

**Unifying UNC Charlotte's push to R1 status through a ONE HEALTH approach
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Leadership:

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We are applying in the category of **existing and emerging excellence**.

Colleges, schools, departments and units of faculty and university professionals participating in the **Bioinformatics Research Center**:

College of Computing and Informatics (Bioinformatics and Genomics, Computer Science)

College of Health and Human Services (Public Health Sciences)

School of Data Science (Health Informatics)

College of Liberal Arts and Sciences (Biological Sciences, Chemistry, Geography and Earth Sciences, Mathematics and Statistics)

College of Engineering (Engineering Technology and Construction Management, Civil and Environmental Engineering)

College of Education (Reading and Elementary Education, Educational Leadership)

Research and Economic Development (Research protections, COVID-19 Testing Center)

OneIT (University Research Computing)

Keywords: Pathogens, Pandemic, Health Equity, Preparedness, Ecosystem Health.

Executive summary

The ongoing pandemic has cost trillions of dollars, millions of lives, and continues to change society in ways we do not yet fully understand. SARS-CoV-2 marks the third recent transmission of a deadly coronavirus from animals to humans. It is clear that preventing future zoonotic disease transmission in tandem with managing and treating long-standing transmissible diseases (e.g., malaria) are major challenges in the 21st century. However, meeting these challenges requires a comprehensive and equitable perspective on human, animal, and ecosystem health. This interdisciplinary approach is often called ONE HEALTH¹. The approach has been accepted as an organizing theme across academia, medicine, and government on an international scale. By building research, technological, and social infrastructure that illuminates the underlying processes driving emergent disease we can develop resiliency against future threats.

The Bioinformatics Research Center (BRC) already has a network of well-recognized faculty dedicated to developing this resiliency with a ONE HEALTH approach. The BRC and our close partner, University Research Computing (URC) have significant equipment and network infrastructure that will be leveraged by many researchers, at all career stages, to transition to an internationally recognized research and education center. Federal agencies, including NSF, DoD, and NIH, have emphasized cross-disciplinary research and engagement as illustrated in ONE HEALTH in their respective future priorities. Our goals align with these regional and national priorities to reduce the overall impact of human diseases, reduce health disparities, and guide practices that increase ecosystem health. To these ends, members of the BRC from five Colleges are already engaged in projects focusing on infectious diseases including emerging zoonotic pathogens such as coronaviruses as well as difficult durable problems such as malaria, antibiotic resistance, food safety, and the socioeconomic burden of failing ecosystem and public health. We are doing this empirical work while countering misinformation through education, peer-reviewed publications, and public speaking.

We are now integrating epidemiological, ecological, biological, bioinformatics, evolutionary, and educational expertise to combat the spread of SARS-CoV-2. For example, the ONE HEALTH perspective is evident in the response of BRC associated researchers using wastewater surveillance to halt outbreaks of SAR-CoV-2 on campus. As illustrated within this nomination, we have demonstrated continued success in securing grants, contracts, publications, and media presence. With the careful guidance of University leadership, we are developing new research spaces and infrastructure. We also work very closely with University media relations to craft sound public health messages. With these investments, we are training and placing students and postdoctoral fellows in academia, health care, and industry jobs, particularly in the region. The dividends of this work are more economic opportunities in important fields such as biotechnology, medical genomics, and analytics that will be central to the expanding healthcare industry in the region. As an access institution with research and education in cutting-edge and societally crucial fields, our ONE HEALTH guided BRC research network presents the opportunity for students to **be and find** solutions to economