mental Health Institute
MMSIG	Memphis Microbiome Special Interest Group
MOU	Memorandum of Understanding
MPA	Master of Public Administration
MPH	Master of Public Health
MPhil	Master of Philosophy
MPI	Multiple principal investigator
MPMS	Metabolic Phenotyping Mass Spectrometry unit
MRC	Molecular Resource Center
MS	Master of Science
MSc	Master of Science
MSD	Master of Science in Dentistry
MTA	Material transfer agreement
NAMS	North American Menopause Society
NAS	National Academy of Sciences
NCES	National Center for Education Statistics
NCI	National Cancer Institute
NCMP	NAMS Certified Menopause Practitioner
NCTR	National Center for Toxicological Research

NGS	New Grant Support
NHLBI	National Heart, Lung, and Blood Institute
NI	Neuroscience Institute
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NMR	Nuclear Magnetic Resonance
NRSA	National Research Service Award
NSD	Nervous system disorders
NVRN	Neurovascular registered nurse
ODMD	Obesity, diabetes, and metabolic disorders
OIA	Office of International Affairs
OIE	Office of Institutional Effectiveness
OR	Office of Research
ORD	Office of Research Development
ORI	Oak Ridge Institute
ORMC	Office of Research Marketing and Communications
ORNL	Oak Ridge National Laboratory
ORSA	Office of Research Safety Affairs
OSP	Office of Sponsored Programs
OSPR-1	Operational Strategic Plan for Research, 1 st edition
OSPR-2	Operational Strategic Plan for Research, 2 nd edition
OSW	Office of Scientific Writing
PCBs	Polychlorinated biphenyls
PET	Positron emission tomography
PharmD	Doctor of Pharmacy
PHAST	Pharmacology, Addiction Science, and Toxicology
PhD	Doctor of Philosophy
PI	Principal Investigator
PK	Pharmacokinetics
PMC	Proteomics and Metabolomics Core
PNS	Peripheral nervous system
PRAPARE	Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences
PSI	Program for Streptococcal Infections
PWAS	Proteome-wide association studies
QA	Quality Assessment
QEP	Quality Enhancement Plan
RBC	Red blood cell
RBL	Regional Biocontainment Laboratory
RCA	Research Collaboration Agreement
RHC	Research Histology Core
RISC	Reduced instruction set computing
RIT	Research information technology
RMSCCT	Regenerative Medicine and Stem Cell-based Technologies
RN	Registered Nurse
ROH	Regional One Health
ROI	Return on investment
RSC	Radiation Safety Committee
SAMHSA	Substance Abuse and Mental Health Services Administration
SARS	Sudden acute respiratory syndrome
SAS	Statistical Analysis System
SBIR	Small Business Innovation Research
SCIG	Stem Cell Interest Group
SDOH	Social determinants of health
SJCRH	St. Jude Children's Research Hospital
SMART	Substance Misuse and Addiction Resource for Tennessee

SOAR	Summit for Opioid Addiction and Response
SOP	Standard operating procedures
SPECT	Single photon emission computed tomography
SPSS	Statistical Package for the Social Sciences
SR	Southern Research
STCC	Southwest Tennessee Community College
STTR	Small Business Technology Transfer
SUD	Substance use disorders
TED	Technology, Entertainment, Design
TennIRM	Tennessee Institute of Regenerative Medicine
TN	Tennessee
TN-CTSI	Tennessee Clinical and Translational Science Institute
TNECD	TN Department of Economic and Community Development
TN-PHC	Tennessee Population Health Consortium
TN-POPnet	Tennessee Population Health Data Network
TOPMed	Trans-Omics for Precision Medicine
UBBI	University of Tennessee BioBusiness Incubator
UCH	University Clinical Health
UCI	Urban Child Institute
UM	University of Memphis
US	United States
UT	University of Tennessee
UTC	University of Tennessee Chattanooga
UTHSC	University of Tennessee Health Science Center
UTIA	University of Tennessee Institute of Agriculture
UT Knoxville	University of Tennessee Knoxville
UTSI	University of Tennessee Space Institute
UTRF	University of Tennessee Research Foundation
VA	Veterans Administration
VAMC	VA Medical Center
VHA	Veterans Health Administration
VU	Vanderbilt University
WHI	Women's Health Initiative

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EXECUTIVE SUMMARY

The process. This second Operational Strategic Plan for Research (OSPR-2) was built on the foundation of its immediate predecessor of 2016. It represents and updates those research directions and initiatives that we regard to be the most critical for research success at the University of Tennessee Health Science Center (UTHSC) over the next 5 years — from 2021 to 2026. OSPR-2 incorporates the recommendations of many UTHSC faculty members to our administration and to the Chancellor. The OSPR-2 committee was selected by the Vice Chancellor for Research, Dr. Steven R. Goodman, and the deans and leaders of the four UTHSC campuses — Memphis, Knoxville, Chattanooga, and Nashville. The resulting product represents ideas from all UTHSC colleges and campuses. OSPR-2 was written primarily by senior members of the research faculty but with important contributions by research administrators that have guided the recommendations on operational facets. To engage many faculty members in the production of OSPR-2, the process has intentionally been highly iterative.

The Vice Chancellor for Research charged the OSPR-2 committee to update, revise, and extend OSPR-1. Work began in October 2020 to address three major questions: 1. What are the most important Areas of Excellence (AoE) and Cross-Cutting Platforms (CCP) for our faculty's research programs? 2. What areas do we think are most critical to grow over the next 5 years? 3. Do the conclusions embedded in OSPR-1 still apply, and if not, how should the structure and/or the recommendations be changed?

Next, the entire faculty of UTHSC was invited to participate in a survey on the draft AoE and CCP. This survey was meant to ensure that the OSPR-2 committee had selected the right topics and that the committee was not missing any key components. The survey allowed a broader voice than the membership of the OSPR-2 committee alone. Respondents were able to enter free-text comments on several topics. For a brief overview of the results, please see [Appendix 1](#).

In early spring 2021, our committee arrived at a consensus on the final seven AoE (two of which are aspiring) and four CCP to include in OSPR-2. Workgroup leaders for each area were charged by the co-chairs with the assistance of the Vice Chancellor for Research. These leaders were tasked with soliciting and assimilating the input of not only the other committee members but also a wider base of faculty members across colleges and campuses. A full list of contributors to these workgroups is provided on pages 2–3. In the latter part of spring 2021, workgroups were assembled with the help of the Vice Chancellor for Research to develop the sections of OSPR-2 focused on operational items that are needed to support the infrastructure of all AoE and CCP.

Reports from all workgroups were presented at several full committee meetings, to the Faculty Senate's Faculty Research Committee, to the Vice Chancellor for Research, the Research Council, and the full Faculty Senate. Suggestions from each of these groups were integrated by the OSPR-2 workgroups and reviewed by the full OSPR-2 committee. As such, OSPR-2 is not the work of the OSPR-2 committee co-chairs alone, but rather that of the entire committee with input from faculty and staff members across the university. While the product is faculty-driven it is not a "grass roots" effort. The goal was to establish broad consensus across the many different viewpoints represented by the full OSPR-2 committee, since it was unrealistic to try to reach unanimity. Committee members did agree that prioritization and implementation of research strategies must be based on strong cooperation at college and campus levels. Given many unpredictable events that impact research — the coronavirus disease 2019 (COVID-19) pandemic being a prime example — all of us working on OSPR-2 recognize that we must expect and even encourage flexible implementation of our proposals over the next five years.

The AoE and the CCP were found to have similar needs, which are presented below in alphabetical order. There is no intended ranking between the two, as both categories are equally crucial to our research success. Subcategories within each area are also alphabetized.

Recommendations from the AoE

- **Cancer** research remains a priority for UTHSC. Our local depth of clinical, translational, and basic science research rivals that of any center but we have not yet effectively leveraged these resources to

be competitive for a Cancer Center Support Grant (CCSG) application to the National Cancer Institute (NCI).

- Research in **Cardio-renal and Vascular Disease** and in **Obesity, Diabetes, and Metabolic Disorders**, historical powerhouses at UTHSC, suffer from difficulties with siloed researchers, suboptimal networking and collaboration, and a lack of protected time for research by clinician-scientist faculty members. A challenge is presented in this area for effectively working with hospital and clinical partners.
- **Infection, Immunity, and Inflammation** research has major strengths within the Institute for the Study of Host Pathogen Systems (ISHPS), the Center for Pediatric Experimental Therapeutics (CPET), the Program for Streptococcal Infections (PSI), the Memphis Microbiome Special Interest Group (MMSIG), and the Regional Biocontainment Laboratory (RBL). However, faculty members must coalesce, communicate, and collaborate more effectively to seize the huge opportunity for research following COVID-19.
- **Nervous System Disorders** research has excellent resources provided by our light-sheet and super-resolution microscopy cores, the Neuroscience Institute (NI), and neurological clinical trials through the Clinical Trials Network of Tennessee (CTN2), but we must recruit a dynamic institute director who will bring energy to reinvigorate efforts and recruit more faculty members.
- **Regenerative Medicine and Stem Cell Based Technology** and **Women's Health** are our two aspiring AoE in research. We need to expand the depth of the bench for both areas by recruitment of faculty and support the successes in these areas to date.

Recommendations from the CCP

- **Drug Discovery and Development** has been a UTHSC strength but this area has acute core laboratory and technical needs that must be addressed to fully support this platform. The strategic hiring of a senior leader in this area will also lend needed support to junior faculty members.
- **Global Health** research that is emerging at UTHSC will require the addition of active researchers, better coordination and training, and more support for international collaborations.
- **Health Disparities** greatly affect the health of the citizens of Tennessee and this area was therefore designated as UTHSC's institutional Quality Enhancement Project (QEP). This platform requires access to large-scale data and the expertise to use them for research. Communication and security need to be enhanced in this area.
- **Precision Healthcare** is a historical area of strength that continues to grow. However, to reach and remain at the cutting edge of this field will require ongoing training, more vigorous recruitment, and enhanced computing infrastructure.

One overarching theme. UTHSC has multiple missions, but if we lose sight of our research mission, we will lose the edge in both our clinical care and our educational goals. UTHSC's missions are all tightly linked to high quality state-of-the-art academic health care, from primary to tertiary. The solution embedded in OSPR-2 is first and foremost to collaborate much more effectively across departments, colleges, campuses, and external collaborators – in short, to erode the walls of departments and colleges and to bridge the often-stark chasms that separate clinical service, education, and research. Through this collaboration, UTHSC is supported across the state of Tennessee to become a magnet for health care research and impactful prevention and treatment.

INTRODUCTORY COMMENTS

We have witnessed major milestones in the development of research on the UTHSC campuses since OSPR-1 in 2016. This progress has been made while achieving our core mission *“To cultivate and support discovery, innovation, commercialization, and economic growth within the University of Tennessee Health Science Center and the state of Tennessee, with the dedication to improve the health of Tennesseans, the nation, and the global community.”* Thanks to both the state of Tennessee and the energy of the leaders on all UTHSC campuses, our research infrastructure is much stronger now than it was five years ago. We have made major advances in research administration and our research infrastructure, including improvements within the Office of Sponsored Programs (OSP), the Office of Research Development (ORD), and the Office of Scientific Writing (OSW). We have also strengthened our institutional research cores, which include the Advanced Imaging Core (AIC), Flow Cytometry and Cell Sorting (FCCS), the Laboratory Animal Care Unit (LACU), the Medicinal Chemistry Core (MCC), Molecular Bioinformatics (MBIO), the Molecular Resource Center (MRC), the Proteomics and Metabolomics Core (PMC), the RBL, and the Research Histology Core (RHC). Our research mission is beginning to have a genuine statewide reach, exemplified by establishment of the CTN2, which facilitates UTHSC-coordinated clinical trials in collaboration with many health systems and hospitals. Other examples include the rapidly expanding statewide efforts in fighting the COVID-19 pandemic that coordinate ground-breaking collaborative research between our RBL, the Oak Ridge National Laboratory (ORNL), and Regeneron Pharmaceuticals; and collaborations between Le Bonheur Children's Hospital (LBCH), Regional One Health (ROH), and East Tennessee State University (ETSU) to generate a joint genomics and electronic health care database that includes the data from 100,000 Tennesseans. The success of the Collaborative Research Network (CORNET) intramural funding program has also promoted research collaborations within the UTHSC Memphis campus, across UTHSC campuses, and with other local, national, and global research institutions. The Tennessee Clinical and Translational Institute (TN-CTSI) has improved support for students, trainees, and faculty members conducting clinical and translational research. We are headed in the right direction, but rather than being satisfied with our past successes, we must do more and achieve much more.

Our collective mission and the single most important aim related to OSPR-2 is to devise a pragmatic strategy that will improve the health of Tennesseans. Our strategy combines our academic teaching roles across the state and innovative research with genuine clinical impact in not only Tennessee, but across the nation and the world, as was so dramatically proven by UTHSC responses to the COVID-19 pandemic and the opiate crisis.

The goal of OSPR-2 (2021–2026) is to serve as a general guide to improving research at UTHSC, since it contains both strategic components and some operational recommendations. As mentioned in the **Executive Summary**, the creation of OSPR-2 was driven by research intensive faculty members and the research leadership of all UTHSC colleges and campuses. OSPR-2 has also benefited from significant input and guidance from senior administrators in the chancellery and in the colleges. This has been, appropriately, a bottom-up process in terms of content and a top-down process in terms of general procedures, tempo, and tone.

The OSPR-2 document addresses two key questions. First, what lessons did we carry forward from OSPR-1? Second, how do we propose to take research to the next level, one that will make UTHSC a leader in not only the education of outstanding clinicians and researchers, but also in research achievement at the highest level? Achieving such a status is not merely about an influx of money or a specific number of extramural grants funded. Rather, achieving these major goals will involve long-term vision, commitment, and collaboration among members of the faculty, staff, and administration, and even key members of the state government. OSPR-1 provided us with an operational template upon which we can continue to build successfully over the next 5-year period.

The OSPR-2 team has settled on two overarching strategies that should guide UTHSC research.

Overarching Strategy 1. Focus on statewide growth. Given the reality of the 500 miles that span the state of Tennessee and the distances between our campuses, what are the most effective and scalable strategies for redoubling our efforts to make UTHSC *the* statewide health science center for prevention, treatment, and research growth? For the health of our residents, it is key that we cover every county in Tennessee. In doing so, we can exploit regional strengths and expertise to better serve the diverse population within our state.

The COVID-19 pandemic has proved that remote collaboration and telemedicine can be highly effective and highly scalable for teaching, some types of clinical care, and many types of research. Video conferencing is a game changer that has the same impact today that desktop computers did in the 1980s and the infancy of the internet did in the 1990s. We must exploit this inexpensive technology to convert the 500-mile stretch of I-40 into a virtual desktop, as if each individual were sitting side-by-side in the same room. The research endeavor should leverage faculty and staff members across our campuses to work together as seamless units, without undue concern for the location of chairs, desks, and benches. What matters most is how to achieve rapid progress toward effective prevention, treatment, and care. In the next five years, we must recruit and retain the best scientists and place them and key research resources across the entire span of Tennessee to unite research using the best and fastest connections.

Overarching Strategy 2. Sustain and build research institutes and research centers among colleges and campuses. In the next five years, we must communicate and collaborate more effectively among our disparate research efforts. We need to find, nurture, and amplify the unifying themes that lead to synergy among UTHSC researchers, institutes, and centers. This means supporting a culture that emphasizes true camaraderie rather than competition among units. This culture must permeate from top to bottom, via the examples set by administrators and the senior leadership on all UTHSC campuses.

As a practical matter with a historical basis and precedence, faculty members are recruited into academic departments within the six colleges of UTHSC. Our historical core mission from 1911 has been to teach the next generation of clinicians, clinical staff, and scientists, which remains one reason that recommendations for recruitment and tenure decisions are made initially by department chairs and deans. Expert clinicians and educators are in high demand, but for us to be a genuine academic center, health care professionals must be encouraged to actively engage in research. While it is the long-term responsibility of the colleges and their deans to guide, build, and support faculty research, there is an acute need to coordinate, reconcile, and facilitate efforts across colleges and campuses. The major leadership role of the Vice Chancellor for Research is to provide an institutional vision, catalyze research, and provide core platforms and regulatory environments that support cutting-edge biomedical research across the state. Six years ago, our newly hired Vice Chancellor for Research outlined a vision for integrating and growing research. That bold mission and broad mandate required substantial adjustments institution-wide, many of which were well described in OSPR-1. These adjustments have grown both the quality and quantity of our research and have enhanced our statewide and national impact.

One key aim of OSPR-2 is to encourage deeper integration, flexible collaboration, and cooperation among multiple research activities and at four complementary levels:

- 1) *Individual researchers and their research groups.* OSPR-2 has been reiteratively drafted, reviewed, and vetted by over 40 such investigators across many fields and styles of research.
- 2) *Research centers funded mainly by departments and colleges.* Such centers are critical for achieving collegiality among departments and colleges and for reaching the critical mass required to sustain vibrant research programs and larger projects.
- 3) *UTHSC clinical research centers and collaborations spread across campuses.* These efforts are critical for building collaborative clinical and basic research programs of excellence. Examples include the UTHSC Knoxville collaboration with ORNL, the UTHSC Chattanooga collaboration with Erlanger Health System, and the UTHSC Nashville collaboration with Ascension Saint Thomas.
- 4) *Larger and more formally recognized areas of research excellence.* OSPR-2 highlights many of these AoE. Some have stable funding by the state of Tennessee and are generally administered by the chancellery. These include the NI, TN-CTSI, CTN2, ISHPS, the MRC, and the Tennessee Institute of Regenerative Medicine (TennIRM). These chancellery-level programs, which are usually flagged with the word *institute*, strive to catalyze research across all these levels. This top level often goes well beyond UTHSC and includes collaboration with other independent institutions such as ORNL, the University of Memphis (UM), St Jude Children's Research Hospital (SJCRH), the Urban Child Institute (UCI), other

units of the University of Tennessee (UT), the UT Research Foundation (UTRF), corporate partners, insurance providers, and many national and international research partners.

What are the best strategies for managing and integrating these four levels of research? First, faculty and staff members must have home appointments in one or more colleges and departments. Departments are the main unit of academic research, which provide long term stability and collegiality for retention and promotion. However, for optimal growth, chairs, deans, and chancellors must team up effectively at the very first stages of institute development and during the recruitment of key faculty members who will foster institute goals. All faculty members benefit greatly from the research infrastructure constructed by the chancellery, while the deans and departments can benefit from the chancellery's help with start-up packages, pilot grants, and bridge funding. College-led efforts must be complementary and build on the strengths that are provided by the chancellery. In turn, the chancellery's efforts must be developed in conjunction with the needs of the colleges.

Perhaps our most important partners are the citizens of the state of Tennessee and their elected representatives. The UT system has relied on these partners since our inception in 1911. We need them to understand, appreciate, and fund the efforts made by our research teams on behalf of their health, welfare, and training. Given the relentless pace of progress, we must ensure that we are performing cutting-edge research in all the AoE and CCP highlighted in OSPR-2, supported by state-of-the art cores and other facilities.

AREAS OF EXCELLENCE

CANCER **Area of Excellence**

Background and Current Status

Cancer prevention, care, and research remain mission-driven priorities for UTHSC. Regional clinical, translational, and basic science expertise rival those of many top academic centers elsewhere. However, we have not yet effectively leveraged these resources to grow programmatically. UTHSC is currently realigning its clinical cancer care faculty and services towards the submission of a formal CCSG application to the NCI. Our goal is to secure the first NCI-designated Cancer Center serving the Midsouth region and the entire state of Tennessee. Such a center will deliver transdisciplinary, state-of-the-art resources to the broad reach of all UTHSC campuses to prevent, diagnose, and treat cancer in diverse populations. This access will include the availability of first-tier institutional and cooperative group clinical trials offered in the context of subspecialty care. Formal designation as an NCI Cancer Center is associated elsewhere with a 10% improvement in cancer-related treatment outcomes. The presence of resources and talent associated with an NCI-designated Cancer Center will help to stimulate investments in the local economy by private biomedical industry partners. We require basic, translational, and population science commitment across all campuses of the UT system to support a successful center grant submission; all boats will rise from this effort. As part of this strategic aim, we propose the following Focus Areas for future investment:

- 1) Clinical Trials Program
- 2) Cancer Cell Biology and Therapeutics
- 3) Cancer Disparities [Training] Programs

Focus Area 1. Cancer Clinical Trials Program

The creation of a cancer clinical trials program is a requirement for NCI Cancer Center designation and will ensure necessary resources for transdisciplinary research. The NCI CCSG model encompasses four administrative capabilities that are not yet formally in place at UTHSC: 1) clinical protocol and data management; 2) data and safety monitoring; 3) the inclusion of women and minorities in clinical research; and 4) the inclusion of individuals across the lifespan in clinical research. CCSG designation also requires minimum threshold numbers for patient trial enrollment that are currently not being met. This Focus Area will require the formal allocation of existing or new clinical trials office administrative/operational support. We are initially targeting patient trial accrual at 3% of our index population by year 2, and 7% by year 5 of OSPR-2. Staffing/overhead to secure these milestones should be guaranteed during the first three years and then transitioned to a mixed model of support, including a portfolio of industry-supported clinical trials.

Focus Area 2. Cancer Cell Biology and Therapeutics

We have existing strengths in cancer cell biology, drug discovery, and an impressive biorepository collection. We must develop and shepherd “home-grown” novel therapeutics into clinical trials, including scaling our current strength in small molecule development and expanding our preclinical tumor modelling capabilities. We must broaden our expertise in cancer cell biology through recruitment and training support. We must expand and develop programs in basic cellular mechanisms and in drug discovery programs via stable financial support, infrastructure improvements, and recruitment of expertise in cancer drug discovery, development, and early phase clinical trials. One way to foster research among interdisciplinary groups teams would be to offer pilot grants. There was high return on investment for prior rounds of internal funding before the relationship with West Cancer Center ended. The UTHSC College of Pharmacy (COP) Drug Discovery Center (DDC) already provides a strong platform for development of small molecule drugs. It would be an important selling point for our NCI CCSG submission to demonstrate local phase I development of drugs that were invented in-house. Drugs could be further developed through establishment of a university-based start-up company to attract equity or angel investors. UTHSC could take on the role of an equity investor in university start-ups to propel clinical development until such time as equity investors are willing to seek out the drugs. Several other universities have developed this model, including the University of Chicago, University of California at Berkeley, and University of Michigan.

Focus Area 3. Cancer Disparities Training Programs

One of three stated major areas of research encompassed by the NCI CCSG model is “cancer prevention, control, and population science.” Successful CCSG submissions must demonstrate depth in grant support across several thematic areas (e.g., epidemiology, primary prevention, early detection, health services, dissemination,

palliation, and survivorship). The populations of Memphis, the state of Tennessee, and the Upper Mississippi Delta region historically suffer disproportionate cancer prevalence and mortality rates, particularly in disadvantaged groups. Examples include prostate, colon, pancreatic, and triple negative breast cancers. Since OSPR-1, UTHSC has strengthened its nationally recognized Department of Preventive Medicine, bioinformatics infrastructure, community outreach programs, and statewide academic collaboration across UTHSC campuses. This can be leveraged immediately as a capstone of our anticipated NCI CCSG submission. Our goal is to develop internal training grant programs that support graduate and postdoctoral students, with a focus on diversity-based recruitment and training. We must also further engage at-risk communities in the design of and accrual to UTHSC epidemiologic studies and clinical trials. The goal is to engage and support community-based organizations directly working toward improving survival, access, and education for cancer patients in neighboring at-risk communities. To support these efforts, we must develop epidemiology, biostatistics, data warehousing and analytics, and clinical trials support through the recruitment of leaders in one or more of these areas.

Institutional Impact and Deliverables

The workgroup strongly feels that the developments outlined in this document will allow UTHSC to successfully compete for an NCI Cancer Center designation. The deliverables for OSPR-2 are to open no fewer than five new clinical cancer trials by March 1, 2022, an initial milestone towards an NCI submission. We plan to use the NCI CCSG model as a framework for objective evaluation of progress over the 5-year duration of this plan. The UTHSC Office of Research should ideally adopt a performance-based evaluation system for administrative activities based on national norms. Next, we will submit applications for National Research Service Award (NRSA) Institutional Research Training Grant (T32 or T35) support from NCI that is specific to disparities-focused clinical or translational cancer research. Further, we will spearhead creation of one or more collaborative cancer-specific clinical trial(s) or funded research project(s) at every UTHSC campus.

Synergies and Collaborative Potential

The Cancer AoE will leverage and solidify longstanding collaboration with local provider and research partners, including Baptist Memorial Health Care (BMHC), LBCH, Methodist Le Bonheur Healthcare (MLBH), ROH, SJCRH, and the Memphis VA Medical Center (VAMC). Importantly, we will promote and scale collaboration across the state through new and existing partnerships with all UT campuses and facilities. Creating a cancer clinical trials program will directly support translational and population health research activity across the full cancer treatment continuum. Such activity is rigorously evaluated during NCI CCSG reviews. The alignment of the Cancer AoE with the Health Disparities CCP will promote synergies and new collaborative funding opportunities. This is envisioned to include cancer-focused genomics, molecular epidemiology, and drug development studies dedicated to historically underrepresented populations across the state.

CARDIO-RENAL AND VASCULAR DISEASE

Area of Excellence

Background and Current Status

Cardiovascular diseases represent the number one cause of death in Tennessee and worldwide, while deaths associated with kidney disease have increased over the past two decades. Kidney, heart, and vascular diseases (including stroke) tend to co-occur, which makes collaborative research in these areas feasible and desirable. Tennessee is an epicenter for heart, neurovascular, kidney and systemic vascular diseases, due to a confluence of highly prevalent cross-cutting risk factors such as obesity, diabetes, hypertension, hyperlipidemia, and racial and socio-economic disparities. This means that UTHSC is well positioned to be a scientific leader for research in these areas to affect positive change in the community. UTHSC has already amassed an important concentration of expertise in cardio-renal and vascular research. Existing program strengths include cardiovascular and renal complications in sickle cell disease; pathogenesis and treatment of acute kidney injury; impact of the fibroblast growth factor-23 (FGF23)-Klotho endocrine axis in renal and cardiovascular diseases; atherosclerosis, arterial stiffness, hypertension and heart diseases; vascular biology and ion channels; fatty acid metabolism; cardiovascular and renal aging; stem cell and molecular therapy for cardiovascular and renal disease; polycystic kidney diseases, including autosomal dominant polycystic disease and tuberous sclerosis complex; and outcomes research in chronic kidney disease. This work is facilitated by biobanks for hemodialysis and cardiovascular samples, research platforms for genome-wide and proteome-wide association studies (GWAS and PWAS, respectively), a cardiovascular nuclear imaging program, clinical trial research programs in cardiology, stroke, sickle cell disease and nephrology, an academic drug development consortium for therapeutics, and neurovascular reperfusion therapies. In a keyword analysis of scientific articles and grants from UTHSC, heart, kidney and blood vessels represented the most productive area during the period of July 2016-December 2020. In the OSPR-2 faculty survey, cardio-renal and vascular disease was the fifth most important research area and several themes encompassed by this AoE were mentioned by the faculty as priorities. OSPR-2 presents an opportunity for further development of cardiovascular, renal, and metabolic (CRM) research through strategic planning and investments, e.g., the establishment of a CRM center or institute that spans clinical, basic, and translational programs supported by CCP and cores. As part of OSPR-2, we propose the following Focus Areas for future investment:

- 1) Therapeutic target identification and intervention development for cardio-renal and vascular diseases
- 2) Cardio-renal and vascular complications of genetic and epigenetic disorders (sickle cell disease, autosomal dominant polycystic kidney disease, and tuberous sclerosis complex).

Focus Area 1. Therapeutic target identification and intervention development for cardio-renal and vascular diseases

The Tennessee population is heavily affected by cardiovascular and renal risk factors, which are confounded by racial, environmental, and socio-behavioral characteristics. There is a need to promote basic cardiovascular and renal research discovery of novel treatment targets and the translation of these discoveries to clinical practice and improved health outcomes. This can be achieved through consolidation and further development of existing UTHSC academic drug consortia and their collaboration with ORNL. Consideration should be given to incorporate individually successful units into a CRM center or institute. Needed investments include focused recruitment of investigators and support personnel (data analysts, research coordinators, grants administrator, project managers); infrastructure investment (office space, lab space); purchasing of equipment (office and lab equipment); and intramural support for a Tennessee Cardiovascular Genomics Registry Bank that will support prospective collection of consecutive blood samples alongside physiologic, clinical, geospatial, environmental, and socio-behavioral factors.

Focus Area 2. Cardio-renal and vascular complications of genetic and epigenetic disorders (sickle cell disease, autosomal dominant polycystic kidney disease, and tuberous sclerosis complex)

Pediatric and adult patients with sickle cell disease exhibit endothelial dysfunction characterized by a blunted response to inhibition of nitric oxide synthase and a resistance to exogenous nitric oxide. With high prevalence of disorders associated with endothelial dysfunction in Tennessee, combined with the available expertise at LBCH, ROH, and SJCRH, it is highly desirable to develop a strength in vascular biology at UTHSC. This would enhance our ability to further evaluate the role of endothelial dysfunction and other vascular abnormalities in cardiovascular disorders, validate biomarkers, and evaluate targeted therapies. Needed investments include

purchase of equipment for phenotyping (research echocardiography lab, but also other tools, including invasive methods to assess vascular reactivity); infrastructure (offices, lab space); and personnel (cluster hiring of basic and translational cardiovascular and renal investigators, data analysts, research coordinators, administrators).

Institutional Impact and Deliverables

The impact of the proposed developments would be multifaceted and include the integration of several areas that excel as separate units but don't currently work together (physiology, nephrology, cardiology, hematology, neurovascular, nursing, geospatial informatics, pharmacology, preventive medicine, biostatistics, pediatric and adult aspects of sickle cell disease and other genetic disorders research); promotion of team science; increased industry investment in new drug and device development that can be expanded to promote not only discovery but expansion to epidemiologic research and clinical trials; enhanced research funding; and consolidation and further development of UTHSC's leading role in developmental and lifespan research. Furthermore, there would also be a potential to become a leading center in genetic disorders research and a magnet that benefits not only research but also clinical and educational recruitment. Deliverables include increased extramural funding; applying for an O'Brien Center grant, a Pediatric Center of Excellence, and other U01 or P30 grants from the National Institutes of Health (NIH); expansion on collaborative initiatives within and outside UTHSC; and hiring of additional investigators and staff members.

Synergies and Collaborative Potential

The proposed developments would foster collaborations between basic scientists (vascular biologists, physiologists, etc.), clinicians (e.g., cardiologists, nephrologists, hematologists, radiologists, nurse scientists) and epidemiologists from all UTHSC campuses, SJCRH, LBCH, and institutions outside UTHSC. There would be synergy with other areas focusing on disparities (e.g., cancer), with bioinformatics (e.g., an enterprise data warehouse (EDW)), with ORNL, and with other areas focused on developmental and lifespan issues.

INFECTION, INFLAMMATION, AND IMMUNITY Area of Excellence

Background and Current Status

Current challenges impacting the fields of Infection, Inflammation, and Immunity (III) require the development of new multidisciplinary approaches and cross-cutting teams to solve these problems. UTHSC employs numerous investigators whose work is focused on aspects of III. Currently, there are significant strengths in the specific areas of viral, fungal, and bacterial pathogenesis, viral and bacterial co-infections, viral and bacterial vaccine development, identification of novel antiviral, antifungal, and antibacterial therapeutics, improvement of the therapeutic efficacy of antibacterial and antifungal drugs, delineation of molecular mechanisms underpinning antimicrobial resistance, and the impact of the microbiome on infection. These specific research strengths stretch across the lifespan of an individual, with investigators focused on projects that range from aspects of pediatric infectious diseases to the impact of aging on inflammation and innate immunity.

Cross-college collaborative potential is supported by existing institutes, centers, and special interest groups, including ISHPS, the CPET, the PSI, and the MMSIG. Investigators focused on research in III are also supported by the RBL, one of 12 such facilities in the U.S. built by the NIH. The RBL provides a safe research environment for working with infectious agents and performing experiments that require biosafety levels 2 or 3 (BSL-2 or BSL-3). The facility contains a wide array of instrumentation, expertise in infectious disease research, and an experimental animal facility (vivarium) that supports research in this area. The overall goal of OSPR-2 pertaining to this AoE is to build upon current strengths and maximize opportunities to realize the translational impact of basic science discoveries. We therefore propose the following Focus Areas for future investment:

- 1) Microbial Immunity
- 2) Systems Biology of Host-Pathogen Interactions

Focus Area 1. Microbial Immunology

Host damage during infectious disease is a complex outcome characterized by a host-microbe damage response framework. The outcome of infection is dictated by pathogen virulence, by the magnitude and effectiveness of the host inflammatory and immune responses to clear infection, and by complex host genetic and environmental factors. Therefore, to successfully tackle the problem of infectious disease requires an understanding of pathogenic fitness and the delineation of host-pathogen interactions through the study of host responses. At UTHSC, a significant number of investigators study aspects of bacterial, viral, and fungal pathogenesis, most of which utilize multiple animal models of disease. Many of the organisms under study are mucosal pathogens and multiple UTHSC investigators investigate facets of mucosal immunology, highlighting the potential for greater synergistic interactions among these investigators. However, there is a lack of critical mass of investigators across UTHSC colleges and campuses that are specifically focused on the immunology of infectious diseases. There exists an opportunity to enrich the UTHSC research environment through investing in the targeted recruitment of new faculty members in microbial immunology. These investments should be designed to promote synergistic cross-college collaborations.

Immediate investment is required for the cluster hire of investigators studying microbial immunology with the focused goal of generating synergistic collaborations across UTHSC colleges and campuses. Specifically, investments are required for cluster hires of new investigators in three areas: inflammation and immunity of respiratory infections caused by fungal, viral, and bacterial infections; host responses to bacterial and fungal oral and urogenital infections; and host genetic factors underpinning host immune response to infection. Investments are also needed to create formal mentorship committees for new hires, the retention of junior faculty, and the establishment of centralized forums of discussion and shared research space for current and newly recruited investigators connected to specific institutes or centers. Finally, investments are needed to better enable access to clinical samples (blood, stool, tissue, etc.) from across the patient lifespan, from pediatric patients (LBCH) to geriatric patients (ROH, MLBH, and the Memphis VAMC).

Focus Area 2. Systems Biology of Host-Pathogen Interactions

Current research programs at UTHSC connect clinical course of disease, pathogenic burden, and diagnostic biomarkers using computational or experimental models and data from cohorts of pediatric and adult patients with bacterial or viral infections. Novel predictive modeling is used to reveal how diagnostic biosignatures from

multi-omics data change with treatment regimens and outcomes. Further development of predictive algorithms is warranted to guide treatment regimens and intervention choice. In addition, further development, expansion, and integration of all -omics areas and bioinformatic analyses will be critical for growth in this area.

Seed funding will enable teams of researchers to tackle important public health challenges in infectious disease biology, prognosis, and treatment using multiple -omics technologies, big data analytics, and advanced modeling. Examples of target infectious diseases include sepsis, pneumonia, and COVID-19. Investment in biorepositories to facilitate these studies will also be crucial.

Institutional Impact and Deliverables

We envision that investment in microbial immunology over the next five years will enrich the scientific and academic environment within UTHSC, producing top-tier collaborative science focused on improved therapy of infectious and inflammatory diseases. In turn, these investments will promote increased competitiveness for extramural funding and will better position investigators whose research focuses on IIR for program project grant applications. Specifically, the requested cluster hire investments will significantly increase competitiveness for collaborative NIH multiple principal investigator (MPI) grant awards, program project grants, and NRSA training grant (T32) opportunities. We anticipate that this will result from new faculty cluster hires that re-establish a critical mass of microbial immunology researchers. This will not only support the basic science and translational work of current investigators in IIR but will also act as a catalyst for the development of new research areas and collaborative projects. The predictive models generated for the Systems Biology of Host-Pathogen Interactions Focus Area will be used to inform diagnoses and design personalized therapeutic treatments on an individual basis. These results will provide a new framework for the discovery and development of the next generation of antibiotics and antivirals. Additional outcomes of cross-disciplinary research include a first-of-its-kind clinical, multi-omics dataset that can also be used to develop predictive models for pulmonary diseases (e.g., asthma and chronic obstructive pulmonary disease (COPD)) that are exacerbated by respiratory tract infections. Computational modeling will reveal 1) the existence of diagnostic biosignatures governing disease outcomes that are common to pathogens that cause pneumonia and those that are unique to specific pathogens or respiratory illnesses, and 2) how these diagnostic biosignatures change with treatment regimens and clinical outcomes.

Synergies and Collaborative Potential

Building a strong core of microbial immunology opens collaborative potential across all UTHSC colleges and campuses and with investigators at SJCRH in Memphis. Synergistic collaborations between clinicians and basic scientists in all colleges will significantly increase as newly hired microbial immunologists become focal points of interaction to translate data from animal models of infection to human patients. The recruitment of immunologists who study host responses to mucosal pathogens will help to better integrate current faculty members whose research is focused on infectious diseases with those who study mucosal immunology. Recruitment of investigators whose research is focused on host genetic factors that impact inflammation and other host responses will promote synergistic collaborations with existing strengths in genetics and genomics at UTHSC. With respect to the systems biology, the development of predictive models demands the merger of knowledge, analytical abilities, and technical skills from several scientific disciplines. ISHPS has led several workshops for multidisciplinary teams of scientists and clinicians from UTHSC COM, COP, and CON to explore the intersection of their research interests. These discussions have resulted in one multi-disciplinary publication so far, with others in progress, albeit slowed by the COVID-19 pandemic. Many other synergies at UTHSC may be developed and harnessed in this manner, leading to the expansion of collaboration with regional academic and corporate partners. Active support will foster the growth of collaborative partnerships. For example, the recent UTHSC CORNET awards for collaborative study of the COVID-19 pandemic stimulated nine such collaborations.

NERVOUS SYSTEM DISORDERS Area of Excellence

Background and Current Status

This AoE focuses on the multifaceted mechanisms that drive the development and treatment of nervous system disorders (NSD). Our objectives focus on the following areas related to NSD: a) discovery, localization, and functional analysis of genetic, epigenetic, and environmental factors contributing to these disorders; b) identification of genetic and environmental risk factors that contribute to the development and severity of NSD, including social determinants of health (SDOH) and access to health care; c) common molecular and cellular processes that mediate susceptibility to NSD, including but not limited to oxidative stress, mitochondrial dysfunction, inflammation, transcriptional dysregulation, defective cell signaling, and protein misfolding/aggregation; d) identification of new molecular targets for NSD and development of drugs against these targets; e) development of model systems to decipher the origins and nature of neurological disorders; and f) development and incorporation of computational methods to understand central nervous system (CNS)/peripheral nervous system (PNS) physiology, pathophysiology, and responses to intervention.

The importance of NSD to the UT mission is underlined by the organization of statewide events by the UT leadership, such as launching the Summit for Opioid Addiction and Response (SOAR) and Substance Misuse and Addiction Resource for Tennessee (SMART) Policy Network (see Focus Area 2). This AoE was also recognized as integral in the faculty survey, ranking fourth out of the seven AoE in its importance to both current and future research programs. Moreover, faculty members' verbatim comments underscored the importance of resource investments in several relevant topics, including addiction, mental health, neurodegenerative disorders, and developmental and/or geriatric/aging health. Members of the faculty also requested further investments in clinical and basic science research partnerships. Specific requests from the faculty reflected their strong support for investment in technologies that are critical for the advancement of neuroscience research, including computational biology, cryo-electron microscopy (Cryo-EM) and other methods used in structural biology, genomics, high-resolution imaging, nuclear magnetic resonance (NMR)/positron emission tomography (PET) imaging, and organ-in-chip. Such technologies would also benefit other AoE. In the past five years, the UTHSC Office of Research has invested in additional new imaging techniques, such as light-sheet fluorescence microscopy and super-resolution microscopy. Centralization of these and other imaging instruments in the AIC, along with technical support in the use of these instruments, has assisted the success of this AoE. The development of the CTN2 and the Clinical Trials Governance Board (CTGB) are other positive developments that have grown clinical trials within the area of neurology.

NSD continues to be one of the strongest research areas at UTHSC in terms of successful acquisition of extramural funding by NI members, which increased 7.6% from \$18,858,802 (FY2020) to \$20,291,627 (FY2021). The NI continues to provide graduate student and postdoctoral support, pilot project funds, and core facilities (e.g., the AIC) for neuroscientists and their collaborators. Other strengths in NSD include the recruitment of a new chair in Psychiatry who, in conjunction with other clinical and basic science departments, will help to reorganize and revamp the College of Medicine (COM) Center for Addiction Science.

Despite these strengths, the number of basic and clinical neuroscience faculty members at UTHSC has declined since 2016. The loss of physician/clinical neuroscientists in particular has made it much more difficult for PhD scientists to collaborate in translational research on NSD or to include a clinically driven component in their research programs. The Vice Chancellor for Research has offered to join forces with the COM to raise funds via the UTRF to create a substantial package to recruit a new director of the NI, along with funding for additional hires. The NSD workgroup fully supports this initiative. When selecting a new director for the NI, consideration should be given to its future research trajectories and whether this leader should be recruited internally or externally. Discussions should include the chancellor, the chairs of the Departments of Psychiatry, Neurology, and Anatomy and Neurobiology, and other neuroscientists and research leaders from across all UT colleges and campuses. As part of OSPR-2, we propose the following Focus Areas for future investment:

- 1) Movement Disorders, Neurodegenerative, and Cerebrovascular Diseases
- 2) Neurobiology of Addiction and Substance Use Disorders (SUD)
- 3) Neurotoxicology

Focus Area 1. Movement Disorders, Neurodegenerative, and Cerebrovascular Diseases

Understanding the pathogenesis of movement disorders and neurodegenerative and cerebrovascular diseases represents major interest areas of both the NIH and various research foundations. This research Focus Area is appropriate given the aging U.S. population. Across UT academic units, solid research programs in movement disorders and neurodegenerative diseases should prioritize research questions regarding Alzheimer's disease (AD) and other dementias, Parkinson's disease, Huntington's disease, traumatic brain injury, multiple sclerosis, dystonia, and the natural consequence of aging on memory and cognition. Most of the neuroscientists who previously worked in neurodegenerative disorders at UTHSC have left and not been replaced, thereby greatly diminishing the depth and breadth of UT researchers in this AoE.

UTHSC includes research strengths in the disruption of brain circulation, microcirculation, in particular the neurovascular unit, in addition to the blood-brain barrier. Recent recruits include a new faculty member in the Department of Anatomy and Neurobiology, who studies the impact of inflammation-oxidative stress on progression of neurovascular brain injury after stroke. Collaborations between the COM Neurology and Neurosurgery departments and the College of Nursing (CON) contribute to strengths in observational and translational science and clinical trials in this area. These collaborations are extramurally funded by NIH and industry sources.

Ideal Focus Areas for new faculty recruits include systems neurobiology, development of rodent models, gene therapy, molecular and/or cell biology of neurodegenerative disorders; molecular and/or cell biology of neuronal cell signaling, and clinical science on AD, dementia, neuroregeneration, and neurorehabilitation.

Focus Area 2. Neurobiology of Addiction and Substance Use Disorders

This Focus Area has been restructured from OSPR-1 to include a variety of prevalent conditions and contributing societal problems that are peripherally related to the chronic brain condition termed addiction, including opioid overdose, binge drinking, and fetal alcohol spectrum disorders (FASD). This term, which was carried over from OSPR-1, encompasses additional addictive behaviors that are separate from substance addiction (e.g., addiction to gambling). UTHSC faculty members have expertise in the neurosciences, genetics, genomics, epigenetics, pharmacology, toxicology, and pharmaceutical sciences. These are related to the development of and the phenotypic and manifestations of addictive and substance abuse disorders, including the mechanisms of compulsive drug use and addiction, gene and environment factors that influence alcohol consumption, differential susceptibility of brain and brain circulation to alcohol, FASD, caffeine-alcohol interactions, perinatal abstinence syndrome, and the complex interactions between social, genetic, and sensory factors that regulate drug abuse behavior.

This Focus Area has support from UT leadership, as indicated by their sponsorship of two SOAR events, the ongoing SMART events, and the meetings of the Southern Chapter of the Substance Abuse and Mental Health Services Administration (SAMHSA). These activities brought together health-care providers and researchers across the UT system and the state of Tennessee. The UTHSC Department of Pharmacology, Addiction Science, and Toxicology (PHAST) recently recruited two new faculty members whose laboratories study compulsive drug-seeking using mouse and nematode (*Caenorhabditis elegans*) models, and stress and drug-seeking behavior involving peptide signaling in the amygdala of the brain. Given the high co-morbidity of psychiatric and psychological disorders with addictive behaviors, current and future effort should integrate academic activities with the needs of the communities that we serve. We also recommend a statewide educational effort to help de-stigmatize addiction.

Valuable areas for new hires include: optogenetics and chemogenetics, genetics of individual differences in distinct stages of SUD, and brain/mini-circuitry/blood-brain barrier on a chip. There is a dire need for clinician scientists with an emphasis on addiction to support not only research but also the clinical practice needs of our local community.

Focus Area 3. Neurotoxicology

This Focus Area includes not only chemical pollutants but also internal and external exposures to a variety of non-traditional sources of toxicants, such as the microbiome, infectious agents, altered nutrition, and even stress. This wider consideration reflects the view held by the National Institute of Environmental Health Sciences

(NIEHS), which funds research in these areas. The untoward consequences of such varied exposures can occur at different developmental epochs across the lifespan and often result from the interaction of several insults that are likely to be different for different toxicants and individuals. Thus, susceptibility and outcomes are fundamentally important questions that merit investigation. The focus of this area has been expanded from that of OSPR-1 to incorporate externally funded UTHSC investigators who study the nervous system in response to specific environmental exposures, albeit not using genomics approaches.

Valuable areas for new hires: an epidemiologist with expertise in population or systems genetics, pharmacogenetics, epigenetics, environmental toxicology, nutrition, and the epigenome/microbiome.

Resources that could benefit all Focus Areas include computational neuroscience, a transgenic rodent core, a portal that integrates scientists according to their model systems (zebrafish (*Danio rerio*), nematodes (*C. elegans*), fruit flies (*Drosophila melanogaster*), etc.), access to magnetic resonance imaging (MRI), PET, and single photon emission computed tomography (SPECT) imaging for small animal and human research, and the addition of clinician-scientists across UTHSC colleges and campuses.

Institutional Impact and Deliverables

The Focus Areas above lend themselves to the creation of interdisciplinary research institutes across the UTHSC system. Simultaneously, we will seek to secure interdisciplinary program project and center grants that include the use of institutional research core facilities. Such features will enhance the inclusion of all basic and clinical science research components of the UT system. We will quantify our success in achieving these goals using several variables that include, but are not limited to, an increase in the number of (a) submitted grants, (b) funded proposals with a concurrent increase in extramural funds, (c) publications and their scientific impact; and (d) intellectual property (IP) disclosures that manifest as patents, licensing of IP, and entrepreneurship.

Synergies and Collaborative Potential

As stated in OSPR-1, this AoE provides a framework for enhancing team science. The importance of this deliverable should be emphasized because the unifying themes that are described elsewhere in this section will foster an economy of scale, thereby enabling groups of scientists to address questions that are too large for any single investigator. Moreover, it provides the depth and breadth of intra-professional research teams that can address broad questions of basic science, from health disparities and prevention to drug discovery and treatment. There is marked synergistic potential outlined specifically within the Health Disparities and Precision Medicine CCP and the Drug Discovery and Development CCP. A successful completion of the goals of this AoE will not only enhance the specific Focus Areas of investigation but also promote collaboration across all UTHSC colleges and campuses.

OBESITY, DIABETES, AND METABOLIC DISORDERS

Area of Excellence

Background and Current Status

UTHSC currently supports a wide range of clinical, basic, behavioral and community research programs that address obesity, diabetes, and metabolic disorders (ODMD). These chronic conditions are prevalent in the Mid-South, disproportionately affect certain vulnerable populations, and are associated with significant morbidity, mortality, and health care costs. Therefore, a continued research focus in these areas will enable UTHSC to become nationally recognized for ODMD research. The overarching goal of this AoE is to increase our understanding of the biological, behavioral, and socioeconomic factors and mechanisms that lead to the development and progression of ODMD. Our vision is to enable discovery and development of strategies for the prevention and management of ODMD and to improve the quality of life and survival across the lifespan. Incorporated in this overall vision is our goal to eliminate disparities in the development and outcome of ODMD through collaboration and synergies with other research AoE. As part of ORSP-2, we propose three Focus Areas for future investment:

- 1) Biological Mechanisms Underlying Obesity, Diabetes, and Metabolic Disorders. Unraveling the genetic, molecular (omics), biochemical and demographic determinants of susceptibility to and outcome of ODMD across the lifespan
- 2) Environmental, Socioeconomic and Behavioral Determinants. Dissect the environmental, socioeconomic, and behavioral co-factors that determine susceptibility to and outcome of ODMD across the lifespan
- 3) Preventive/Therapeutic Interventions. Prevention, management, and reversal of ODMD through the development and application of innovative behavioral, clinical, cellular, molecular, pharmacological, and combined approaches

Focus Area 1. Biological Mechanisms Underlying Obesity, Diabetes, and Metabolic Disorders

The research base of funded investigators at UTHSC has strong representation in basic, clinical, and translational sciences in ODMD. However, the research endeavor would benefit from increased communication, interaction, collaboration, and cross-pollination of ideas aimed at amplifying joint interdisciplinary research activities on all UTHSC campuses. Increased synergy could grow this area further through targeted recruitment strategies to bring in faculty members with expertise in 1) signal transduction, including hormonal signaling in brain and peripheral tissues and regulation of appetite and feeding; 2) clinical, behavioral, and basic science approaches to diabetes, obesity, and energetics; and 3) basic science and clinical approaches to diabetes, musculoskeletal health, physical functioning, aging and sarcopenia. Each of these areas would bridge gaps in expertise and promote additional collaborations within the area of ODMD.

Focus Area 2. Environmental, Socioeconomic and Behavioral Determinants

This area straddles the internal environment (including microbial and affective) to the external built environment as determinants and moderators of health and disease, and their interactions with behavioral and socioeconomic permissive factors. Components of the internal and external environments with established or emerging links to ODMD include (a) behavioral-nutrition, physical activity, motivation, depression; (b) toxicological-air pollutants, plastics, polychlorinated biphenyls (PCBs)/endocrine disrupting chemicals, inflammation, oxidative stress; (c) microbial-gut and other microbiomes and the metagenomes, and (d) the built macro environment and SDOH. The integration of environmental and biobehavioral insights with biological processes (Focus Area 1) could expand knowledge immeasurably. Currently, investigators focusing on this area are scattered across various campuses, colleges, and departments of UTHSC. As above, increased synergy could be found to grow this area, with targeted recruitment of faculty with expertise in 1) environmental/clinical toxicology with interests in endocrine disrupting chemicals; 2) microbiome and omics sciences; 3) health disparities and SDOH; and 3) behavioral aspects of SDOH.

Focus Area 3. Preventive/Therapeutic Interventions

The overall objective of this Focus Area is to discover effective interventions for the prevention and treatment of ODMD and innovative approaches for reversing the underlying pathophysiological processes. Insights from Focus Areas 1 and 2 on the mechanisms/determinants of susceptibility to ODMD would inform the rationale and design of novel preventive and therapeutic interventions, with opportunity for collaboration with industry. Given

the centrality of obesity as an underlying risk factor, the creation of an Institute for Obesity and Related Disorders would serve as a valuable platform for interaction and collaboration among investigators. Ideal members for this institute would fall into the following areas: 1) basic/clinical researchers in obesity and diabetes; 2) lifestyle interventionists/exercise physiologists; 3) clinical trial specialists.

In all areas, a targeted funding mechanism and infrastructure to foster increased interaction and joint interdisciplinary research activities among investigators, with thematic links to ODMD scattered across UTHSC colleges and campuses statewide would be a most desirable high-yield investment. Additional support for mentoring, training, and empowering clinical faculty members to enable research capability and productivity would expand and strengthen the human capital engaged in investigation and discovery.

Institutional Impact and Deliverables

Each of the research Focus Areas will be assessed according to the following criteria: (a) evidence of a successful launch of new research initiatives in ODMD; (b) demonstration of successful collaboration across UTHSC entities; (c) number of clinical faculty earning certificates of completion in research training, (d) extramural funding in pertinent areas; (e) publications and presentations; and (f) measurable impact on health outcomes in ODMD.

Synergies and Collaborative Potential

The UTHSC Memphis campus already hosts well-established units in most UTHSC colleges, including COD, COHP, COM, CON, COP that are involved in ODMD research activities. Additional opportunities for collaboration exist with CTN2, with investigators at UTHSC campuses in Nashville, Knoxville, and Chattanooga, with ORNL, and with other regional institutions. Opportunities for local collaboration and synergies include Christ Community Health Services (CCHS), Church Health, the Tennessee State Health Department the UCI, UM, UTHSC-affiliated hospitals, and the UTRF and rural health initiatives such as West Tennessee Healthcare and Cherokee Health Systems.

REGENERATIVE MEDICINE AND STEM CELL-BASED TECHNOLOGIES

Aspiring Area of Excellence

Background and Current Status

The exploding interest in the application of regenerative medicine to fields as diverse as dentistry, neurology, and rehabilitation science represents the cutting-edge use of personalized therapy by unleashing the natural healing powers of dormant stem cells residing in our tissues. In addition, the insights into stem cell biology that are gained from research in regenerative medicine expand our understanding of cancer cell biology, pharmaceutical targeting, and patient response to therapy, among many other fields. These research interests have been pursued by investigators across all colleges at UTHSC with the goal of improving human health. Regenerative medicine explores the therapeutic potential of these healing powers residing in the human body by combining the most advanced molecular methodologies and bioengineering technologies available. Stem cell-based technologies can create a platform for bridging these areas of expertise in a setting that fosters discussion, interaction, cross-discipline pollination, and networking at UTHSC and its partners.

In line with these aspirations, OSPR-1 (2015–2020) established the goal of developing research efforts in stem cell biology and regenerative therapies over the next five to ten years. The implementation of this strategic goal was formalized in September 2017, when Chancellor Schwab established the Memphis Institute of Regenerative Medicine (MIRM) as a UTHSC institute that spans the city of Memphis by including members from both academic and industry partners. This initiative has grown to 54 investigators housed in departments across many UTHSC colleges and campuses. The OSPR-2 committee faculty survey found that 54 out of 220 respondents ranked regenerative medicine and stem cell-based technologies (RMSCT) first or second in terms of its relative importance to their current research, whereas 57 respondents ranked it first or second for its importance to their research over the next five years. During this time, UTHSC has developed regenerative- and stem cell-based collaborative efforts at four levels: **1) local academia** (LBCH, Southwest Tennessee Community College (STCC), SJCRH, UM, and the Memphis VAMC, **2) industry** (Medtronic, Stryker Medical, Smith and Nephew, Southern Research (SR), and FedEx), **3) state** (the UT Institute of Agriculture (UTIA) College of Veterinary Medicine, ORNL, and the state-wide non-profit organization Life Science Tennessee), and **4) several international academic institutes**. Due to ongoing expansion within the state, the UT leadership and the External Industry Advisory Board decided to re-brand MIRM as the Tennessee Institute of Regenerative Medicine (TennIRM). The UTHSC-affiliated members of TennIRM have an extensive record of publications and grants (for details, see <https://tennirm.org/about-us>).

Economic development through health science research is one of the priorities emphasized in OSPR-2. The TennIRM Advisory Board takes an active role in workforce development and expanding academic industry cooperation. Therefore, the strategic alliance and coordination between the Memphis Economic Development Growth Engine (EDGE) and the Tennessee Department of Economic and Community Development (TN-ECD) remain highly important in expanding scientific research, education, and training in regenerative medicine and stem cell research. UTHSC investigators on our campuses have already made progress in two critical areas of research: **1) 3D bioprinting** of vascular grafts, and **2) stem-cell treatment** of osteoarthritis. Substantial progress has been achieved in translational and preclinical research in both areas to move these technologies into clinical trials. In summary, we have achieved all goals set forth in OSPR-1.

Advancing Regenerative Medicine and Stem Cell Technologies at UTHSC

Since its inception in 2015, the Stem Cell Interest Group (SCIG) on UTHSC's campus was established with approximately 30 members from UTHSC, UM and SJCRH. TennIRM has grown to more than 70 members from different institutions and companies in the state, nationally, and internationally. Member expertise includes stem cell biology, cancer biology, bone biology, muscle biology, material science, regenerative therapeutics, rehabilitation sciences, cell-based clinical therapies, and clinical grade cell processing technologies that reflect the multispecialty impact of this approach for clinical problems in the future. Despite this success, interdisciplinary collaborations between scientists and clinicians remain underdeveloped and offer a compelling opportunity for coalition and growth.

Areas in need of further focused development

RMSCT investigators have a growing need for enhanced information exchange (e.g., a dedicated website, seminar series, and an annual conference), additional administrative support and increased dedicated research infrastructure (e.g., micro-PET/CT, a large-scale mammalian stem cell culture core, and support personnel to operate these facilities). Such support is essential for national research competitiveness in this rapidly developing field. UTHSC and affiliated researchers should better utilize the expertise and resources of TennIRM. Excellent opportunities to partner with clinical investigators in the Drug Discovery and Development CCP are available. The opportunity for growth in basic stem cell research and translational biotherapeutics development must be harnessed and a robust extramural funding base established to succeed in this highly competitive research field.

There is now an increasing need to unite and synergize faculty members in an academic unit that cuts across colleges and campuses. An integrated unit is the most efficient conduit for future recruitment, retention and promoting interactions between regenerative medicine, rehabilitation science, and stem cell investigators. A unified academic unit at UTHSC could develop and teach a curriculum in RMSCT to UTHSC students in all colleges.

Institutional Impact and Deliverables

To direct future growth and as part of OSPR-2, we propose the following Focus Areas for future investment:

- 1) Stem cell biology on multipotent and induced pluripotent stem cells
- 2) Tissue engineering of customized cellular scaffolds
- 3) Translational and preclinical small and large animal models for tissue engineering stemming from our unique access to the Biosynsphere and 3D bioprinting instrumentation leased from Revotek, Ltd.
- 4) Merging tissue regenerative concepts with rehabilitation therapies and developing predictive methods for the treatment and patient care of disabilities related to aging, injury, and chronic disease
- 5) Pre-clinical trials and treatments using tissue regeneration concepts

During the next five years, we will require additional investigators in stem cell and regenerative medicine. Aligned with the Strategic Plan for Recruitment and Retention, cluster and cohort hiring techniques are highly effective and can lead to camaraderie and collaborations that enable effective peer mentoring. Cluster hires foster peer support, productivity, and retention. Our recommendations are as follows.

- 1) RMSCT faculty should better utilize TennIRM resources and organization to develop more effective channels of communications between investigators, clinicians, and industry partners that can lead to joint research projects.
- 2) RMSCT faculty should promote new extramural, preferably collaborative grant applications seeded by annual CORNET pilot grants to enhance new competitive grant application development.
- 3) RMSCT investigators collectively will submit at least three new grant applications annually and work toward the submission of bigger programmatic grant applications to federal and philanthropic organizations to grow the research portfolio,
- 4) UTHSC needs to develop cutting-edge research infrastructure and core services to enable basic and widespread translational stem cell research (in vascular, bone, cartilage, hematopoietic, dental, and other areas, classified by technology readiness levels (TRL) three to four and beyond) by applying for extramural grants and development of philanthropy. UTHSC should seek state support for recruitments and partial funding of the newly established core service and instruments that will also serve the educational/training of our students at multiple levels in all colleges.
- 5) Within the next three years, RMSCT faculty will work to develop a sterile stem cell-based biofabrication unit in cooperation with the UTHSC Plough Center for Sterile Drug Delivery Solutions. This development will allow pre-clinical and clinical trials and treatments to be initiated utilizing the CTN2 affiliated hospitals and practice plans (TRL5 and above).

Synergies and Collaborative Potential

The primary research interests of faculty members in RMSCT at UTHSC and TennIRM-affiliated faculty members at UM involves the regeneration of blood vessels, teeth, bones, muscles, and cartilage tissues. Each system requires a physical scaffold made from a customizable extracellular matrix to maintain structural integrity while facilitating repair mechanisms. The national recognition of UM faculty members in biodegradable/3D bioprintable

scaffold design and biomatrix development presents a unique collaborative opportunity for UTHSC faculty. Increased cooperation with the Plough Center is needed for mounting clinical trials or treatments. Closer ties should be explored with SJCRH, which operates two controlled good manufacturing production facilities. Closer synergies should be pursued with TennIRM, the UTHSC Cancer Research Center, the Drug Discovery and Development CCP, and the UTHSC Division of Rehabilitation Sciences, including its Center for Muscle Metabolism and Neuropathology (CM²N). We plan increased collaboration that integrates with VA initiatives for funding involving basic research fostering the understanding of tissue regeneration from injury and clinical trials. We will also pursue new collaborations with faculty members with expertise in bone and muscle biology, adult mesenchymal and pluripotent stem cells, and nanoparticles from across all UTHSC campuses and colleges, including the UTIA College of Veterinary Medicine.

WOMEN'S HEALTH

Aspiring Area of Excellence

Background and Current Status

Elements of this research field appeared in OSPR-1. Its formal recognition in OSPR-2 as an Aspiring AoE signals a welcome effort to alter a long-standing disparity in research. There is a historically established pattern of exclusion of women from medical research, despite the recognition that sex plays a major role in risk and presentation of diseases beyond the disorders generally thought to be exclusive to a woman's physiology, including uterine and ovarian cancers. Clinical decisions are often made about women's health care based solely on research conducted on males, ignoring that many findings may not be applicable or generalize to women. NIH acknowledged this oversight and established the Office of Research in Women's Health in 1990, in response to political and scientific concerns and pressure from advocacy groups. Not only is this research directed to address women's specific concerns with regards to both basic and clinical science research, it also supports the inclusion of women investigators in the research community. New grant applications to the NIH specifically require applicants to include a section describing the inclusion of women (and children) in any proposed clinical research, which favors proposals that address these concerns.

Research in Women's Health at UTHSC will benefit from ongoing access to unique resources already within the UTHSC framework, summarized here:

1. The Women's Health Initiative (WHI) is a multi-site study that encompasses three long-term, separate but overlapping clinical trials (in hormone therapy, diet modification, and calcium/vitamin D trials) and a large observational study conducted since 1993–2005 whose enrollment includes 161,000 postmenopausal women who have been extensively phenotyped. The WHI has shown connections between major causes of morbidity and mortality for women including cardiovascular disease (heart disease and stroke), cancer, fractures, and cognitive function/dementia. The WHI generated a large existing dataset and a large biorepository that contains serum, plasma, DNA, RBCs, spot urine, whole blood mRNA, and adjudicated outcomes. The WHI dataset is linked to other important datasets such as the U.S. Centers for Medicare and Medicaid Service (CMS). The WHI has contributed data/specimens to the Biologic Specimen and Data Repository Information Coordinating Center (BioLINCC), the Database of Genotypes and Phenotypes (dbGaP), and the National Heart, Lung, and Blood Institute (NHLBI) Trans-Omics for Precision Medicine (TOPMed) program. A WHI Extension Study is now underway for continued follow up (until 2026).
2. The Conditions Affecting Neurocognitive Development and Learning in Early Childhood (CANDLE) observational longitudinal cohort study enrolled 1,503 women during their second trimester of pregnancy (62% AA; 57% low income). The cohort has been followed for eight to fourteen years, through delivery and during childhood for effects on brain development of prenatal actions, home environment, childhood experiences, toxin exposure, and genetics. The CANDLE study generated a large existing dataset and a large biorepository with serum, plasma, DNA, and placenta.
3. Biorepository of Integrated Genomics (BIG) initiative has enrolled 20,000 subjects since 2015, with an aim to explore genomic data associated with drug metabolism, pharmacogenetic treatment guidance, and prognostic indicators of disease progression. The resulting data are housed in an EDW. Funding and plans for expansion to 100,000 adult Tennesseans from the Mississippi Delta to Appalachia.
4. The UTHSC EDW is an in-house built standardized aggregated health care data warehouse that houses data from our hospital partners across Tennessee.

Capitalizing on these resources will allow this area of research to continue to grow. Further growth can be realized by focusing on the following two approaches to Women's Health, for future investment:

- 1) Lifespan Approach
- 2) Disparities

Focus Area 1. Lifespan Approach

Women have increased longevity compared to males, with increased risk of fragility and other effects of aging. These differences invite an exploration of how transitions across the aging continuum inform an understanding of women's health. Reproductive potential and hormonal transitions are a traditional way of framing these

investigations. Healthy aging is an increasing interest in the research community and responds to the needs of our aging U.S. population.

Focus Area 2. Disparities

Evidence of disparities in healthcare and the connections to SDOH are widely available. As noted previously, women in general and within different subgroups experience disparities of healthcare status, access and outcome, and this Focus Area will provide investigation into that experience.

In both Focus Areas, investments are needed to deepen the alignment between research and clinical programs. Such alignment is essential to make progress in this area. Research interests and action must accompany programmatic efforts made in all areas that are designed to impact and reduce disparities. Research results should inform future versions of the programs that address these inequities. Specific suggestions include expanding the CTN2 network to rural partners like West Tennessee Healthcare and Cherokee Health Systems, resourcing the Tennessee Appalachian Health Study, and providing research assistants for fundamental programming ingredients such as community needs assessments and awareness and inclusion of rural drivers of health disparities. Further, a single, coordinated IRB is needed to facilitate and accelerate collaboration across all UTHSC campuses for growth in this and other AoE.

Institutional Impact and Deliverables

UTHSC investment in the development of clinicians with the training, time, and funding for the conduct of research in this AoE is necessary and should address existing disparities in representation within the field in general. As a result, UTHSC will become a leading institution and facilitate the development of a functional network to increase communication among researchers. Further impact will be realized as the research objectives of the new department chair in obstetrics and gynecology on the Memphis campus are announced.

Synergies and Collaborative Potential

Increased collaboration and synergies are anticipated with the Obesity, Diabetes, and Disorders of Metabolism (ODMD) AoE by exploring the connections between type 2 diabetes and gestational diabetes, gestational hypertension, and preeclampsia and the role of intrauterine growth restriction (IUGR), preterm labor, gestational diabetes, and gestational hypertension as predictors of cardiovascular disease. Development of a cardio-obstetrics focus will amplify study opportunities along this axis and align with the Cardio-renal and Vascular Disease AoE. Additional crossover and collaboration will be seen as other AoE include women's health topics, such as Cancer (through ovarian cancer Phase 1 trials and access to cancer prevention funding). Other recommended areas of collaboration include examination of disparities in vulvar, vaginal, and cervical cancers, menopause, and sexual health with attention to the understudied African American population in alignment with the Health Disparities CCP, and connection to existing rodent laboratory resources for inquiry into longevity analysis, with exploration of healthy aging and healthy cognitive aging in conjunction with the Nervous System Disorders AoE. Collaborative potential exists with the Center for Innovation in Health Equity Research (CIHER) at UTHSC. Alignment could also be developed with the Precision Healthcare CCP through exploration of WHI and CANDLE resources with investigators in the Department of Preventive Medicine, and exploration of EDW and BIG resources with investigators in the Center for Biomedical Informatics (CBMI).

CROSS-CUTTING PLATFORMS

DRUG DISCOVERY AND DEVELOPMENT Cross-Cutting Platform

Background and Current Status

Drug Discovery and Development (D3) classically focuses on chemically defined small molecule drugs, but biologic therapies, including antibodies, vaccines, and proteins, are now equally prominent and successful in treating disease. The academic drug discovery process is largely focused on the preclinical stages, namely 1) target identification, 2) target validation, 3) hit identification, and 4) lead generation. Protection of intellectual property is commonly sought after the generation of lead compounds and before further development is continued with 5) lead optimization for absorption, distribution, metabolism, elimination (ADME), toxicology, and pre-clinical pharmacokinetics (PK).

Current strengths at UTHSC include the MCC and individual medicinal chemistry faculty, the COP Drug Discovery Center, the Plough Center and individual lab strengths in therapeutic formulations, the UTRF-supporting entrepreneurship efforts, the RBL supporting infectious disease programs, the COP Analytical Chemistry Core, and access to computational resources at ORNL and ISAAC.

Current weaknesses include a critical lack of biophysical and structural biology infrastructure, limited expertise, and support of faculty members in later stages of drug discovery (clinical development), lack of compound libraries and high-throughput screening facilities, lack of dedicated ADME/PK/toxicology services, lack of a dedicated business incubator for supporting academic startups, and limited supporting infrastructure and expertise for biological therapy development on UTHSC campuses.

Existing opportunities for expanding the UTHSC drug discovery and development capabilities include expanding support for biological therapy development to include protein production and biophysical instrumentation; expanding support for biological diagnostics/biomarker development, expanding support for existing drug reformulation and repurposing efforts, especially for orphan and rare diseases; and enhancement of capabilities for core facility support of clustered regularly interspaced short palindromic repeats (CRISPR)-CRISPR-associated protein 9 (Cas9) applications to accelerate target validation studies.

Perceived threats to our drug discovery activities include competition with other institutions for faculty and trainees, and a lack of stable support for drug discovery over each stage of the development process, from concept to clinic ready.

As part of OSPR-2, we support the following three Focus Areas for future investment:

- 1) Drug Discovery Resources
- 2) Increase Support for Development
- 3) Develop a Biological Therapeutics Discovery Program at UTHSC

Focus Area 1. Drug Discovery Resources

Acquisition and expansion of resources and infrastructure is necessary for continued support of drug discovery and development focused research at UTHSC. The committee identified several areas of weakness that can be prioritized for investment, including biophysical and structural biology, computer-aided drug design, compound library screening, and ADME/PK resources.

There is a critical need for biophysical and structural biology resources for target validation, characterization, and lead optimization stages of discovery. Investment in the following equipment for general access would strengthen existing drug discovery programs and incentivize new hires: a) high-field nuclear magnetic resonance (NMR) instrument, b) isothermal titration calorimeter and/or surface plasmon resonance, and c) circular dichroism. The addition of computer-aided drug design techniques will support several areas of the drug discovery process, including target characterization, hit identification, and lead optimization. There is an opportunity for investment in three areas: a) expansion of drug discovery software access to our researchers, b) investment in hardware (onsite workstations or processing clusters) or expanded access to remote resources, and c) development of training programs.

Hit identification for early-stage drug discovery would be greatly facilitated by investment in screening libraries, and infrastructure for medium-throughput compound screening would add significantly to current and future drug discovery efforts on campuses, while minimizing the need for a costly robotic facility. A priority is the acquisition of large high-quality compound libraries, including a diversity-based drug-like set (approximately 50,000 compounds), and a fragment or lead-like set. Supporting infrastructure and equipment would include storage freezers, plate readers, and liquid handlers. As an alternative, structure-based ensemble docking using supercomputers at UT Knoxville/ORNL to perform virtual high throughput screening of chemical libraries could be expanded.

Early assessment of compound physicochemical, ADME, toxicity, and PK properties for the lead optimization stage of drug discovery represent a critical need. Key parameters that should be assessed/optimized for lead compounds include solubility, permeability, stability, plasma protein binding, toxicity, and pre-clinical PK. The campuses lack dedicated resources for assessment of these properties in-house through a dedicated or expanded core facility (Analytical or Med Chem Core). Alternatively, an institution master contract with an external service provider could be established for a bulk reduction in costs.

Focus Area 2. Increase Support for Development

Drug development is hypercompetitive as only a minority of grant programs support preclinical development and industry partners (pharma and biotech companies) are bombarded with early-stage lead compound opportunities.

To compete successfully for grants and partnerships, we recommend the following institutional investments. Pilot grants (e.g., targeted CORNETs) to support drug development will stimulate the collaborations between PIs in complementary fields that are most successful in drug discovery. Support for investigational new drug (IND)-enabling studies such as ADME and toxicology studies will facilitate the advancement of compounds in the pipeline. These data will be critical to de-risking a compound and attracting additional funding from public or private sources. Access to expert guidance for the good laboratory practice (GLP)/good manufacturing practice (GMP)/IND regulatory process through internal or contracted external experts will help PIs develop a roadmap to first-in-human studies. Development of an on-campus bio-business incubator will support startup formation. Office and wet lab space should be made available for UTHSC startups to lease, particularly with the closure of the Memphis Bioworks Foundation in 2021.

Focus Area 3. Develop a Biological Therapeutics Discovery Program at UTHSC

Biopharmaceuticals, including antibodies, peptides, gene-editing therapies, and chimeric antigen receptor (CAR)-expressing T cells, are a significant part of the therapeutic market and a major focus of pharmaceutical companies. Most best-selling therapies in the U.S. are biologics. However, current capabilities for biologics research at UTHSC are insufficient to support a focused biologics discovery and development program. This Focus Area proposes expanding resources available to faculty to allow them to broaden treatment options from traditional small molecules into biological therapies.

The following investments are needed to facilitate work in this area. Active recruitment of faculty members who are developing biological therapeutics and could collaborate with existing faculty. This investment would likely be by treatment modality (cell therapy, antibody development, gene editing) and would need a different hire for each. The expectation is that two to three new faculty members would be sufficient to enhance biological therapeutics research. Resources to develop initial treatment modalities to support proof-of-concept research that can later be translated to pharma partners via licensing or into a start-up company outside of the UTHSC campuses would be helpful. This could be accomplished by expanding existing resources (e.g., the MRC) to support additional biological development in-house. Alternatively, the campuses could enter into a master services agreement with an established contract resource organization to obtain favorable pricing for external therapeutic development.

Institutional Impact and Deliverables

A greater emphasis on the Focus Areas outlined for this CCP will lead to expansion of UTHSC's therapeutic pipeline, and the acceleration of compounds and biologics discovered at UTHSC into first-in-human clinical trials. A compound that is IND-ready and/or has Phase I clinical data is exponentially more marketable than less

advanced compounds. Thus, in turn, there will also be an increased number of grants and industry research and development contracts in this area. UTHSC will benefit further from increased technology transfer revenue produced from marketing of more advanced agents.

Synergies and Collaborative Potential

High performing academic drug discovery teams usually consist of PIs with medical/biological domain expertise partnered with PIs having chemistry/pharmaceutical expertise. Synergies exist with the UTHSC COP Drug Discovery Center, the MCC, the COP analytical facility, the TN-CTSI, and active or interested drug discovery researchers on all UTHSC campuses. Cross-campus collaboration is a key goal of the Focus Areas within Drug Discovery and Development, and as such, expanded resources in this area would benefit all faculty performing therapeutics research. Active partnering between the COP and research-intensive departments across colleges and campuses with the URTF will increase access to external pharma resources for sponsored collaborations and co-development efforts.

GLOBAL HEALTH Cross-Cutting Platform

Background and Current Status

The NIH has increasingly focused on global health, presenting an opportunity for UTHSC to position itself as a major player in this arena. Global health research cross cuts across all research AoE identified in the faculty survey. UTHSC already has strengths in global health across the spectrum, with particular strengths in the CoN and COM, and collaborations with SJCRH and other institutions worldwide (including universities and clinical care facilities located in China, Peru, Argentina, the Netherlands, Zambia, Kenya, Tanzania, and Ghana, among others). These projects touch on Focus Areas outlined in the Cancer AoE, in the Cardio-renal and Vascular Diseases AoE, and in other areas of research important for our institution, including the Health Disparities CCP. Further, there are many researchers on campus interested in expanding their research this way. Given that this work is still emerging in our institution, there was a great need to capitalize on our previous successes and harmonize efforts across departments and colleges. As such, the two focus areas were identified by the Global Health workgroup and the OSPR-2 committee:

- 1) Leverage Existing Resources
- 2) Build New Infrastructure

Focus Area 1. Leverage Existing Resources

Many UTHSC faculty members and collaborators have mobilized international teams for research, healthcare delivery, and training, including securing external funding to support their programs, and individuals across campus are interested in expanding their research this way. However, existing and potential investigators are not aware of each other, nor are research efforts coordinated by domain or geography to allow collaboration within UTHSC and across colleges.

We recommend that the Office of Research encourage new collaborations through small grant programs such as the CORNET mechanism. To leverage these seed funds effectively into extramural support, this workgroup recommends that the office also maintain a database of potential funders outside NIH, including charities and philanthropic organizations. A country or regional liaison officer could be embedded in that new office to support all investigators working in that region.

Another challenge common to global health research is a lack of uniformity of research management procedures. The creation of standardization protocols for research management would support many faculty members but especially investigators who perform global health research. Expansion of the Office of International Affairs' responsibilities or investing in a new office (perhaps within the CMGH) would support current and potential global health researchers in their efforts to develop global partnerships and promote initiatives. This office would bring together grass-roots efforts to benefit from best practices and UTHSC services, streamline contracting, provide boilerplate templates for material transfer agreements (MTAs), memoranda of understanding (MOUs), and data use agreements (DUAs), facilitate planning, and organize visits of foreign partners to UTHSC and of UTHSC investigators to international locations. The provision of protected time for development in this area would allow faculty members to conduct research more readily and develop their global research programs.

Another way to leverage existing resources is through capitalizing on our existing wealth of knowledge on global health research. As the research training arm of UTHSC, the College of Graduate Health Sciences (CGHS) hosts approximately 200 international students and postdoctoral scholars at any given time. These trainees bring valuable biomedical research skills back to their home countries when their training is finished. Trainees can also enhance the international visibility of UTHSC through continued collaboration and their "ambassadorship" in promoting research at our institution. A formalized program of recruiting international students, residents, and postdoctoral fellows as ambassadors to their home countries would allow these individuals to leverage their experiences at UTHSC to become global health leaders when they return. A program that provides credit towards a degree or certificate in this area will require a commitment of dedicated resources from colleges and faculty members, sources of outside funding, and partnerships with foreign institutions. However, such effort would greatly benefit both the educational and research missions at UTHSC.

Focus Area 2. Build New Infrastructure

UTHSC has many strengths in global health research but suffers from a relative lack of coordination and institutional support. NIH-sponsored research trends are poised to create more global health impact in the future; leading universities are investing heavily in response to these trends. Yet, educational opportunities for students to participate in global research are limited at this time. A lack of efficiency and connections means that individual researchers must build their own infrastructure and repeat the same procedures each time. A significant expansion of the international office or establishing a new body to support global health resources could support development of new educational programs and internships with a goal of being supported by NIH training grants.

Institutional Impact and Deliverables

As a result of these efforts, campus- and system-wide coordination of global health research through a common registry of global health researchers on campus would provide a place for new collaborations and proactive efforts to combine efforts in the same research sites. Such a communication system would also allow greater advertisement of global health research-enabling technologies such as multilingual databases, contact management systems, and document repositories (e.g., those offered by ResonanceHealth.org at no cost) could be more widely advertised. An ambassadorship program would raise the international visibility and position UTHSC to become a haven for those seeking training in global health research and put various AoE into context on the world stage.

Synergies and Collaborative Potential

Communication between colleges on the Global Health aspects of the research AoE will be critical to researchers forging new collaborations in these areas. This would be greatly facilitated by partnerships with other US-based organizations, such as SJCRH, and with institutions in the home country of the research sites. To be competitive in a challenging funding environment, UTHSC must demonstrate its potential for innovative global health research and its ability to form and participate in new international collaborations. Many excellent programs already exist, including the CON program in South America, the COM recently established Center for Multicultural and Global Health (CMGH), and collaborations between the two have been proposed. These programs aim to support clinical education and research. CMGH aims to produce more physician-scientists and improve connections between UTHSC and outside researchers. Members are already performing research in Ghana, Zambia, Kenya, and Tanzania. There is also a solid visiting student and scholar program in collaboration with Sichuan University – West China Hospital's Center for Regenerative Medicine. Encouraging programs to collaborate will be important in establishing UTHSC's credentials.

Further, this CCP exhibits particular synergy across the research and educational missions. The development of medical education to include research would add a steady stream of physician-scientists into the pipeline. Investment in research support will allow scientists to develop global health programs that intersect with educational programs and certifications. A summer school or summer internships for students across all colleges would provide an opportunity to learn about global health research. Efforts that focus on global health will become self-sustaining as they will improve UTHSC's standing to qualify for NIH training grants. A certificate in healthcare supply chain integrity has been identified as one potential collaborative area that has emerged as particularly critical to the conduct of research and the health and safety of patients worldwide.

HEALTH DISPARITIES Cross-Cutting Platform

Background and Current Status

Health disparities are still pervasive in the US. Disparities occur across different population groups including, but not limited to, groups characterized by race and ethnicity, income, geographic location, age, and literacy. Since OSPR-1, UTHSC has shown considerable growth in health disparities research. This growth is expected to continue in coming years, stimulated in many ways, including by the CORNET award competitions for health disparities research and adverse childhood experiences. As reflected by the 2021 faculty survey, health disparities research is important to UTHSC faculty with respect to their current and future programs of research. The Health Disparities CCP also aligns with institutional priorities and activities, for example the UTHSC QEP with its focus on the SDOH, the TN-CTSI that seeks to reduce health disparities, and the Tennessee Population Health Consortium (TN-PHC) that will focus on building statewide data resources for population health and health disparities research through its Tennessee Population Health Data Network (TN-POPnet). Significantly, the colleges of UTHSC have increased their efforts to address health disparities. The COD initiative entitled, “A 21st Century Initiative-Oral-Systemic and Population-Based Health for All” and the COP “Health Disparities and Equity Promotion Think Theme” are two examples of recent initiatives. The COP also aspires to establish a health disparities research center.

UTHSC is well positioned to make a significant impact on health disparities, given our work with diverse populations experiencing health disparities, our methodological expertise (e.g., mixed methods research, artificial intelligence, among others), and our statewide presence. To become a national leader in this field of research, and as part of OSPR-2, we support the following three Focus Areas for future investment:

- 1) increase team science and cross pollination across health disparity researchers
- 2) develop a scientifically diverse, health disparities research workforce
- 3) accelerate the acquisition and use of SDOH data

Focus Area 1. Increase Team Science and Cross Pollination Across Health Disparity Researchers

While many researchers across the UTHSC system lead health disparity research programs, individuals tend to work in silos with few informal or formal opportunities to learn about each other’s scholarship and find areas of mutual interest that can lead to new lines of research.

The following investments are needed in this area. 1) Health disparities CORNET awards that require new research collaborations. Preference will be given to projects that are led by researchers across the translational continuum (T0–T4) and for collaborations that cross disciplinary boundaries (e.g., the intersection field of genomic medicine, precision health, artificial intelligence, and data science). 2) A health disparities rapid grant review program that includes internal and external reviewers. In addition to providing investigators with feedback that would strengthen their grant proposals, an internal review process would provide a way for researchers to learn about the scholarship ongoing at UTHSC. 3) A seminar series dedicated to health disparities research across the lifespan that will focus on disparities within each of the OSPR-2 research AoE. 4) A health disparities workgroup that will share activities/research, find areas of synergy, plan to respond to new/emerging opportunities, share resources, problem-solve roadblocks to health disparities research, among other priorities. 5) Seed money would foster and maintain community partnerships (e.g., community-academic grant pilot programs, support for community meetings, support for the regional patient advisory councils, etc.) that will be pivotal in meeting the needs of our community and expanding research in this area. Given the central role of collaborations in the TN-CTSI, this institute might be best positioned to fund such a seed program.

Focus Area 2. Develop a Scientifically Diverse, Health Disparities Research Workforce

While the TN-CTSI has significantly increased the workforce training at UTHSC, there is an opportunity to offer training that is specific to health disparities. We would design these programs for different audiences including clinical faculty who are adding research activities to their educational or clinical activities and students and faculty who are learning about SDOH through the QEP.

Investments are needed in the annual TN-CTSI budget in the following areas: 1) an accelerated health disparities research training program for faculty members; 2) sustained financial and interprofessional support for faculty

research projects with an emphasis on clinical collaborative practice; 3) advanced quality improvement, population health sciences, and health outcomes research training for medical residents, fellows, and faculty, and 4) ongoing training (e.g., workshops) to support students and faculty members who have increased their knowledge of SDOH through the QEP and are interested in applying this new knowledge to their research questions and conducting research projects in the area.

Focus Area 3. Accelerate the Acquisition and Use of SDOH Data

While addressing SDOH is critical to eliminating health disparities, it can be challenging to acquire and use SDOH data. The collection of SDOH data is not part of the standard of care for many health systems and additional resources are needed to address this limitation. Further, sources of SDOH data are often heterogeneous with discrepancies that present challenges for their collection, integration, and processing. These data are often collected at poor temporal and geographical resolution with unknown validity and precision and in many cases, the data might not be representative of the population of interest. For some health systems, SDOH variables are documented in clinic notes, but novel methods (like natural language processing) are needed to extract that data. Publicly available data collection instruments (e.g., PhenX toolkit, phenxtoolkit.org/collections/view/6) can play a key role for investigators interested in addressing individual and structural health disparities. However, there is a low level of awareness among investigators as to what is available, and how to access such resources. Some investigators may perceive that these resources will be difficult to access, and there is a perceived barrier that prevents their use of these freely available resources.

Investments are needed to establish a SDOH research core facility. This core (with accompanying staff) would be responsible for increasing the availability of statewide health and healthcare data that includes SDOH. These data would be used for recruitment, outcome monitoring, health surveillance and health disparities research in both pragmatic and health services research. The SDOH Core would lead initiatives to make these data more attractive and accessible to a wide array of users and more available through their incorporation into electronic health records (EHRs) and intelligent digital health systems. The core would oversee a collection of publicly available integrated and curated datasets (as an annotated resource) through a user-friendly platform and would help researchers navigate use of the data. The core would take the lead in developing and validating new, state-of-the-art SDOH assessment tools and serve as a repository of these tools. Metrics of success will include the number of health systems that systematically incorporate the assessment of SDOH in their clinical workflows, such as the Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences (PRAPARE); the development of programs to access clinic notes and extract SDOH; and the number of users of the new core. The SDOH Core will work in close connection with CBMI and TN-POPnet to collect, integrate, process, exchange, and store SDOH data to ensure their meaningful use in improving patient care and population health. More specifically, the CBMI and TN-PHC will provide the technological assistance necessary to maintain interoperability of SDOH datasets with existing health and non-health data sources across UTHSC and its affiliated hospitals and clinics. Support is specifically needed for the hiring of a TN-PHC data analyst specifically tasked with linking clinical and SDOH data for population health research and quality improvement initiatives. CBMI will also provide scientific input on artificial intelligence (AI) solutions that can use the integrated SDOH datasets to conduct in-depth health disparities research and address the need for quality and equitable health care.

Institutional Impact and Deliverables

These investments will serve to increase: 1) institutional readiness to respond to a broader range of health disparity funding opportunities (e.g., track record of investigators and/or community partners working together); 2) the number of health disparities research projects submitted and funded; 3) collaboration and funded research, across colleges, UTHSC campuses, and the community; and 4) sharing of resources and intellectual capital to accelerate health disparities research. Metrics of success for this Focus Area include an increase from FY2021 external funding levels for health disparities research projects. Of specific importance are the number of projects that reflect newly formed research teams, the number that involve more than one UTHSC campus, and the number on which UTHSC researchers collaborate with external partners (e.g., healthcare systems, community organizations). A further deliverable is the number of individuals who successfully complete the training programs.

An investment in the SDOH Core facility would result in: 1) access to high quality and integrated SDOH datasets that will provide preliminary data critical to the submission of competitive grant applications; 2) a valuable deliverable to our healthcare and community partners, e.g., a link between SDOH and patient outcomes; 3) an in-depth and refined understanding of SDOH and health outcomes that will position us to discover the key drivers of health disparities and inform testable interventions; and 4) institutional support for the incorporation of SDOH in the EHRs of UTHSC's clinical environments and SDOH follow-up in the patient care management that may also include data about the patient's social capital and social networks.

Synergies and Collaborative Potential

This Focus Area provides many opportunities to collaborate. MLBH's North Hospital and LBCH will soon begin to pilot a program that will assess and provide resources around SDOH for hospitalized patients. As a healthcare academic center, UTHSC is also positioned to be a liaison for teaching private practitioners how to incorporate SDOH into their clinical practices with emphasis toward interprofessional education and clinical collaborative practices. Finally, the use of SDOH is of interest to many investigators across the research AoE, thereby providing opportunities to leverage collective expertise and together build the proposed SDOH core. Finally, there is an opportunity for TN-CTSI to expand its programming and to collaborate with the leaders of the UTHSC QEP to engage individuals who, for example, complete the certificate in SDOH and are now interested in applying their knowledge to research activities.

PRECISION HEALTHCARE Cross-Cutting Platform

Background and Current Status

Precision healthcare seeks to customize healthcare with decisions, practices, and/or products tailored to the individual, and to maximize treatment and prevention effectiveness by accounting for individual variability in genes, environment, and lifestyle. Components of precision healthcare research include 1) biobanking, 2) genomic sequencing and other “omics,” 3) bioinformatics and biomedical informatics, and 4) health care practitioners who are trained to deliver personalized healthcare at the bedside. UTHSC has made substantial progress in precision healthcare research by creating the BIG and 100K Genomes Initiatives. To date, progress at UTHSC includes over twenty thousand children enrolled in the BIG Initiative and preparation for enrollment launch at two other research sites, ROH (Memphis) and ETSU (Johnson City, TN). By linking to hospitals in Memphis, Knoxville, and possibly elsewhere, we will enable a statewide precision medicine effort that could benefit the citizens of Tennessee and further our research mission. In collaboration with Regeneron Pharmaceuticals, UTHSC will soon have access to over 9,000 pediatric whole-exome sequences (~50% African American) as a first step toward obtaining 100,000 sequences as part of the UTHSC 100K Genome Project. Combining DNA sequencing with EHR of the participants and environmental data (including SDOH), this will create one of the largest, ethnically diverse genome databases in the U.S.

In the time since OSPR-1, precision healthcare has come to embrace the roles of AI and machine learning (ML) in medicine. Although UTHSC has established many successful endeavors in various applications of AI, they are not optimally or interactionally cohesive and are not poised to leverage expertise and resources. For example, these research endeavors include 1) the UTHSC CBI (uthsc.edu/cbmi); 2) the Le Bonheur Children’s Foundation Research Institute (lebonheur.org/locations/children-s-foundation-research-institute); 3) the Department of Preventive Medicine’s biostatistics and epidemiological research (uthsc.edu/preventive-medicine/index.php); 4) the Department of Genetics, Genomics and Informatics (uthsc.edu/genetics/); 5) the UTHSC AI for Precision Medicine collective (ai4pm.org); 6) Health Informatics and Information Management research in the Department of Diagnostics and Health Sciences (uthsc.edu/health-professions/diagnostic-health-sciences/hiim/index.php); 7) the collaboration with ORNL’s high-performance computing (ornl.gov/); and 8) individual investigators who may not know each other. In addition, substantial but relatively underutilized data resources are available for research, including the statewide research EDW that links EHR and will soon include genomic data (uthsc.edu/cbmi/research/predictive-analytics.php). A recent retreat at UTHSC highlighted that the informatics community at UTHSC is not ideally positioned to take full advantage of its resources in terms of personnel, infrastructure, code, education programs, and data.

There is a growing expectation in the biomedical community that investigations involving large datasets will extend beyond linking observational data. These investigations must begin to make inferences and solve problems to assist the healthcare professional. Furthermore, UTHSC’s Information Technology Services (ITS) recognizes that it has a pivotal role in facilitating UTHSC’s endeavors in the broad field of AI in Healthcare. UTHSC does not currently have a cohesive vision for building on these resources, and aspirational goals to advance research activities related to AI in Healthcare have gone relatively unsupported. As part of this OSPR-2, we support the following three Focus Areas for future investment:

- 1) Continued development of the UTHSC 100,000 Genome Initiative
- 2) Continued development of longitudinal healthcare datasets, including the EDW for all UTHSC affiliated medical center subjects
- 3) Continued development of a training program for AI and precision healthcare

We have made substantial progress towards these goals since the first report. Now, however, there should be a close and sustained focus on developing shared location, joint teaching, and leveraged resources to support researchers in this area. The hiring of personnel such as data scientist support staff who are well trained in AI/ML will be critical to the success of junior faculty. A centrally located shared physical space is needed to serve as a condensing point for faculty, staff, and trainees to interact. Education efforts need to be broader, aspirational, and foundational, including a certificate program. Physical investments needed include greater available computing infrastructure, access to resources that are flexible in access control and have a well-defined governance structure to preserve security. UTHSC should continue to improve its ability to utilize cloud resources

effectively, utilize the relationship with ORNL ISAAC, and provide the capability for data sharing that is secure, de-identifiable, traceable to provenance, and backed-up. A thematic seminar series and training programs should be established that align curriculum with partner institutions. Finally, it is important to establish an incentive structure for collaboration and credit allocation that takes account of the ever-increasing role of collaborative science at NIH and elsewhere. Eventual implementation of omics in clinical care will require increased numbers of people (staff, faculty, etc.) well versed in clinical interpretation of such data/test results (e.g., genetic counselors, geneticists, etc.).

Institutional Impact and Deliverables

These investments will result in co-localization of interested personnel, the development of multi-institutional collaborations that utilize these unique data sets, and a clinical application research initiative. There will be a collaborative research technology environment sufficiently funded to meet the established needs along with educational programs and thematic seminar series, boot camps, and degree and certificate programs will be established as resources allow. The collaborations with UT Knoxville, ORNL, and UM will become better defined.

Synergies and Collaborative Potential

UTHSC will have a recognized core of investigators, projects, and standing in the field and its multi-institutional collaborations with unique datasets will set UTHSC apart in its unique resources. With the linked datasets (longitudinal electronic medical record data linked to DNA for up to 100,000 individuals in Tennessee), we believe that UTHSC is poised to play a significantly increased role in national and international collaborations of genomics and human health.

OPERATIONAL ITEMS

RESEARCH FACULTY RECRUITMENT, RETENTION, AND DEVELOPMENT

OSPR-2 outlines consensus areas of research, all of which will benefit significantly from sustained and focused recruitment at all levels. This will take vision and tactical resilience. Recruitment is expensive and funding is almost always volatile and often contingent on partnerships. Finding researchers, educators, and clinicians who fit UTHSC's missions will always require tight communication and cooperation among colleges, UTHSC campuses, and the chancellery. Recruitment, retention, and development efforts must make every effort to be inclusive of all, but especially to focus on inclusion of faculty members from populations who are underrepresented in science. We suggest several tactics that may be helpful in achieving this goal.

Tactic 1. We are in a strong position to recruit top talent in health disparities research across the state of Tennessee, from Appalachia to the Mississippi Delta. In the last five years, we have made strides in research on sickle cell disease, cancer disparities, diseases of childhood and old age, substance use disorders, and other disorders and health outcomes that are linked to social and environmental context. To sustain this progress, we must develop and revitalize programs that reach, teach, and recruit the next generations of scientists, starting at the undergraduate level. We need to grow our own and support our many communities in Tennessee.

Tactic 2. We cannot afford to hire in isolation, focusing only on the needs of the hiring unit. All recruits should ideally have cross-cutting impact across departments, colleges, and UTHSC campuses. The best candidates should be enthusiastic and gifted collaborators who have broad intellectual interests ranging from fundamental biology to prevention and clinical care and can work collaboratively across and within multiple fields.

Tactic 3. Cluster and cohort hiring techniques are highly effective and can lead to camaraderie and collaborations that enable effective peer mentoring. Cluster hires foster peer support, productivity, and retention.

Tactic 4. All facets of research are accelerating rapidly. No one can stop learning and everyone needs to be a student, an educator, and a mentor. The following institutional strategies and tactics will contribute to effective lifelong research growth.

Institutional leaders must focus their faculty members to work on projects with scientific quality and importance, as well as clinical and community impact, rather than focusing on the numbers of publications, numbers of grants, and impact factors. The engine of good science is great questions and taking smart risks to reach provisional answers. Allowing faculty autonomy in their pursuits will encourage research vitality, risk taking, and growth.

At the same time, leaders must encourage as much interaction and crosstalk as possible among and across all groups of researchers and clinicians. We tend to exaggerate the differences between mentors and mentees, when in truth there is at best a subtle difference. The mentor may understand the administration and politics of research a bit better, while the mentee may understand the technology and key questions as well or even better than the mentor. Throughout our institution, we must endeavor to minimize silos and hierarchical arrangements and maximize communication. Teach by example in a subtle way that relies on many informal discussions.

After recruitment and onboarding of new researchers, their retention is equally important. Some strategies that have been suggested for enhancing retention of our most talented researchers include the following. Incentivize additional grants more heavily, i.e., provide researchers with salary incentives or additional startup funds to facilitate continued expansion of their research program. Raise salary scales to at least the 50% percentile for faculty at peer institutions nationwide. Celebrate all successes (not just funding acquired but include high-level presentations and impactful publications) to make people feel appreciated and to let others know what their UTHSC peers are doing. Provide a gathering place or faculty club on campus that is open after business hours to allow late afternoon social hours among scientists and research interest groups, thereby increasing collegiality and opportunities for collaboration. Develop "cohorts" of new hires and provide them with activities that allow them to mingle and share challenges and solutions, both related and unrelated to the faculty role. Support the creation of laboratory dyads or triads to promote collaboration and collegiality, to share resources and reduce cost of staff, and allow the PI to focus on the broader questions within the program of research, rather than on the day-to-day activities of the laboratory. Finally, continue to grow the existing bridge funding and seed money

support for faculty as their large grants end, with efforts guided by the AoE and CCP from OSPR-2, in alignment with the mission and vision of the UTHSC colleges and campuses.

RESEARCH MISSION OF INSTITUTES AND CENTERS

Research institutes and centers are critical for the development of interdisciplinary research at UTHSC. Centers are generally comprised of faculty and staff members within a single department or across multiple departments within a college, while institutes are generally formed from collaborations of faculty members with primary academic appointments in multiple colleges and often on multiple UTHSC campuses. Institutes may also include partnerships with other academic and non-academic partners. Both institutes and centers are intended to facilitate the research of individual researchers and to catalyze larger research programs that have the potential to lead to national and international awards. They are both key to growing research and to supporting the recruitment and retention of talented faculty members. Thus, UTHSC should continue to follow and expand this path, concentrating its growth resources toward seeding collaborations across departments, colleges, UTHSC campuses, and with non-traditional industries and research organizations in the state, the region, the country, and internationally. Fostering this approach of emphasizing and enhancing research growth beyond research silos will ensure that UTHSC will maintain its growth trajectory and significantly impact its ranking among U.S. research-oriented health science centers.

Value Added Proposition: The OSPR-2 recognizes that collaboration, in the broadest sense, is a multiplier of research opportunities and growth of the investigative enterprise at UTHSC. In other words, the premise of centers and institutes is driven by the mutual interest of investigators in collaborative partnerships with a myriad of institutional benefits. A few valuable examples are as follows:

- (1) The development of institutes and centers are a critical feature for building both within and across colleges, where they provide an interprofessional critical mass of investigators in specific research areas. Such a critical mass of senior, mid-level, and junior faculty within a thematic area will provide much needed mentoring opportunities and aid in faculty retention.
- (2) Utilizing institutes and centers as a focal point for future research growth provides an opportunity for true collaborative shared hires, i.e., those hires that cross colleges, departments, and training disciplines. Shared hires permit leveraging of available resources, though all faculty will have a “home department” for promotion and tenure progression.
- (3) Institutes and centers provide an excellent platform for the successful submission of program project, center, and training grants, where the faculty themselves and the research project are well supported within an interdisciplinary environment.

In summary, research institutes and centers facilitate a range of research and creative activity by catalyzing unique interdisciplinary and interprofessional collaborations across multiple domains. In so doing, they cultivate talent and innovation at the intersections of traditional disciplines in basic, translational, and clinical science.

RESEARCH CORES

Institutional cores are shared resources widely used by health science center faculty from multiple departments, colleges, and campuses. Effectively and efficiently managing institutional core resources is intimately tied to the overarching goal of OSPR-2, namely, to accelerate the research enterprise for UTHSC campuses. In this respect, the objective is to ensure the quality of the institutional research cores by enabling the necessary infrastructure, accessibility, accountability, oversight, and fiscal responsibility of institutional investments. Beyond fiscal considerations, there are many unaccounted benefits that warrant the underwriting of cores, which include, but are not limited to, (a) maintaining international recognition of research programs; (b) increasing extramural funding; (c) supporting active research grants and contracts that require core services; and (d) recruiting and retaining faculty members. Importantly, smaller institutions require the same research core facilities as larger ones but have fewer investigators to support them. Notably, the research cores enterprise at all academic health science centers are subsidized.

Overview of Existing Cores

Philosophy: Institutional-level cores receive their budgets from the institution. On the Memphis campus, the internal service fees are set based upon market evaluation, in which pricing for services is compared among our peer academic institutions, preferably those public institutions located in the South or Midsouth. Using this market-based information, prices for equivalent services are set in the bottom-third to bottom-half of internal prices at our peer institutions. Since 2016, institutional-level cores on the Memphis campus have been managed with a business-like model through the creation of three-year *pro forma* business plans to develop core operating budgets (excluding capital equipment). Core activities and performance are reviewed annually using data-based metrics and a series of litmus test questions to evaluate whether investment in the core facility should continue. The core activity and core analysis reports are publicly accessible.

Analysis: On the Memphis campus, there are currently nine institutional cores including: (a) the Lab Animal Care Unit (LACU); (b) the Regional Biocontainment Laboratory (RBL); (c) the Molecular Resource Center (MRC); (d) the Flow Cytometry and Flow Sorting core (FCCS); (e) the Molecular Bioinformatics core (mBIO); (f) the Proteomics and Metabolomics core (PMC), which includes the Metabolic Phenotyping Mass Spectrometry unit (MPMS); (g) the Research Histology core (RHC); (i) the Medicinal Chemistry core (MedChem) and (k) the Advanced Imaging core (AIC). The individual cores are managed by directors who report to the Associate Vice Chancellor for Research and Core Laboratories and the Senior Associate Vice Chancellor for Research.

Notably, none of the nine institutional core facilities is self-sufficient, with sizeable institutional investment in support of staff positions and common operating expenses (laboratory supplies, service agreements, maintenance contracts, small equipment, etc.). Historically, the institutional cores have been underfunded, ending each fiscal year with deficits that required additional institutional underwriting to achieve a net zero overall budget.

There remain opportunities for further improvement in management of core operations, which are not mutually exclusive from one another. This OSPR proposes: 1) a “right-sizing” of the subsidy provided by the institution, including a separate annual budget for the purchase of equipment (i.e., replacement of broken or outdated equipment, or the addition of instruments for new technologies); 2) more aggressive marketing of core services statewide to all health science center campuses, to increase awareness of core facilities and to stimulate increase in core recoveries; users on all UTHSC campuses are recharged “internal” user rates; 3) enhanced efforts to obtain extramural support for core equipment (for example through S10 instrumentation grants), as well as philanthropic support; 4) more frequent surveys of users to identify operational or technical bottlenecks, and 5) applying lean management principles to core operations to effectively manage core budgets. In addition, the leadership of the core facilities across the health science center campuses should meet at least twice per year with the VPR at the university system level to ensure that these resources benefit all campuses. When used together, these approaches will allow the Office of Research to achieve the long-term goal of reducing the deficits in the institutional cores’ budget at the end of each fiscal year, while simultaneously investing in one new institutional core to meet researcher needs approximately every two years on the Memphis campus.

New Institutional Cores

The same guiding principles described above should be applied to any consideration of developing a new institutional core facility or expanding an existing core. Needs are identified through a variety of channels, including faculty surveys, town hall events, and requests made to the Office of Research. Working groups with expertise in relevant technologies and platforms are developed. Once the specific modalities that will best serve the needs of the research community are identified, a business plan is created for the new core, focused on the estimated operating budget, based on projected expenses and revenues from core users. Internal advisory boards are established to advise on core operations and to provide input into core use policies. This workflow was implemented to add the MPMS unit of the PMC, the MCC, and the AIC during execution of OSPR-1.

From 2016 to 2018, capital equipment for the cores was purchased with startup funds provided to the Vice Chancellor for Research. However, as this source of funding has expired, new equipment purchased since 2018 has been funded through indirect cost returns to the Office of Research, which were not provided in FY2021, and will not be provided in FY2022. To sustain and to expand the cores, it is now critical for the Office of Research to partner with colleges, centers, or institutes to purchase capital equipment that benefits multiple researchers, to seek philanthropic support, to secure gift-in-kind discounts by strengthening relationships with vendors, and to secure recurring funds from the institution (see above) for replacement of outdated, aging, or failed equipment.

Institutional Cores to be Developed that Cross Research Pillars. A biophysical and structural biology core; a drug development core focused on ADME/PK/toxicology services; a single cell analysis core that uses existing instruments on campus (Fluidigm C1 and 10X Genomics); and expansion of the histology core to include new support services, such as whole slide digitization and automated colorimetric quantification of immunostained specimens.

Institutional Cores to be Expanded that Cross Research Pillars. Addition of advanced genomics, transcriptomics and methylomics instruments, including long-read sequencing technologies and spatial genomics technology to the Molecular Resource Center; addition of a dedicated mass spectrometer for untargeted metabolomics to the PMC; addition of drug libraries to the MCC; and expansion of support for new drug discoveries, including biologics, and existing drug reformulation and repurposing efforts, especially for orphan and rare diseases, likely in partnership with the COP.

COMPUTATIONAL RESOURCES AND RESEARCH INFORMATION TECHNOLOGY

Research information technology (RIT) is a key catalyst for our research programs in all colleges and UTHSC campuses. UTHSC is a world-class leader in cancer genomics, research EHR enterprise data warehousing, the use of AI to address health care disparities, pan-genomic analysis, and systems genomics of mice, rats, and humans. UTHSC is home of the first and oldest continuously operating web service in biomedical research, GeneNetwork (genenetwork.org). We are in an excellent position to capitalize and leverage expertise in RIT, thanks in large part to new collaborations between UTHSC and Regeneron Pharmaceuticals that will generate massive datasets for well over 20,000 children at LBCH over the next five years.

Recent experience has proven that we as an institution need professional RIT within UTHSC proper. Our close collaboration with ORNL-UTK (2018–2021) has had a strong and positive impact on RIT, which has included the following successes: greatly improved high-speed internet (IT2 at >10 Gbit to ORNL and UTK), access to storage and compute facilities at UTK; professional systems administration; and smooth access to standard command-line Linux workflows for genomics and EHR projects. As a result, UTHSC now owns ~3 PB of Luster storage in the UT ISAAC secure high-performance computing (HPC) cluster, including a large secure data enclave and shared access to over 2,000 cores.

The past five years have also highlighted key problems for the UTHSC Memphis campus. Our faculty, staff, and administrators need more control and influence over the following: decisions regarding hardware and software implementation; hiring and deployment of IT professionals; greater flexibility with respect to code development for novel code and hardware research; and improved support and training related to databases, health informatics, and systems administration. We also need to address the unmet needs of researchers who have rich but small data resource requirements and do not know how to exploit high performance systems from their desktops.

Executive Vice Chancellor Kennard Brown, Vice Chancellor for ITS Dan Harder, members of the research faculty, campus leaders, and the global research and advisory consulting firm Gartner have evaluated the research technology needs for UTHSC and drafted a research IT plan for campus. This section of OSPR-2 relies on portions of the consultants' overview, including recommendations for RIT that ideally should be implemented over the next five years.

During this time, we must expand capacity and sophistication in a well-coordinated way. We will need to accommodate a more than 10-fold increase in computational and storage needs. At present, we must efficiently and safely store and share massive datasets, for example those linked to the new collaboration between the UTHSC Biorepository and the BIG Initiative, LBCH and Regeneron Pharmaceuticals (20,000 genomes), massive data from new imaging systems, and many large genomics and omics projects. Based on anticipated future projects, many UTHSC researchers will also need improved support for complex high-content data. The consensus is that over the next five years we need to accomplish the following operational goals:

- 1) Expand and integrate research computing hardware and personnel in RIT across all UTHSC campuses
- 2) Expand storage to at least 5 PB and provide high speed links among all UTHSC campuses and with UT Knoxville-ISAAC
- 3) Double the numbers of nodes and compute cycles, with a target of 1,000 nodes for general research computing
- 4) Enhanced support for experimental research hardware used in computationally intense statistics and machine learning applications, especially advanced reduced instruction set computing (RISC) machines (ARM) and graphics processing unit (GPU) systems
- 5) Devise more effective ways to share and administrate RIT at the chancellery level
- 6) Adopt flexible but secure infrastructures that accommodate unprotected experimental work, Health Insurance Portability and Accountability Act (HIPAA) compliant data processing, internal and international collaborators, and our growing set of hospital and CTN2 partners
- 7) Develop a close-knit RIT culture in which researchers and RIT staff value each other as collaborators rather than as users and administrators
- 8) RIT and faculty with computational expertise, which is rare in a health science center, need to work harder on outreach and training in cutting-edge data science methods for other faculty and staff

The main benefits of this approach and proposal are:

- 1) Increased research revenues through improved competitiveness in the granting process by leveraging technology investments across all departments. UTHSC is more competitive collectively by pooling investments in infrastructure from each of our component “parts.”
- 2) Governance that engages the faculty to guide strategic research IT direction, and leverage funds where investments make sense.
- 3) Establishment of central resources that benefit all research faculty and staff.
- 4) Establishment of the following leveraged resources for all departments/faculty: a) network; b) storage; c) compute cycles; d) architectural services; and e) training services

Funding Recommendations and Priorities

Priority 1. Provide a strong cyber and research ecosystem, providing support for current environments, database, and statistical needs across campus

- 1) Provide system administration, technical ownership, database administration, and software development support of the Research EDW, GeneNetwork, and other major UTHSC systems.
 - Hire one database analyst
- 2) Provide system administration of current HPC infrastructure and data storage
 - Hire one system administrator specializing in Linux and full stack development
- 3) Provide central support for grants applications and foundational research needs and provide support for and administer primary statistical applications, including the Statistical Analysis System (SAS), Stata, the Statistical Package for the Social Sciences (SPSS), and R.
 - Hire one application support analyst for statistical applications and overall support
- 4) Build an ecosystem of cybersecurity to reduce UTHSC risk level
 - Hire one cybersecurity analyst
- 5) Provide a director level position to lead technical Research IT division
 - Hire one Research Technology Officer

Priority 2. Build a research storage environment and science network, capable of securely storing and transporting large amounts of images, files, and research data

Establish an enterprise-grade, HIPAA-compliant, research storage infrastructure and networking ecosystem that complements the system we own at ISAAC. This will entail the following measures.

- 1) Expand and deploy new storage arrays with high-speed interconnections
- 2) Upgrade the number and diversity of computing systems available to UTHSC researchers on demand, including GPU, ARM, and large-memory central processing unit (CPU) nodes.
- 3) Deploy ISAAC and/or Microsoft Azure backup

Priority 3. Establish research IT governance councils

We propose the establishment of a RIT council that is comprised of nine research intensive members of faculty and staff at all levels of computational expertise (one member appointed by each college and at least one member from each UTHSC campus), with *ex officio* members to include the VC for ITS and the chair of the UTHSC Faculty Senate Computing Resource subcommittee. We also propose a Research Deans Technology Council, with joint leadership by the VC for ITS and the Vice Chancellor for Research, and with the Chair of the RIT Council as an *ex officio* member.

RESEARCH SPACE

As defined in UTHSC's approved Allocation of Research Space procedure (see below), laboratory space is an essential resource that must meet the needs of the research endeavor in sufficient quantity and quality for UTHSC to reach, maintain and potentially surpass its research goals. Even considering on-going renovations to existing buildings on the UTHSC Memphis campus, the lack of available high-quality research space limits the recruitment of outstanding basic science and clinical research faculty members and the expansion of existing successful programs.

One of the major challenges facing the Memphis campus is its aging buildings. At the time of this writing, campus research space continues to undergo a major transition as part of UTHSC's capital renovation plans. The Crowe, Mooney, and Nash Buildings, and the Nash Annex are undergoing renovations to accommodate the College of Nursing, administrative offices, and updates to laboratory space. New research space has become available recently in the Translational Science, Pharmacy, and Cancer buildings. We propose that these buildings give UTHSC the ability to develop interdisciplinary, interdepartmental, and intercollegiate research themes that will increase collaborations across the entire Memphis campus, improve the quantity and quality of both basic and clinical science, and provide the structure for establishing strong and focused translational research unit(s). We recommend that faculty members should occupy these buildings based upon specific area(s) of research excellence (as defined by OSPR-2), independent of their college and departmental affiliations, and should be organized in proximity to one another based on a research focus theme. Additionally, as UTHSC's allocation of research space procedure is implemented over time, similar principles of thematic use of space should be applied to other buildings such as the Pharmacy and Van Vleet buildings.

To aid in the ongoing transition to the thematic use of research space, the Research Cabinet should advise the Vice Chancellor for Research on:

- 1) The optimal usage of research space throughout UTHSC, including the space that becomes available as researchers migrate back to the Nash/Nash Annex and other buildings currently under renovation.
- 2) The design of new thematically driven research space that will come online during the next ten years.
- 3) The identification of existing and further development of new dry laboratory space that surpasses the typical needs of computer-based research. For example, investigators in physical therapy require dry space for equipment such as treadmills and gait motion analysis instruments.

UTHSC's current Allocation of Research Space procedure was approved by the chancellor in 2016 and again in 2019, after revision following the first triennial space review in that same year. The goal of the first triennial review was to begin the process of assuring the most efficient and effective alignment of space with the university's research mission and to allow for growth of successful programs. Moreover, in addition to establishing appropriate funding-based metrics for space allocation to the colleges, an important goal was to create reserve space to act as swing space during periods of renovation and to be available for recruitment of new faculty members and for expansion of individual faculty laboratory spaces due to increased funding. We continue to endorse the principles and processes outlined in the Allocation of Research Space procedure and strongly approve its implementation.

RESEARCH DEVELOPMENT

In 2015, the Vice Chancellor for Research created the Office of Research Development (ORD) and hired its first director. Since its inception, this multi-faceted office has grown to encompass: (a) administration of intramural grant programs (CORNET awards, Bridge Funding, and New Grant Support); (b) administration of limited submission competitions; (c) management of grant consulting services for faculty; (d) identification and dissemination of extramural grant opportunities; and (e) organization of seminars, symposia, and other research events to increase collaborations both within and outside of UTHSC.

OSPR-2 strongly endorses the continuation of the above noted programs and resources, which have had a significant positive impact on the research enterprise. With an investment of \$2.3 million by the Office of Research, the CORNET awards have resulted in approximately \$29 million in extramural grants and contracts for UTHSC, a 12.9-fold return on investment (ROI). New Grant Support (NGS) and Bridge Funding (BF) are critically important resources both for investigators who have a proven track record of success in attaining extramural funding and for investigators who are trying to secure their first extramural grant. Limited submission announcements, internal competitions among UTHSC investigators, and subsequent grant submissions have grown significantly over the past five years, largely resulting from better communication methods for reaching faculty, including the subscription to the *InfoReady Review* (IRR) online platform for managing internal funding competitions and the addition of Notices of Intent announcements for limited submission opportunities at NIH and the Health Resources and Services Administration (HRSA). To increase the quality and success rate of extramural research proposals, the Office of Research contracted with Hanover Research in 2018 to provide grant consulting, grant prospecting services, and grantsmanship training sessions for the entire UTHSC research community, including both on-site and virtual formats. As another means of assisting investigators to identify funding opportunities, ORD offers Funding Institutional, an online searchable database of funding opportunities, funders, and awarded grants and maintains the FundOPs listserv. The CORNET awards program also created symposia and conferences that bring researchers together to establish new collaborations and present the results of their CORNET-funded research. To date, seven CORNET symposia have been held at UTHSC or partnering institutions. These symposia included speaker sessions, poster presentations, and a networking component to allow investigators time to meet others with shared research interests and to discuss potential research collaborations.

The Vice Chancellor for Research should continue support for ORD and expand its staffing, as its administration and proposed expansion of the programs below will be critical to ORD's and the research enterprise's continued success. To accomplish these goals, we recommend:

- 1) A doubling of the funds allocated to both the BF and NGS programs
- 2) Based on its impressive return on investment, OSPR-2 endorses enhanced support for the CORNET program. A \$2M annual budget should be provided to the Office of Research, specifically dedicated to this purpose. As part of implementing OSPR-2, the Vice Chancellor for Research should work with the OSPR-2 implementation team and the leadership across the UTHSC campuses to expand existing CORNETs as well as establish new competitions, in keeping with the goals outlined in the AoE and CCP sections of this document.
- 3) With increased staffing, ORD can:
 1. Offer one-on-one funding consultations to UTHSC investigators
 2. Expand the identification and dissemination of federal, state, and private foundation funding opportunities (including limited submissions) by making full use of IRR and Elsevier's Funding Institutional (FI) and increasing FI training opportunities for UTHSC investigators and business staff
 3. Track and create outcome reports for ORD activities and services, including awards from both UTHSC extramural and Office of Research intramural funding mechanisms.

Because faculty members from all UTHSC colleges and career stages utilize Hanover's services and attend their training sessions, the Vice Chancellor for Research should continue to provide their services. Hanover's training topics should continue to expand to address the diversity of research performed by UTHSC investigators.

SCIENTIFIC WRITING

In 2017, the Vice Chancellor for Research established the Office of Scientific Writing (OSW), and a PhD-level scientific writer was hired as director after OSPR-1 was implemented. The OSW is currently under the leadership of the third such director, who supplies expertise in research, grant smithing, and scientific writing. The OSW aids UTHSC researchers on all four campuses with the preparation of grant submissions, scientific manuscripts, and other forms of research productivity, free of charge. Investigators may choose between copy editing only or scientific writing and editing, which may also include formulating revised drafts that respond to the comments and suggestions of grant or journal reviewers. The OSW has become a much-used resource for faculty and staff members, postdoctoral fellows, and students, assisting with the preparation of over 150 grants and manuscripts annually. The increase in grant funding since OSPR-1 and the productivity of the faculty have led to increasing numbers of manuscripts submitted to top scientific journals. The typical weekly workload includes approximately one grant and three to five manuscripts or review articles, with the greater preponderance requiring scientific writing by the Director. However, the month preceding each of the triennial NIH submission deadlines typically conveys a fivefold increase in grant proposals submitted to OSW. With OSW personnel presently limited to the Director and a 20% FTE staff writer and copyeditor, supplemented with freelance writers as necessitated by the workload, an expansion in staffing will be critical for the future.

The Vice Chancellor for Research should continue support for the OSW, including the hiring of additional scientific writing staff to keep pace with the growth in funding and research productivity. We recommend the following directions for growth of the OSW:

- 1) Add an electronic submission portal, via IRR or other, online platform.
- 2) Implement electronic tracking of projects and streamlined reporting procedures to reflect the continued value of OSW for the Office of Research, particularly its increased rates of grant funding and publications
- 3) Develop marketing strategies and awareness of the OSW in collaboration with the Office of Marketing and Communications (ORMC).
- 4) Organize workshops and faculty meeting presentations to acquaint investigators with OSW services.
- 5) Develop and implement virtual or on-site campus visits to build relationships with investigators on other UTHSC campuses, thereby increasing research productivity.
- 6) Expand the staffing over the next five years to include at least another FTE staff writer.

RESEARCH MARKETING AND COMMUNICATIONS

In 2016, the Vice Chancellor for Research created the Office of Research Marketing and Communications (ORMC). The ORMC supports the goals and mission of the Office of Research by fostering excitement for creativity, innovation, and scholarship. Comprised of a Director and a Communications Coordinator, the team shares valuable information internally and externally about the UTHSC research enterprise and increases awareness within the UTHSC research community about initiatives, services, and resources overseen by the Office of Research.

The ORMC is responsible for:

- 1) Development and maintenance of the Office of Research online presence, including its website, blog (rainmaker.uthsc.edu), social media, and communications.
- 2) Office of Research press releases and media relations.
- 3) Creation, organization, customization, and distribution of marketing content in support of the UTHSC research message and assistance with organizational efforts to promote research achievement.
- 4) Promotion of the Office of Research units, cores, and multidisciplinary research institutes and consortia, provision of targeted information, developmental, and promotional support for special events hosted by the UTHSC Office of Research.
- 5) Organization of various Office of Research events, including the Distinguished Lecture Series and the Hot Topics in Research Series.
- 6) Preparation of all Office of Research documents and presentations (including the Research Space Allocation Plan, Research Core Business Plans and Annual Reports, and OSPR-2).

Taking direction from both the OSPR-2 survey and the ORMC April 2021 communications survey, efforts for the next five years will focus on improving audience reach, increasing messaging awareness, and easing discovery of information and news. Strategies include developing the Research Rainmaker blog to its full capacity, revamping the Office of Research website and navigation, and developing the Office of Research's social media presence with consistent use of all communications channels and enhanced message targeting. Metrics for all our online communications channels (website, blog, and our social media) are reported to the Vice Chancellor for Research monthly to monitor progress and evaluate tactics.

STIMULATING PARTNERSHIPS AND COLLABORATIONS

A. Enhance mechanisms for cross-departmental and cross-campus collaborations

Collaborative Research. Developing interdisciplinary research teams that cross UTHSC departmental, college, and campus boundaries was a major theme of OSPR-1. This has been key to strengthening UTHSC research efforts and the funding to support the research enterprise. In this regard, the Vice Chancellor for Research created the CORNET awards to stimulate the formation of these interdisciplinary teams. CORNET Phase 1 established new cross-college research efforts by providing seed funding for new projects by research teams comprised of investigators from a minimum of two different UTHSC colleges. The Phase 1 competitions (2016, 2017, 2018 and 2020) drew significant faculty interest, with a total of 140 applications. Phase 2 was created to generate cross-campus collaborations between faculty members from multiple UT System institutions. In 2017, a competition for cancer research projects yielded 20 applications. This collaborative opportunity generated proposals from UT Knoxville, UTC, the UT Space Institute, and the UTIA, which includes the College of Veterinary Medicine). As described throughout this document, the CORNET program has been a resounding success, with an initial program investment of \$2,259,555 being leveraged to the acquisition of 27 extramural research grants totaling \$29,249,612 to date.

Since the CORNET program has enhanced UTHSC's competitiveness for grants, OSPR-2 endorses continued and enhanced support for the program. We recommend that a \$2,000,000 annual budget, specifically dedicated to this purpose, should be provided to the Office of Research. As part of implementing OSPR-2, the Vice Chancellor for Research should work with the OSPR-2 implementation team and the leadership across the UTHSC campuses to establish new CORNET competitions, in keeping with the goals and aspirations outlined in the AoE and CCP sections of this document.

Clinical Trials Network of Tennessee (CTN2). CTN2 was created to enhance statewide multi-site clinical trials that involve UTHSC faculty, its participating hospitals and practice plans. In just three years, the statewide network has grown to 13 participating partners wherein CTN2 markets its network access to UTHSC's TN-EDW and statewide trial patients to industry sponsors. To date, CTN2 has generated over seven million dollars in clinical trial contracting and the network continues to expand. In keeping with the Whitlock Consulting Group's recent review of UTHSC's administrative infrastructure to support and conduct clinical trials, OSPR-2 agrees that CTN2 has the potential to continue its transformation of collaborative clinical trial research and as such, institutional support and investment should be continued, if not expanded.

Clinical Trials Governance Board (CTGB). The Vice Chancellor for Research also created a federated model for clinical trials by creating the CTGB. This important model pulls together the various clinical trial groups across the UTHSC campuses and colleges into a collaborative network, bringing to bear a collective expertise that encompasses industry-sponsored research, translational research, federally funded research, epidemiologic research, and investigator-initiated research. The CTGB has been instrumental in providing resources, tools, and guidance to UTHSC investigators and staff to improve the research enterprise statewide. The CTGB has also taken on the responsibility of distributing CTN2 clinical trial opportunities to investigators throughout the state to stimulate their participation in research. CTGB recommends support for an annual statewide event that will bring investigators together in a research symposium/poster session format that allows small group research networking events such as tiny technology, entertainment, design (TED) talks or speed dating.

Tennessee Clinical and Translational Science Institute (TN-CTSI). TN-CTSI was established as a statewide collaborative entity directed toward accelerating and expanding efforts to overcome bottlenecks to the conduct of high-quality clinical and translational research (CTR). The TN-CTSI enhances CTR by accelerating workforce development and community engagement and by promoting team science aimed at improving health outcomes and eliminating health disparities across the entire lifespan in Tennessee, particularly in the state's rural areas and underserved populations. OSPR-2 endorses continued and enhanced support for the TN-CTSI with an annual budget directed toward expanding statewide workforce development and team science, overcoming barriers to collaboration (e.g., institutional research roadblocks), and fostering cross-disciplinary collaborations through the TN-CTSI pilot project program.

In summary, the creation and development of CTN2, the CTGB, and TN-CTSI facilitated the establishment of a closer relationship among the different UTHSC campuses and participating health systems. UTHSC clinical researchers will continue to benefit from this robust networking system that fosters education, provides access to research opportunities, and ultimately allows them to accelerate the implementation of clinical research.

B. Academic institutional collaborations in research

The third phase of the CORNET awards was the development of focused collaborations with other universities in the southeast United States. Towards this goal, during the period encompassing OSPR-1, the UTHSC Vice Chancellor for Research visited other universities to develop research collaborations in the original AoE, and their Focus Areas, as described earlier in this document. Cross-institutional CORNET award competitions drew significant faculty interest with a total of 57 applicant teams, of which 19 were funded.

- 2016 UTHSC/University of Arkansas for Medical Sciences in substance abuse
- 2017 UTHSC/University of Arkansas for Medical Sciences in cancer
- 2019 UTHSC/University of Mississippi Medical Center/Tulane University in health disparities research
- 2019 UTHSC/University of Memphis in adverse childhood experiences
- 2020 UTHSC/University of Memphis in SARS-CoV-2/COVID-19 research

This model should continue to be used to establish strong collaborations with other universities in the southeast US, with the expectation that many of them will lead to spinoff research and independent grant applications. We continue to encourage both individually and institutionally organized research collaborations with investigators at many institutions. For example, we have particularly strong regional collaborations with SJCRH, ORNL, UT Knoxville, UM, Vanderbilt University (VU), and with regional and national companies. These collaborations should continue to strengthen as we expand UTHSC collaborations to partner institutions in other areas of the country in the coming years.

Recommendations

1. We should continue to support institutionally organized research collaborations such as TennIRM and the Oak Ridge Institute (ORI) through cost-sharing agreements.
2. Individually organized research collaborations should continue to receive the support of the Office of Research, coupled with the guidance of the Associate Dean of Research (ADR) from the investigator's college. Support should include early-stage planning, preparation of grants and contracts applications, use of core infrastructure, and management of grants and contracts.

C. Corporate partners in research

Partnerships with corporations, non-profits, and economic-development agencies play an increasing role in research at health science centers nationwide. Granting agencies that fund university-corporate partnerships require that they show real-world value, to add important team skills, and indicate potential interest in moving technology from the pre-clinical research to patients. Corporate partnerships are critical for accessing specialty research grant funds from NIH that are earmarked for the support of commercialization for biomedical breakthroughs. Public-private partnerships between universities and non-profit organizations allow broad access to funds and capabilities needed for research success. Partnerships with federal, regional, and local economic development organizations bring support for the jobs created by public investments into research. Partnerships with scientific equipment vendors can provide support or result in gifts of equipment. These and many other examples show that expanding its relationships with the corporate community is crucial for UTHSC to meet its mission of improving the health of Tennesseans.

Tennessee is fortunate to have many potential corporate partners with a vested interest in the success of medical research. Memphis is particularly rich in hospitals and clinical care providers and manufacturers of medical devices, including small companies focused on the device supply chain and built on the regional transportation infrastructure. Nashville is replete with potential corporate partners in healthcare such as Hospital Corporation of America (HCA). Across the state, nation-wide, and internationally are numerous companies and non-profit organizations focused on drug development and health care distribution, with expertise in clinical trials,

reimbursement, and medical technologies. The key to attracting the participation of such partners is a focused agenda that provides benefit to both parties. For companies across Tennessee and globally involved in the health care arena, there are plenty of opportunities to collaborate with UTHSC for mutual benefit.

The presence of several large non-health care corporate entities across Tennessee, including FedEx, AutoZone, and International Paper (all in Memphis), Bridgestone (Nashville), Covenant Transport (Chattanooga), and Eastman Chemical (Kingsport) provide significant opportunities for expanding partnerships. The capabilities of the ORNL also augment UTHSC research, for example through access to its robust data analysis resources, including the Summit supercomputer and the Compute and Data Environment for Science, which are needed for analysis of large datasets such as those involving genomic contributions to disease or drug actions. The return-on-investment for outreach to non-healthcare companies offers many other opportunities, including the development of novel programs that leverage corporate social responsibility and align mutual interests in promoting occupational health, possibly resulting in opportunities for research funding.

Advisory groups can also stimulate corporate-University partnerships. The TennIRM Industry Advisory Board sets an example of the development of mutually beneficial academic-industry partnerships with joint workforce and product development grant applications. This Advisory Board is comprised of faculty members from partner institutions UTHSC, UM, STCC, and SJCRH. This Industry Advisory Board provides an avenue for collaboration on novel regenerative stem cell/scaffold research and for the development of corporate connections for potential licensing. The resulting model for domestic and international partnership with industry may stimulate new avenues of research or even spark the creation of entrepreneurial ventures.

The Clinical Trial Industry Advisory Committee (CTIAC) provides another example of how industry connections can be grown, while stimulating growth and development of research initiatives at UTHSC. Industry experts on the CTIAC have provided input to CTN2 on industry needs and the development of a business plan that refines service offerings to make them more attractive to industry sponsors. The keys to the creation of successful and functional advisory boards are a diverse set of members from industry and a dedicated UTHSC resource to organize them and provide support for these relationships, thereby setting the stage for meaningful one-on-one partnerships and collaboration.

Going forward, successful partnering of UTHSC with corporations will require investment in faculty and staff to attract and manage such relationships and to connect additional members of the research faculty to the appropriate corporations. For example, the Office of Research appointed an Associate Vice Chancellor for Research who is focused on global cooperation and industry relations and who has been key to establishing the partnerships needed to grow research interests in regenerative medicine. The Office of Research also appointed a Vice Chancellor for Research and Business Development who is tasked with providing active leadership of activities that offer industry partnerships, new revenues from the private sector and business lines that help build a culture-of-entrepreneurship within the institution. The establishment of these critical leadership positions facilitate the building of relationships with companies and non-profit organizations, leading to the development of meaningful partnerships that provide opportunities for researchers.

Corporations expect the University to operate in a manner that matches their business culture and the University must incorporate these approaches when necessary. A case in point is the approach taken to attract and grow industry-sponsored clinical trials across the state. A new non-profit entity, CTN2, was formed as a partnership between UTHSC, UTRF, and 13 clinical partners. CTN2 provides a highly efficient contracting process, as required by its sponsors. To expand collaboration with corporations, UTHSC must continue to evaluate internal processes that enable the University to operate at the pace of business.

D. State, county, and community partners in research

Since the publication of OSPR-1, UTHSC has significantly increased the number and quality of its strategic relationships with state, county, and local community partners to conduct research critical to UTHSC's mission to improve the health of Tennesseans and ameliorate disparities in health and healthcare. For example, the TN-PHC connects UTHSC affiliated health systems, public health specialists, and academic partners across the state. This consortium will encourage adoption of evidence-based practices, transform primary and preventive

care, and measurably improve health outcomes, quality of life, and health equity for the people of Tennessee. Two other examples include the CTIAC and the TennIRM advisory board, each of which is comprised of over twenty industry leaders in their respective areas of expertise and are convened to help UTHSC programs focus their work on items that offer value to the health of Tennesseans. The launch and the growth of CTN2 to expand clinical trials in the state has been an important addition to UTHSC's outreach to the community and to its clinical partners.

The next five years must focus on strengthening these existing collaborations and generating new partnerships with diverse partners statewide, regionally, and nationally. One major mechanism will be to expand the efforts and reach of the UTHSC TN-CTSI through its multisector, statewide Community Advisory Board (CAB). TN-CTSI and TN-PHC will increase partnerships with rural communities and health systems across the state. CTN2 will add medical directors in various regions of the state, starting with Knoxville, to further connect UTHSC to local patients and healthcare systems. UTHSC will actively work with local and state entrepreneurial support organizations such as LaunchTN and EPIcenter to help faculty move their inventions to patients more rapidly, while building internal capacity for the unique health technologies being developed within UTHSC.

E. Healthcare delivery system partners in research

At present, UTHSC partners with numerous healthcare systems across Tennessee, including ROH, Memphis VAMC, MLBH, St. Francis Hospital, BMHC, SJCRH, and Memphis Mental Health Institute (MHI) in the Memphis area; Erlanger Health System in Chattanooga; St. Thomas Health in Nashville, and the UT Medical Center in Knoxville. Many UTHSC faculty members also have affiliations with CCHS, Church Health, and practice groups across the state, where they provide advanced care and supervise the training of clinicians in diverse specialties. Our partnership with these health systems provides access to patient populations (including underserved communities), which could foster major growth of our research enterprise and help address health disparities. Notably, the UTHSC Knoxville campus has a unique opportunity to underserved groups in rural Appalachia. The research EDW and CTN2 exemplify the way in which partnership with health care systems can advance research. The UTHSC CBI maintains the EDW with EHR data from UT affiliated health systems. Using the EDW framework, TN-PHC is developing statewide population health data infrastructure through its TN-POPnet and component diabetes and heart health registries to track health outcomes and improve care across Tennessee. The TN-PHDN engages a growing number of additional health systems across the state, including West Tennessee Healthcare, Ballad Health, and ETSU Health to participate in its initiatives for quality improvement and population health research. Ongoing efforts aim to expand the number of partners in the EDW, CTN2, and TN-PHDN, while encouraging the statewide growth of linked datasets in the EDW, patient registries, and biorepositories.

The COVID-19 pandemic and its disproportionate impact on certain populations and individuals with pre-existing health conditions has provided yet another opportunity for aggregated patient data and registries. The population of Tennessee has a high prevalence of risk factors for increased severity of COVID-19 disease, including diabetes, hypertension, obesity, chronic kidney disease, and heart disease. Following recovery from acute COVID-19 disease, many patients continue to suffer from a myriad of conditions that together comprise post-COVID syndrome. The Multi-Institutional Memphis Pandemic Health Informatics System (MEMPHI-SYS), recently established by UTHSC in collaboration with UM and health system partners, is a crucial step needed to address this chronic condition. Since March 2020, the MEMPHI-SYS COVID-19 Observational Registry has been collecting clinical and laboratory data from University Clinical Health (UCH), Church Health, and CCHS for research purposes. Growing the infrastructure to supporting COVID-19 related research will be essential to achieve the overall objective of improving the health of Tennesseans. Resources such as EDWs, patient registries, and biorepositories can facilitate research at all levels. Coupled with the results of large-scale multi-omics studies, data from EDWs, registries, and biorepositories facilitate high-dimensional analytic modeling that can lead to individualized treatments and improved outcomes (precision medicine). Operationally, UTHSC has streamlined the process for submission and approval of IRB protocols to facilitate projects across institutions. A similar streamlining of the credentialing and approval process for research personnel at partner institutions would be desirable.

One continuing challenge is that the research mission of UTHSC does not always align with the clinical care mission of our partner health systems. A creative approach at the leadership level will be needed to resolve these conflicting priorities by identifying projects and programs of mutual benefit while continuing to emphasize the role of research and discovery as the foundation of modern medicine. Challenges in UTHSC's affiliation with health system partners need to be addressed promptly, to ensure the continued vitality of the institutional research mission. One efficient way to accomplish this objective is to initiate or strengthen alliances between UTHSC and alternate healthcare system partners. The inclusion on the hospital staff of physicians with top research credentials in specialty fields can raise the national reputation of the health systems and drive patient traffic, while advancing science and public health.

In summary, UTHSC's network of healthcare system partners is a robust engine for propelling the growth of basic, clinical, and translational research aimed at increasing knowledge and improving the health of Tennesseans. The EDW and CTN2 are crucial platforms that facilitate such research and continued institutional support for their maintenance and expansion is highly recommended.

F. The Veterans Administration (VA) as a partner in research

Strategic partnerships between UTHSC and the VA enhances team science at both institutions across multiple areas. These partnerships provide a way to improve concentrations and diversity of intra-professional research teams comprised of basic scientists, physicians, physical/occupational/speech therapists, nurses, psychologists, and others who can collectively address research health challenges of both veterans and the general population. The VA Healthcare System is home to a massive comprehensive, system-wide data warehouse, housing EHR and administrative data that are available for a range of epidemiologic studies, patient outcomes, health services, and clinical trials. These rich phenotypic data are complemented with genetic and genomic data that are generated as part of the Million Veteran Program. Major VA funding priorities that synergize with UTHSC strategic plans include traumatic brain injury; neurodegenerative diseases; rehabilitation medicine (amputees, cognitive, etc.); health disparities; women's health; metabolic syndrome; cardiovascular and renal diseases; and cancer, among many others, which align well with the UTHSC AoE. The Memphis VAMC is also a resource for specific patient cohorts suitable for clinical trials. VA funding for Collaborative Merit Awards facilitates joint research among multiple VA investigators with expertise at different centers. Due to the VA's unique regulatory environment, the most effective way to incorporate patients at the VA in clinical trials entails the involvement of VA investigators and funds earmarked for research coordinators. The VA represents an important partner in the collaborative recruitment of scientists, especially clinician-scientists, by providing partial or full salary support, laboratory space, and access to VA intramural grants for clinical and basic research. However, because the VA has no mechanism to supply start-up funds to newly hired investigators, the VA relies on university partners such as UTHSC for this key facet of recruitment. The VA also offers Career Development Awards, which are the equivalent of NIH K awards, for early-career investigators and Research Career Scientist Awards for basic scientists at all levels.

G. National and international collaborations in research

UTHSC is a beneficiary of as well as a contributor to national and international health research. To stimulate national and international collaborations in basic, translational, and clinical research, existing relationships must be strengthened, and new ones forged, in coordination with the CCP in Global Health. The Associate Vice Chancellor for Research and Global Partnerships (AVCR-GP) will continue to provide administrative and strategic coordination that fosters and creates operational alliances of interdisciplinary researchers. The AVCR-GP will establish and maintain, on a global scale, recognition of the faculty in the AoE and the Focus Areas they encompass, by identifying and promoting multi-disciplinary research links and engagement within the faculty, across the university, and with national and international organizations. In the basic research space, the AVCR-GP will coordinate with partners who have already developed Research Collaboration Agreements (RCA) with UTHSC (e.g., ORNL, SR) and strive to continually develop similar partnerships. With the emerging Neurotoxicology Focus Area developed for the Behavior and Brain Diseases AoE, the AVCR-GP will rekindle former plans to develop an RCA between UTHSC and the National Center for Toxicological Research (NCTR) in Little Rock, Arkansas. In the translational research space, the AVCR-GP will prioritize the growth of industry partnerships with local health science industries, especially those represented on the TennIRM advisory board,

(e.g., Medtronic, Smith and Nephew, Stryker, and Bioventus), and will work closely with UTRF to move UTHSC-born discoveries from the bench into the translational stage, e.g., through companies such as Revotek, USA, RxBio, Inc., and U.S. Biologics. In the clinical research space, the AVCR-GP will coordinate with the OSPR-2 CCP in Global Health to create and foster opportunities for global partnerships in advancing clinical investigation. We will work closely with the CTIAB to broaden the network of clinical trial partners in the state of Tennessee, nationally and globally. The AVCR-GP will also evolve strategies to significantly enhance these relationships by working with the ORD to identify and assist faculty with multi-institutional and/or large multi-disciplinary grant and contract submissions.

To stimulate such interactions at the basic, translational, and clinical research levels, the AVCR-GP's office and the researchers within the OSPR-2 CCP in Global Health will develop innovative internship programs for international trainees to aid in the development of global connections and collaborations and to enhance the UT research environment. Towards this goal, the AVCR-GP will continue to develop cooperative agreements with global academic medical institutions in the AoE and the Focus Areas. Such collaborations will include continuation of our research and training collaboration with West China Hospital-Sichuan University, Harbin Medical University, and Zhengzhou University. We will explore the development of new collaborative and training agreements with other potential prospects in Africa, Europe, and Asia. We will utilize the international CORNET pilot grant program and will seek other sources of funding for launching new collaborations. Additionally, the AVCR-GP will work with the relevant administrative offices to ensure that systems are in place to maximize opportunities and experiences for global research partnerships, including coordination with Human Resources, the Postdoctoral Office in UTHSC's CGHS, and the Office of International Affairs to create seamless interactions across institutions. We will coordinate with the International Outreach Program at SJCRH. In short, the AVCR-GP will enhance UTHSC's connectivity within an international network of outstanding researchers.

ENTREPRENEURSHIP

Continuing to grow the research enterprise is one of the primary ways that UTHSC achieves its mission of improving the health of Tennesseans. Entrepreneurship, including building an entrepreneurial culture within the research faculty, is vital to this growth. Granting organizations often require translational plans that show a clear path from innovative research to outcomes for patients. Great research faculty members expect a fully functioning research environment at UTHSC, which includes the services and infrastructure to support them if they should decide to develop companies that stem from their research at UTHSC. The components of an entrepreneurial support ecosystem are **training programs** to teach the business skills needed to be a successful research company founder, **seed funds** to enable proof-of-concept validation work, fully functional **incubators** to support fledgling companies, available **seed- and venture investments** to fund the initial startup company, and deep connections to the **entrepreneurial ecosystem** in the community in which they reside. Moreover, the changing startup landscape also benefits from connections to corporations. Deep sector knowledge can encourage the academic research enterprise to consider different approaches, in some cases with out-of-the-box entrepreneurial activities that make the traditionally conservative university culture uncomfortable. UTHSC has made progress in this area and there is much more work to do.

Considering faculty-inspired innovation in the biomedical sector, the most common pathway is research funding that leads to technology disclosures, ultimately resulting in defensible, UTRF-prosecuted patents that are licensed to a new or existing business. The Office of Research launched the CORNET awards in 2016 to grow new grants and intellectual property. As of October 2021, external funding related to CORNET awards has reached \$29,249,612, an ROI of 12.94 for a ~\$2.3 million investment. In fiscal year 2020, IP disclosures from all UTHSC campuses reached a record of 66 new inventions disclosed, compared to just 38 new inventions in FY2016. Over the same period, annual IP licensing agreements increased from six new agreements signed in 2016 to 21 new agreements in 2020.

UTRF and the Office of Research have a strong and productive working relationship. Vice Chancellor Goodman holds a seat on the UTRF Board of Directors and chairs the HSC Office Executive Committee, an advisory board that oversees the office headed by Dr. Richard Magid. Dr. Magid works closely with the Office of Research on campus entrepreneurial efforts and on CTN2. By example of their joint efforts, during the period 2016-2020, Drs. Goodman and Magid secured a \$500,000 grant from the Department of Commerce (DOC) Regional Innovation Strategies (RIS) i6 program to support the CORNET awards, the UTRF Maturation Grants, and a UTRF Entrepreneur-in-Residence position.

Access to separate, full-service laboratory incubators is a key expectation of faculty and mandatory for application for a Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) grant. Solving this issue was a primary recommendation of our last plan. An initial solution to this was piloted in Memphis 2018, when UTHSC formed a partnership with the Memphis Bioworks Foundation to provide a dedicated Innovation Lab for our research faculty in the Bioworks building, adjacent to the university. UTHSC made a turnkey lab space available for up to 12 months, at no cost to researchers, as they developed their IP in anticipation of submitting an SBIR and/or STTR grant proposal. New companies using the Innovation Lab were required to submit at least one SBIR and/or STTR grant application during the year of occupancy. This was a good solution and several researchers who received Innovation Lab access have gone on to win SBIR grants with their companies.

Because the Memphis building that housed the Innovation Lab was recently sold, the Office of Research has continued to collaborate with the operations team to reposition the 30,000 sq ft. on-campus Van Vleet building as the UT BioBusiness Incubator (UBBI). The UBBI will be laboratory space coupled with related incubator services for faculty startups. Efforts to move faculty into the Van Vleet building have begun, as have efforts to recruit tenants with UTHSC connections from the former Bioworks facility.

An incubator that simplifies the scale up from lab to early phase production is also needed. The Plough Center for Sterile Drug Delivery Solutions serves this purpose for initial drug production, but product development outside of this requires other capabilities. UTHSC purchased the existing 30,000 sq ft. old food bank building just adjacent to the Plough Center facility and is considering its build out for this purpose.

One of the main obstacles to a successful transition from scientist to entrepreneur is the need for mentors and accessible programming to overcome a potential lack of business experience in areas such as management, finance, and development of business strategies. Recognizing and emulating success stories is an important way to overcome these concerns. To bring successful faculty-based entrepreneurs to campus, UTHSC started the Launching Entrepreneurial Activities and Discovery in Science (LEADS) seminars. The LEADS program invites successful and engaging entrepreneurial scientist founders to relay their entrepreneurial stories to UTHSC researchers across the state. Since its launch in 2017, there have been five LEADS talks at UTHSC. The Health Sciences Entrepreneurship Grand Rounds seminar series is a multi-institutional webcast series featuring successful and engaging scientists who have proven experience in entrepreneurial ventures. There have been 25 talks presented to UTHSC, with four of these presented by UTHSC faculty. UTRF conducts a bimonthly Tech Talk series that covers both the basics of IP and commercialization as well as more advanced topics in this field.

One additional model suggested by faculty members is to leverage entrepreneurship education and business seminar courses offered by colleges of business across the state. There are too many examples of entrepreneurship by individual faculty members to detail them here. One example of institutional entrepreneurship was the formation and implementation of the non-profit CTN2, formed in partnership with UTHSC, UTRF (as a subsidiary), and 13 clinical care providers. In 3 years, CTN2 has brought more than 300 clinical trial opportunities to UTHSC and captured clinical trial contracts valued at more than \$12,000,000. Contracted clinical trials include six for COVID-19 related research. CTN2 is led by the Vice Chancellor for Research, supplemented with an Executive Director from outside the university structure who has extensive experience in executing clinical trials.

Seed funding for new ventures is the hardest capital to find. Internally, the pre-commercial CORNET awards should continue to be supported and expanded, including CORNETs focused on projects with high IP and translational promise. UTHSC must formulate and execute a strategy to bring seed funding in the form of equity investments for faculty spinouts that participate in its entrepreneurship program. Our goal would be to create a small evergreen seed fund that could invest up to \$1,000,000 per year into faculty-led companies. Seed funding will be most effective when focused on areas of research strength, such as drug discovery and regenerative medicine. Currently, we are not aware of any entrepreneurship-focused regenerative medicine accelerator programs in the country and believe that UTHSC should offer the first to take and cement a leadership position in this field.

Looking forward, we must maintain what is working and continue building additional programs that support the innovative spark of entrepreneurship that is found in so many UTHSC researchers. Specifically, new programs that deliver access to investment for first-in-human studies will offer the highest potential return. UTHSC is proud of its innovative researchers across the state and the Office of Research must consider programs and planning in each location that houses research faculty. To execute this vision, UTHSC has added an Associate Vice Chancellor of Research and Entrepreneurship (AVCR-E) to implement the statewide vision of the entrepreneurship plan. In addition, UTHSC has attracted an Associate Vice Chancellor of Research and Business Development (AVCR-BD) to assist the Office of Research, UTRF, and UTHSC in developing an angel investor group fund and showcase UTRF/UTHSC startups to venture investors.

PHILANTHROPY TO SUPPORT RESEARCH

History

In FY2018, the Chancellor and the UT Vice Chancellor for Development and Alumni Affairs approved the establishment of a philanthropy program to support research at UTHSC. The program's focus and philanthropic support is strategically managed by the Vice Chancellor for Development and Alumni Affairs and the Vice Chancellor for Research. The Vice Chancellor for Development and Alumni Affairs assigned a Sr. Director of Development for tactical philanthropic support.

The inaugural fundraising plan for attaining philanthropic support of the Office of Research was launched with three specific goals:

- 1) Build an engaged, internal ecosystem and supporting cast
- 2) Identify priorities and collateral materials
- 3) Target best prospects for giving and begin relationship development

The internal ecosystem includes three major groups:

- 1) Research. The Vice Chancellor for Research, consortium and institute directors, core lab directors, and advisory committee members
- 2) Development. The Vice Chancellor for Development and Alumni Affairs and the Senior Director of Development
- 3) Volunteers and philanthropic supporters. These include corporations, foundations, alumni, and non-alumni

Accomplishments for FY2019 – 2021

- 1) Strategic priorities with philanthropic needs that were identified by the Vice Chancellor for Research include institutes and consortia, institutional research cores, and special programs such as clinical trials, administration, and conferences.
- 2) Fundraising fundamentals review sessions were delivered to various department heads and PIs in five colleges.
- 3) Three advisory committees were launched, including TennIRM, clinical trials, and the TN-PHC.
- 4) The Office of Development and Alumni Affairs, in collaboration with ORD and OSP, developed a clearinghouse of corporations and foundations that allows investigators to coordinate and identify which prospects require UTFI's involvement for relationship building and proposal submission.
- 5) Established *Research Insiders*, a group of corporations, foundations, and individuals with a general interest in promoting research or supporting specific research at UTHSC.
- 6) In FY2021, \$2.03 million was raised from corporate and foundation sources to support research-related initiatives. Funding was secured to support TN-PHC, core equipment, the Vice Chancellor for Research Distinguished Lecture Series, and conferences hosted by the Office of Research.

Goals for FY2022 – 2026

- 1) Raise at least \$20,000,000 or more in cumulative philanthropic support for research priorities throughout the planning period (FY2022-2026), as jointly approved by the Vice Chancellor for Research and the Vice Chancellor for Development and Alumni Affairs.
- 2) Cultivate existing advisory committee representatives for individual philanthropic investments.
- 3) Identify and create new advisory committees and members, as needed.
- 4) Grow and engage *Research Insiders* toward advocacy and increased philanthropic support.

RESEARCH INFRASTRUCTURE

At a time of continued increasing competition for extramural grants and contracts, it remains essential that the Office of Research continues to provide investigators with an outstanding research infrastructure that will enhance their productivity and grow the overall research enterprise. Importantly, the Office of Research should continue to foster an environment in which all investigators have access to efficient support services and infrastructure, regardless of their physical location and whether they are working within UTHSC or collaboratively on a local, regional, national, or multi-national scientific initiative.

OSPR-1 identified three specific infrastructure challenges that threatened the productivity of our researchers and, as such, required specific attention by the Office of Research. These were: 1) the quality of the LACU, a critical institutional research core that serves campus investigators whose research involves laboratory animals; 2) the need to expand and strengthen the Grants and Research Agreements (GRA) office to provide an integrated support center that facilitates the pace of research; and 3) review the activities and policies related to university compliance (e.g., IACUC, IRB, IBC, RSC, and ORSA), with the goal of streamlining processes and reducing unnecessary burdens on investigators. Outstanding progress has been made in these and other areas, as follows.

1) In 2017, the LACU staff and leadership were completely reorganized. The appointment of a new Director was followed by a re-derivation of all standard operating procedures (SOPs), policies and staff training practices. A critical centerpiece of the reorganization was the new requirement that all husbandry staff achieve a minimum level of American Association for Laboratory Animals Science (AALAS certification appropriate for their position, with the result that the LACU staff members are now 100% AALAS certified. Importantly, training toward these industry standard certifications has been routinely incorporated into the LACU's continued proficiency training. The reorganization also included the creation and hiring of a Director of Operations, an Assistant Operations/Quality Assurance (QA) Manager, and a Training/QA Coordinator. The staff members who occupy these positions are responsible for the ongoing quality improvements of the LACU, implementation and assessment of both initial and continued staff training, and facility QA monitoring. In the spring of 2018, these LACU enhancements led to a three-year re-accreditation of the facility by Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC), with no mandatory findings for correction. The OSPR-2 recommends that the LACU should continue its program of facility improvement and efficiency by applying its ongoing training in Lean Six Sigma principles.

2) In 2017, sponsored programs staff who were previously housed in the Office of Finance were transferred to a newly created unified Office of Sponsored Programs (OSP), previously known as GRA. To improve efficiency, the unification process crafted by the Office of Research centered around a team-based approach, thereby creating an economy of scale, providing the opportunity for enhanced communication among personnel, and increasing efficiency. A new and highly experienced Associate Vice Chancellor for Research – Office of Sponsored Programs (AVCR-OSP) was also hired. There was also a significant financial investment in additional contracts administrators and grants administrators. The unified office developed new procedures that govern its function. Taken together, these changes have enhanced communication with sponsors and faculty, thereby improving both customer service and OSP performance, especially in the domain of turnaround times on contracts (uthsc.edu/research/sponsored-programs/dashboard-metrics/average-days-instrument-type.php). With grants and contracts continuing to grow at an average rate of ~7% per year, the Office of Research should implement a plan for a commensurate expansion of OSP, which will be critical for the OSP administration to keep pace with the increased volume of basic and clinical research activity.

3) Since the inception of OSPR-1, the Office of Research has maintained an ongoing review of activities and policies related to all areas of research compliance, namely, the Institutional Animal Care and Use Committee (IACUC), Institutional Review Board (IRB), Institutional Biosafety Committee (IBC), Radiation Safety Committee (RSC), and the Office of Research Safety Affairs (ORSA). The fundamental goal is to streamline processes and enhance compliance activities through increased direct customer service-oriented interactions with faculty. In broad brushstrokes, the ongoing review of each compliance committee by Office of Research has reduced unnecessary regulatory burden, provided researchers with clear regulatory guidance related to their specific research activities, and streamlined the submission and review processes. Taken together, the result of these

cultural and operational changes has decreased the time required for approval of the respective research protocols. With specific regard to the IRB, the ongoing growth of clinical trials at UTHSC and the long-term success of UTHSC's CTSA application will require that the IRB obtain accreditation from the Association for the Accreditation of Human Research Protection Programs (AAHRPP). The Office of Research should aggressively pursue this accreditation goal through both continued financial support of the HRP Consulting Group that is currently assisting in the process and increased IRB staffing.

Beginning in 2017, the ORSA leadership and staffing were completely reorganized. Under the leadership of a new director, ORSA achieved the necessary staffing complement and a dramatic shift to a culture of customer service. The office established standard operating procedures, policies, services, and campus training practices that previously did not exist. This overhaul was essential to establish a viable program that ensured the development and delivery of safety, health, and environmental laboratory management program services directly related to the research enterprise. The Office of Research should continue to support the development of innovative laboratory training practices that promote better learning outcomes among a diverse community of researchers.

METRICS AND DASHBOARDS

ORSP-2 provides a five-year roadmap to the growth of research at UTHSC. The Chancellor's robust goal of doubling research over a 10-year period will require an 8% compounded growth that started during OSPR-1 and will continue over the next five years. The metrics and dashboards presented below will allow the UTHSC community to follow the Office of Research's progress toward our common goals and to measure achievements or shortfalls in reaching short and long-term strategic objectives. We will track our progress as compared to similar health science centers and universities ([Appendix 2](#)), using the number of FY2020 dollars awarded as a baseline.

Goal: Increase our UTHSC research grant awards by 8% annually

Metrics:

- 1) Total annual extramural dollars funded based on award statements
- 2) Total direct and indirect dollars awarded annually
- 3) Federal percentage of total award dollars (Annually)
- 4) Total direct and indirect award dollars generated by:
 - a) Campuses
 - b) Colleges
 - c) Departments
 - d) Centers and institutes
 - e) Clinical trials
 - f) Students and postdoctoral fellows
 - g) Industry sponsored research
 - h) Program project or center grants

Goal: Increase UTHSC entrepreneurial activity by 8% annually

Metrics: A sample of cumulative award dollars is available in [Appendix 3](#).

- 1) Annual invention disclosures
- 2) Annual revenue from licenses
- 3) Annual U.S. Patents issued

Goal: Increase research productivity, collaboration, and impact related to each AoE and CCP

Metrics: We will use the Scopus dashboard for our institution to generate the following metrics for each AoE and CCP. A sample of these metrics are available in [Appendix 4](#).

- 1) Number of publications per year
- 2) Number for documents by subject area
- 3) Average CiteScore for top 10 journals
- 4) Total document count for the top 15 research partnerships
- 5) Number of documents by funding sponsor
- 6) H-index for subject area

Goal: Increase mentorship and collaboration across campuses and UTHSC institutions

Metrics:

- 1) Total number of publications that have both junior and senior faculty on the author list, divided by the total number of junior faculty (will require linking UTHSC data and Scopus, which is achievable)
- 2) Number of inter-departmental collaborations, as measured by the number of publications for each pair of departments.
- 3) Number of inter-college collaborations, as measured by the number of publications for each pair of colleges.

Goal: Develop research partnerships in the region, state, nation and globally

Metrics:

- 1) Total direct and indirect award dollars per year based on collaborations that were
 - a) stimulated by the CORNET awards
 - b) with other state, national and international institutions

- 2) Number of research contracts between UTHSC faculty and other academic/non-profit/commercial/industry institutions stratified by whether UTHSC faculty member was the lead PI or the subcontractor
- 3) Number of co-authored publications with faculty members from other institutions
- 4) Number of international trainees (students/fellows) who intern at UTHSC

Goal: Hire 50 new UTHSC faculty members within the AoE, Focus Areas, and CCP. At least 35% of these new faculty members should arrive with extramural funding at the equivalent of a career development award (society or NIH), R21 (or society/foundation equivalent), or better. New faculty members who arrive without extramural funding should be extramurally funded within three years of arrival at the level of a career development award, R01, or better. Retention over five years should be 90% or greater for those faculty members who arrive with funding or who receive funding within three years.

Metrics:

- 1) Hire 10 new research faculty members per year over the next five years
 - A) Number of new research faculty members who arrive annually with appropriate extramural funding
 - B) For new research faculty members who do not arrive with extramural funding, the number who are awarded appropriate funding within 3 years of arrival
 - C) Percentage of these new funded research faculty members who are retained over rolling five- and ten-year periods, with stratification of those leaving the institution as voluntary or involuntary
- 2) Number and percentage of faculty members hired within each AoE or CCP
- 3) Percentage of research faculty members who join UTHSC research centers and institutes

Goal: Increase the research laboratory and office space to accommodate these new researchers and the targeted 8% annual increase in research expenditures. As described in the UTHSC Allocation of Research Space Plan, colleges should maintain 10–30% of their total assignable research space vacant for new initiatives, new hires, expansion of successful researchers and departments, and swing space.

Metrics:

- 1) Annual percentage of total space renovated for research
- 2) Annual percentage of growth of research space
- 3) Annual percentage of research space that remains vacant
- 4) Annual available research laboratory/office space ratio
- 5) Federal indirect cost rate as research space expands

Goal: Over five years, move 10 positions higher on the ranking of academic health centers, based on total amount of NIH dollars awarded annually. To obtain large increases in institutional extramural grant awards, we will need to recruit and grow our own research stars, who would have the needed cache to serve as magnets to draw other research leaders to UTHSC.

Metrics:

- 1) Institutional and individual research recognition
- 2) Institutional NIH ranking
- 3) Number of UTHSC members of the National Academy of Science
- 4) Number of UTHSC AAAS fellows

The Office of Research will coordinate with the Office of Institutional Effectiveness to define, track, and interpret parameters of success and to establish a culture of mission-based management. Together we will develop measurement dashboards and scorecards to monitor and manage progress towards the goals and objectives outlined above.

MITIGATION PLAN

Performance on the metrics described above will be evaluated annually by the Vice Chancellor for Research's Research Cabinet, which will provide a written report to the Vice Chancellor for Research. The Vice Chancellor for Research will share this report with the Research Council for their review, highlighting areas of success and areas where metrics were not met. For those metrics that are not met, the Vice Chancellor for Research and the responsible stakeholders will develop a set of recommendations for a mitigation plan to meet the goal in a defined timeframe proposed to revise the metric. A triennial analysis by the Vice Chancellor for Research's Research Cabinet will include a description of the broader changes that need to be made to OSPR-2 to reach the goals stated in this document and the resulting report will be shared by the Vice Chancellor for Research with the Research Council for review, approval, and implementation.

APPENDICES

Appendix 1

Results from the faculty survey administered to UTHSC faculty members in February 2021. There were 241 survey respondents from across UTHSC campuses, 221 housed on the Memphis campus, 3 on the Nashville campus, 14 on the Knoxville campus, and 3 on the Chattanooga campus. Ninety-one faculty members had achieved the rank of full professor, 64 were associate professors, 66 were assistant professors, and 20 reported a rank of “other.” Most were from the College of Medicine (n=159), with 26 from the College of Dentistry, 16 from the College of Health Professions, nine from the College of Graduate Health Sciences, 14 from the College of Nursing, and 15 from the College of Pharmacy. Figures 1-4 show the results of the relative importance rankings of the AoE and CCP to the respondent’s program of research. Note that by consensus vote of the OSPR-2 committee, the “Developmental/Lifespan Research” Cross Cutting Platform from OSPR-1 was removed and these topics were integrated into each of the AoE, as appropriate.

Please rank, with 1 being most relevant and 7 being least relevant, the relative importance of the following areas to your own program of research now.

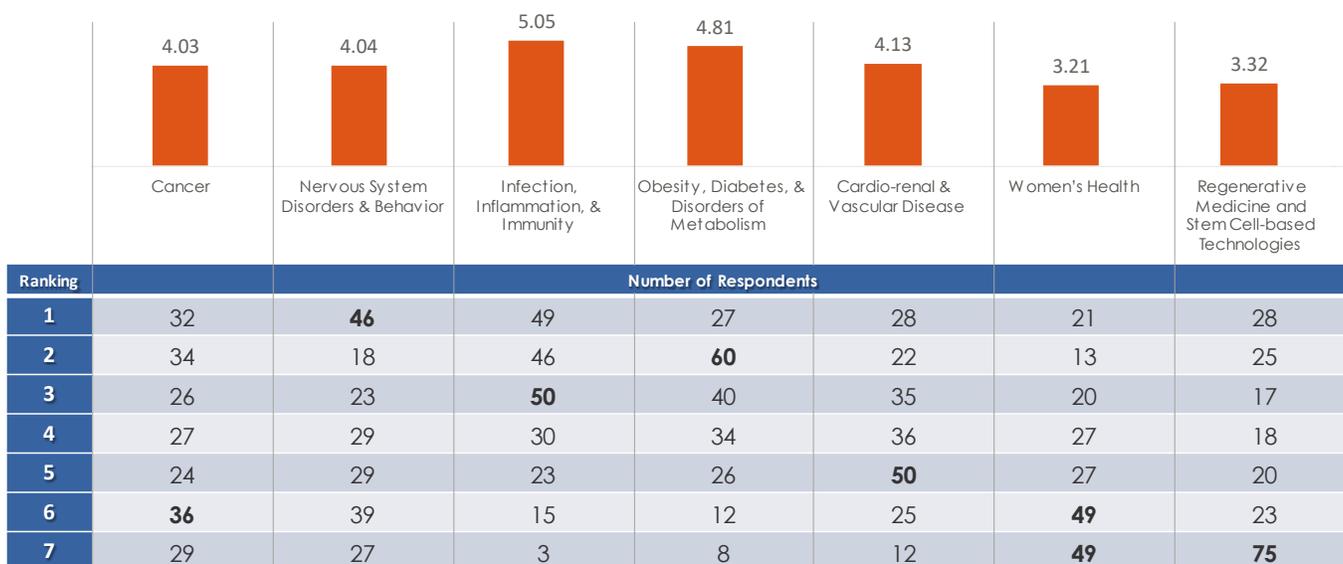


Figure 1. Rankings of the importance of research areas to your current program of research.

Please rank, with 1 being most relevant and 7 being least relevant, the relative importance of the following areas to your own program of research in the next 5 years.

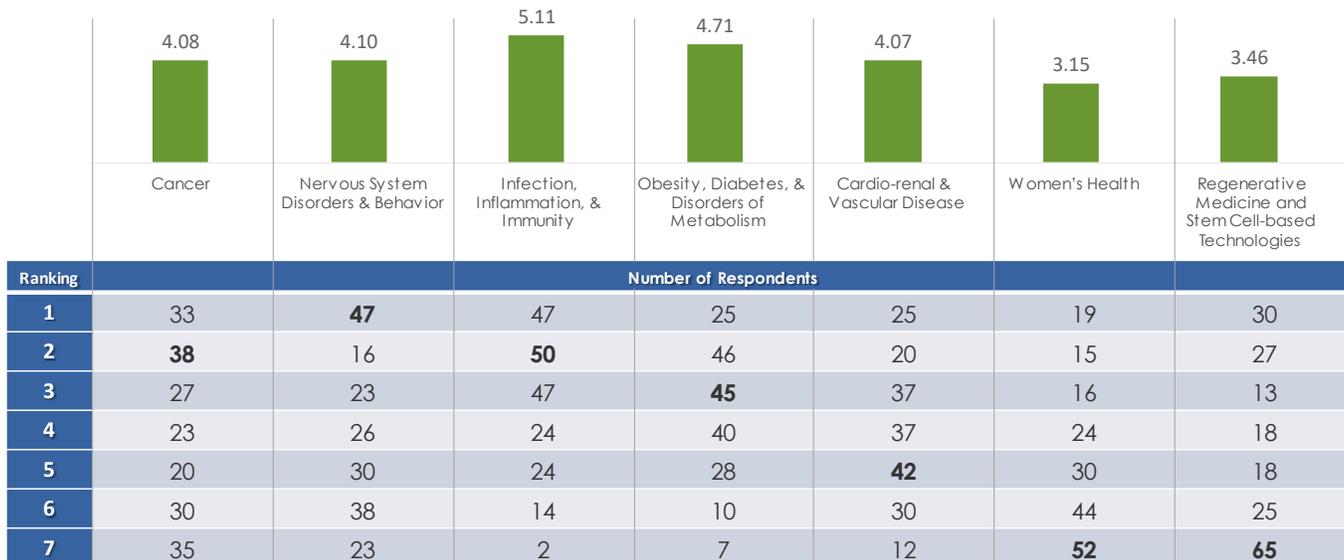


Figure 2. Rankings of the importance of research areas to your program of research in the next five years.

Please rank, with 1 being most relevant and 5 being least relevant, the relative importance of the following cross-cutting platforms to your own program of research now.

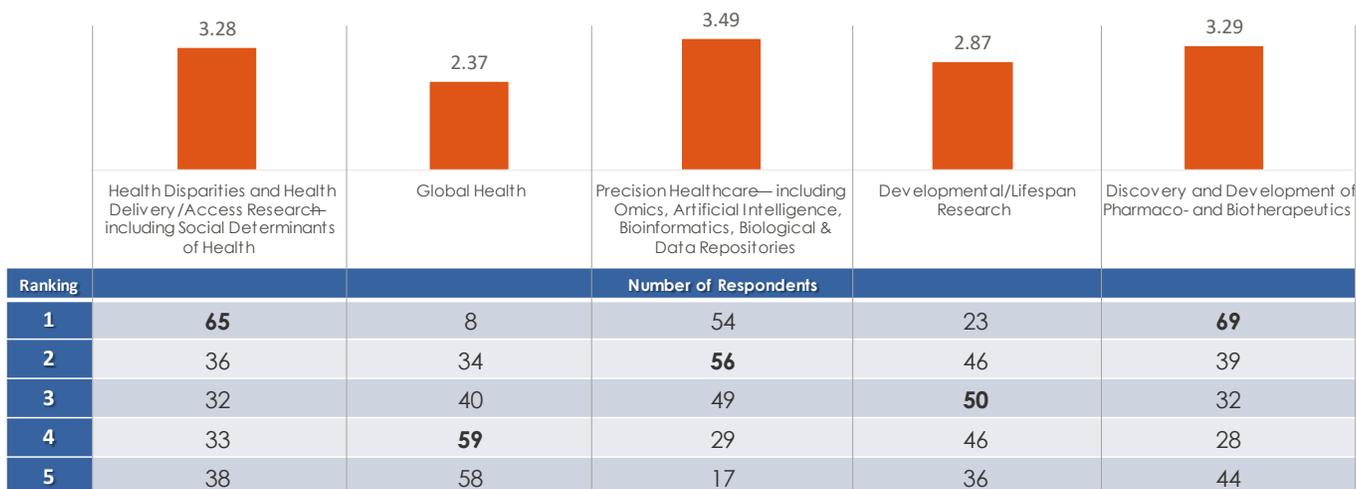


Figure 3. Rankings of the importance of cross cutting platforms to your current program of research.

Please rank, with 1 being most relevant and 5 being least relevant, the relative importance of the following cross-cutting platforms to your own program of research in the next 5 Years.

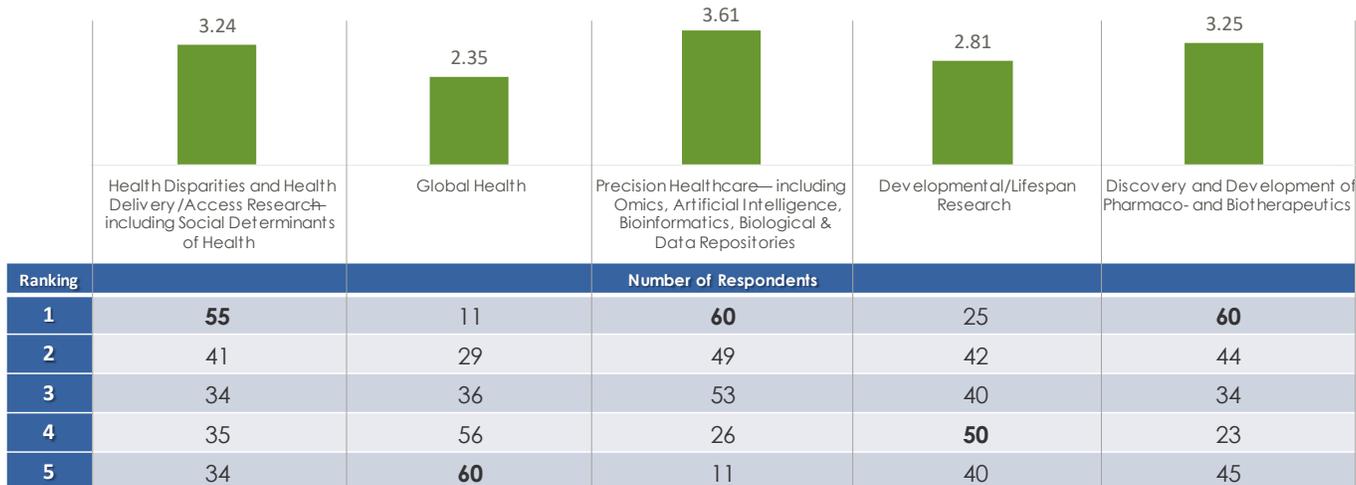


Figure 4. Ranking of the importance of cross cutting platforms to your program of research in the next five years.

Appendix 2

Data was derived from the NIH Reporter and the National Center for Education Statistics (NCES).

NCES: <https://nces.ed.gov/ipeds/datacenter/SelectVariables.aspx?stepId=1>

NIH Reporter: <https://report.nih.gov/award/index.cfm>.

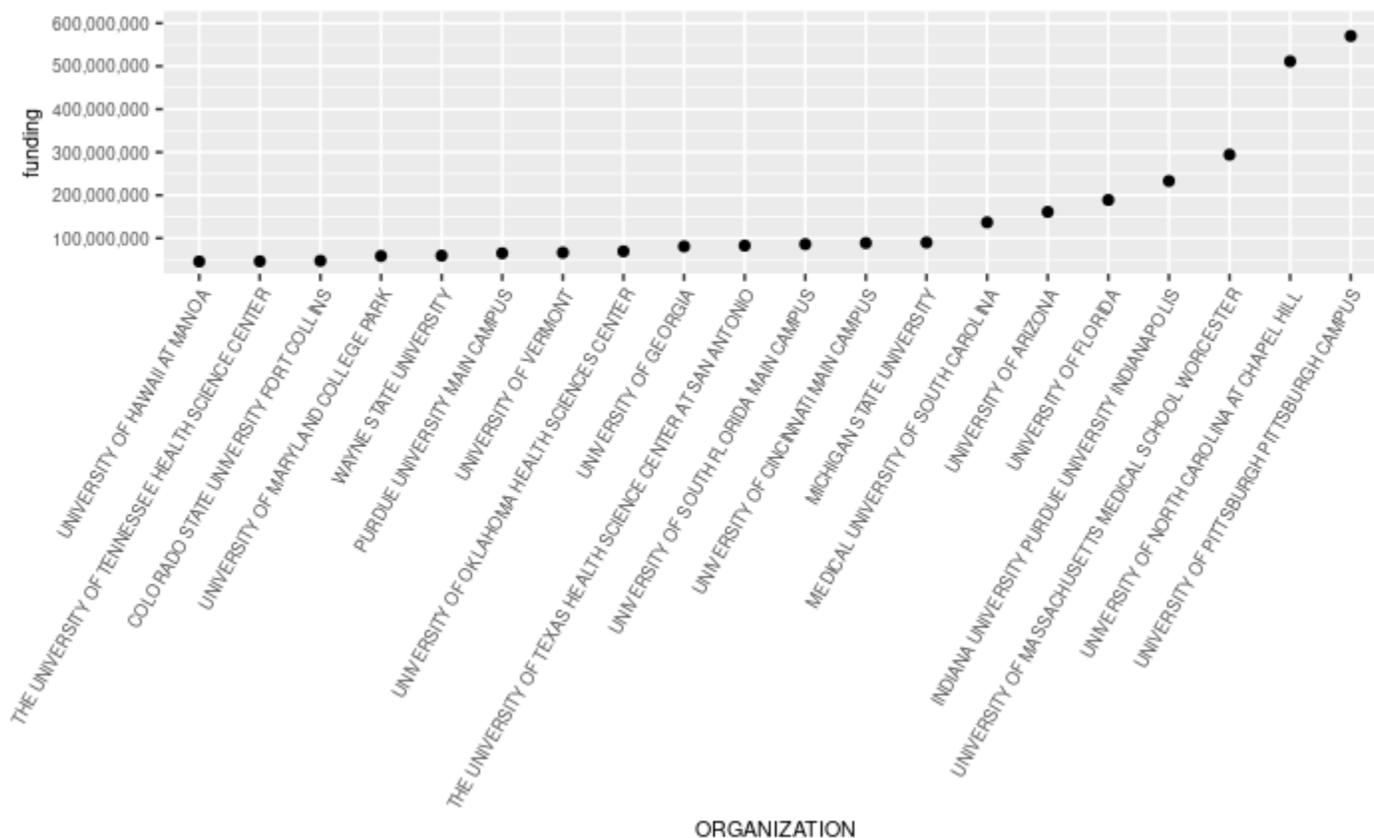
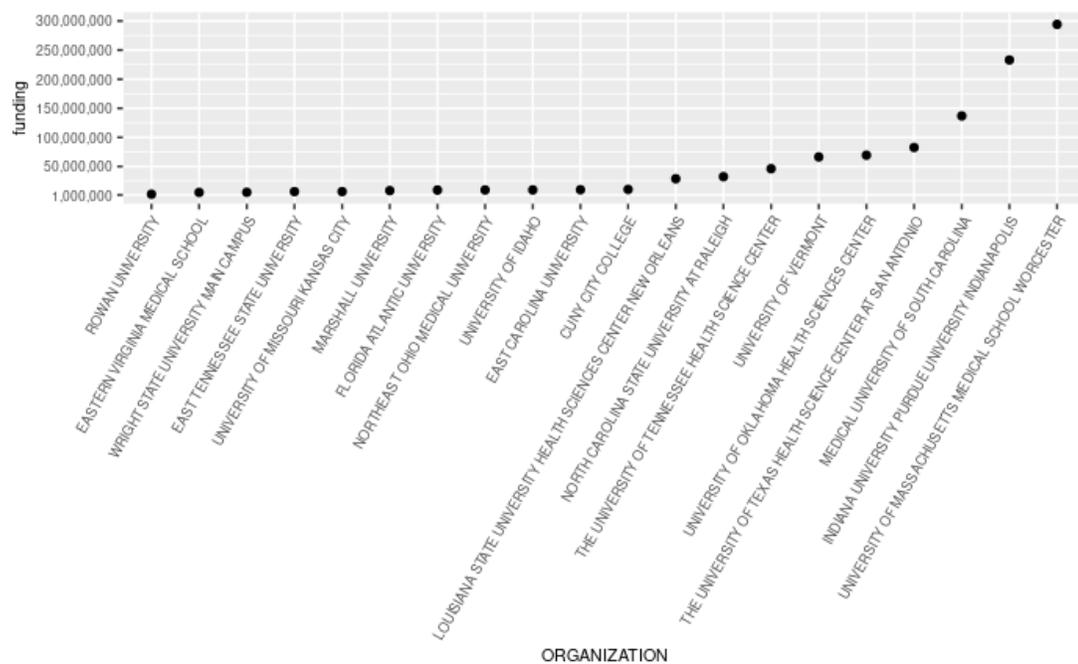


Figure 5. Similar Universities in top 20 of NIH Funding for 2020. UTHSC is ranked 19th in this group. This figure identifies the institutions that are public universities, that do not have a hospital (i.e., the institution did not report revenues from sales and services of hospitals GASB, hospital revenues (FASB), or expenses for hospital services (GASB or FASB), and that grant a medical degree, including Doctor of Medicine (M.D.; 51.1201), Dentistry (D.D.S., D.M.D.; 51.0401), Osteopathic Medicine (D.O.; 51.1901), or Veterinary Medicine (D.V.M.; 51.2401).



Appendix 3

Cumulative Award Dollars (Five Year, Year-to-Date Comparison)

This table provides a year-to-date comparison of the total number and total value of awarded projects for all UTHSC Colleges over the last five years. Data are added at the end of each month. The percentage change compares the current fiscal year to the first fiscal year in the results to date.

Keep in mind the effect of low values on a percentage change calculation.

College	FY17 #	FY17 Amount	FY18 #	FY18 Amount	FY19 #	FY19 Amount	FY20 #	FY20 Amount	FY21 #	FY21 Amount	Percent Change
Administrative Units	5	\$1,530,518	4	\$2,280,553	8	\$1,362,452	18	\$3,539,243	52	\$5,948,111	288.6%
Chat College of Medicine	6	\$65,608	3	\$182,500	1	\$415	2	\$136,095	0	\$0	-100.0%
College of Dentistry	11	\$272,583	7	\$245,248	6	\$175,134	8	\$945,105	7	\$1,109,257	306.9%
College of Graduate Health Sciences	0	\$0	0	\$0	2	\$47,362	1	\$45,046	1	\$196,879	
College of Health Professions	7	\$948,433	9	\$1,410,948	12	\$1,167,092	13	\$1,578,822	11	\$1,177,307	24.1%
College of Medicine	211	\$69,830,544	256	\$73,761,043	282	\$86,559,995	265	\$79,729,622	313	\$101,207,373	44.9%
College of Nursing	10	\$817,495	6	\$553,300	13	\$1,597,723	7	\$1,842,755	11	\$1,934,837	136.7%
College of Pharmacy	35	\$8,612,875	37	\$6,759,930	44	\$8,049,855	54	\$11,492,879	56	\$10,457,275	21.4%
Knox College of Medicine	26	\$2,923,744	28	\$3,016,082	16	\$1,169,923	16	\$1,485,752	29	\$4,568,175	56.2%
Total	311	\$85,001,799	350	\$88,209,604	384	\$100,129,951	384	\$100,795,320	480	\$126,599,214	48.9%

Figure 7. Cumulative Award Dollars, FY2017-2021.

Appendix 4

Publication analysis using Scopus data system. The UTHSC data can be accessed using the following link: <https://www.scopus.com/affil/profile.uri?afid=60002194>. You must first log in via our institutional access. These search results are based on querying our affiliation and women's health. We can work with the library to develop the best search string for each AoE and CCP. We can also provide these metrics of all UTHSC documents.

Search String:

(AF-ID ("University of Tennessee Health Science Center" 60002194) OR AF-ID ("Children's Foundation Research Center" 60014451) OR AF-ID ("The University of Tennessee Graduate School of Medicine" 60030751) OR AF-ID ("University of Tennessee College of Medicine Memphis" 60012655) OR AF-ID ("University of Tennessee College of Pharmacy" 60018156) OR AF-ID ("University of Tennessee Health Science Center College of Dentistry" 60016512) OR AF-ID ("UT Medical Group" 60022833)) AND (women's AND health) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016))

Results are limited to 2016-2020.

Variables from "Analyze search results." **These results are for documents related to women's health only.**

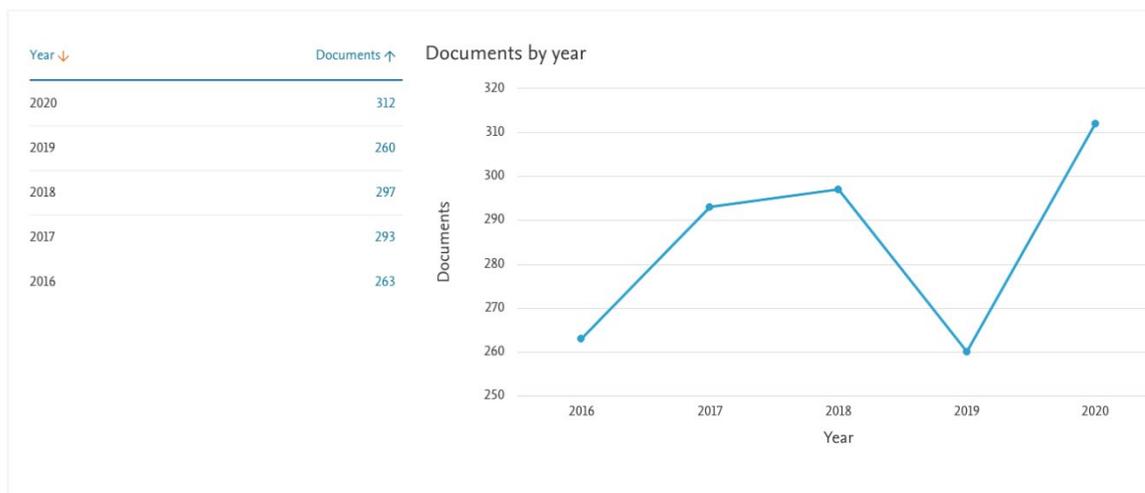


Figure 8. Total documents by year for UTHSC articles related to women's health.

Subject area ↓	Documents ↓
Medicine	1317
Biochemistry, Genetics and Molecular Biology	352
Nursing	110
Neuroscience	89
Pharmacology, Toxicology and Pharmaceutics	83
Immunology and Microbiology	77
Psychology	55
Social Sciences	52
Agricultural and Biological Sciences	43
Multidisciplinary	36
Health Professions	34
Chemistry	30
Dentistry	20
Environmental Science	19
Physics and Astronomy	18
Computer Science	16
Engineering	16
Arts and Humanities	14
Chemical Engineering	10

Documents by subject area

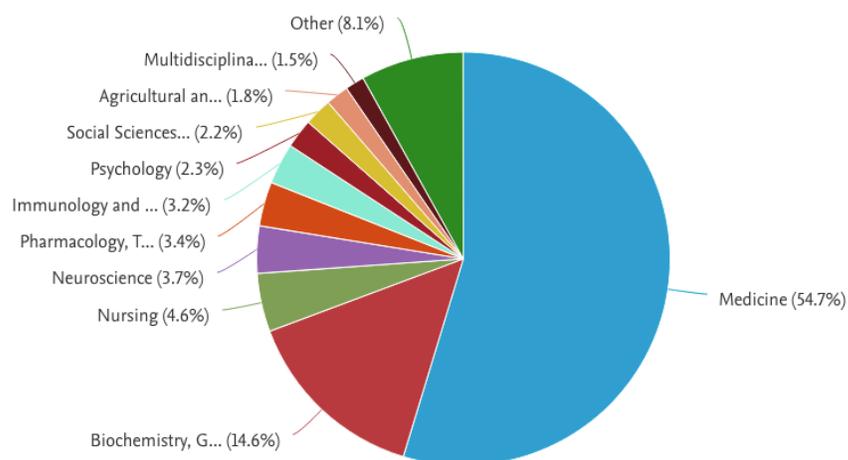


Figure 9. Documents by subject area for UTHSC articles related to women's health 2016-2020.

CiteScore publication by year 

Source 	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Journal of the National Comprehensive Cancer Network : JNCCN	5.4	7.2	7.4	6.1	7.7	8.2	8.7	10.3	11.9	14.4
Journals of Gerontology - Series A Biological Sciences and Medical Sciences	7.7	8.6	8.2	8.9	9.5	10.2	9.8	8.6	8.6	9.1
Obesity	7.8	8.1	7.4	7	7.1	7.2	7.3	7.2	7.2	7.1
PLoS ONE	4.5	4.1	4.4	5.1	5.6	5.9	5.7	5.4	5.2	5.3
Scientific Reports	0.2	1.1	2.4	4.2	4.2	4.2	4.8	6.4	7.2	7.1
American Journal of Kidney Diseases	9	9	8	7.6	8.5	9.2	10.2	10	10.4	10.7
Diabetes Care	14.6	16.3	16.4	16.9	19.8	21.9	23.7	22.8	22.3	23
Journal of the American Geriatrics Society	7.2	7.2	7.4	7.8	7.5	6.5	6.7	6.9	6.7	7.5
Journal of Clinical Endocrinology and Metabolism	11.5	11	11.4	11	11.2	11.3	11.4	10.9	9.8	8.5
Journal of Maternal-Fetal and Neonatal Medicine	2.4	2	2.5	2.7	3.1	2.4	2.3	2.6	3.1	3.2

Figure 10. Cite score for the top 10 journals in which UTHSC researchers publish. CiteScore 2020 is based on the number of citations received in 2017-2020 for five peer-reviewed document types (articles, reviews, conference papers, data papers, and book chapters) by a journal in the same four years, divided by the number peer-reviewed documents indexed in Scopus and published in those same four years.

Affiliation Documents 

 Harvard Medical School	183
 Brigham and Women's Hospital	175
 The University of Alabama at Birmingham	171
 St. Jude Children's Research Hospital	158
 University of California, San Diego	147
 University of California, San Francisco	138
 The University of Utah	131
 Cleveland Clinic Foundation	125
 University of Washington	121

Documents by affiliation

Compare the document counts for up to 15 affiliations.

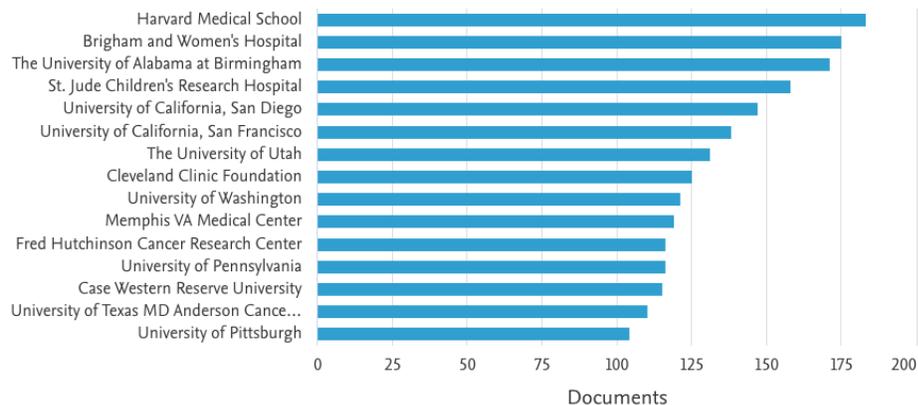


Figure 11. Collaborations with other institutions. These affiliations are derived from co-authors of UTHSC articles related to women's health 2016-2020.

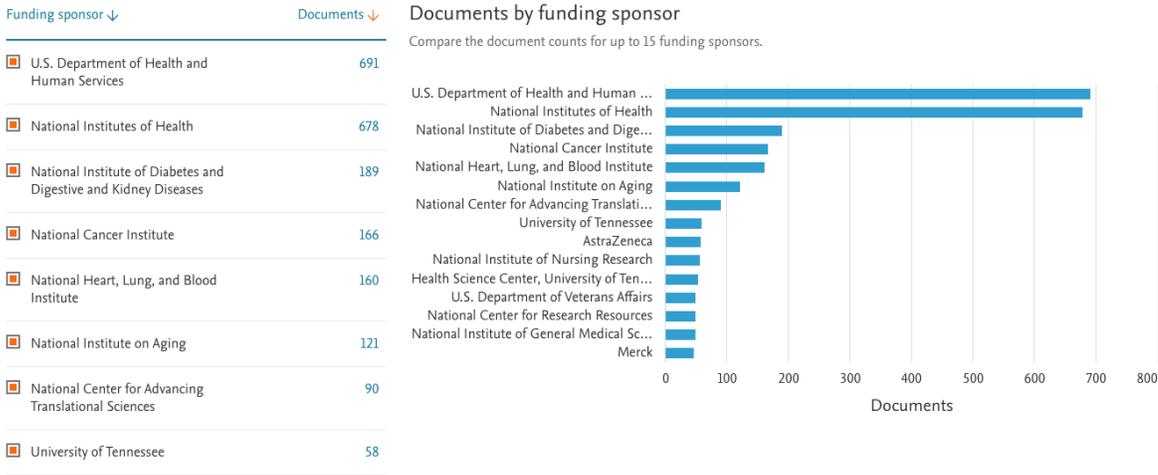


Figure 5. Number of publications mentioning funding sponsors for UTHSC articles related to women’s health 2016-2020.

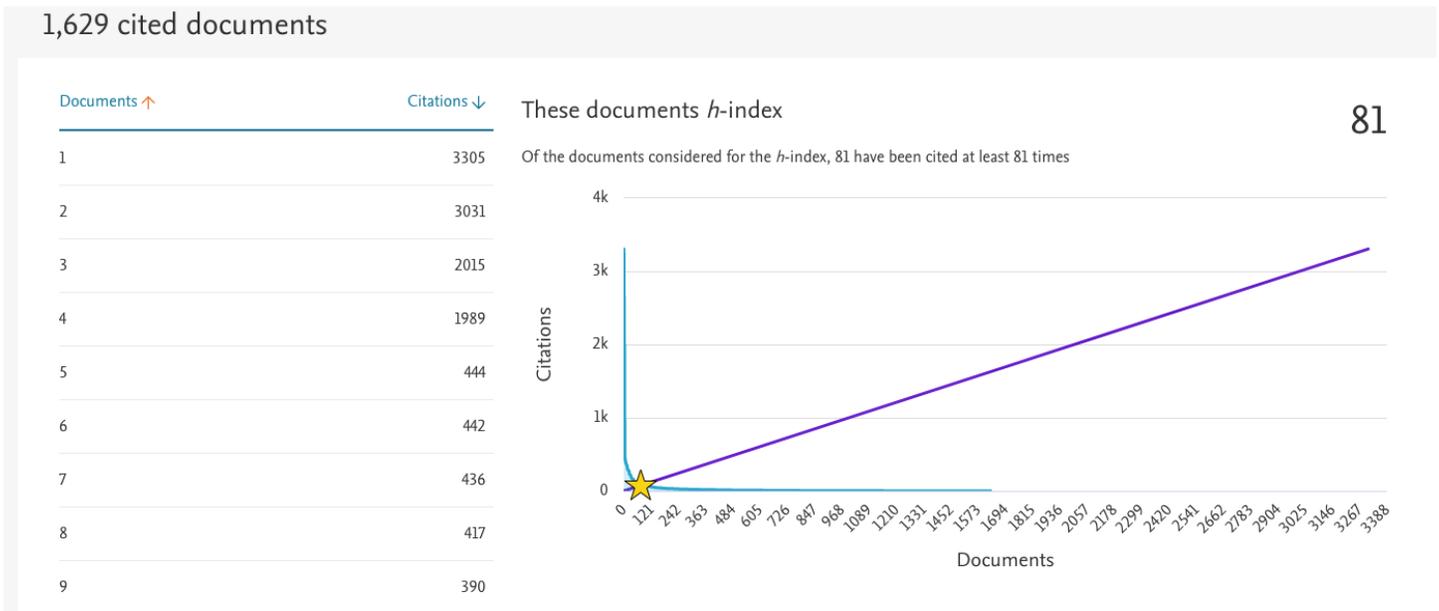


Figure 6. H-index for UTHSC articles related to women’s health 2016-2020.

Cross-Cutting Platforms

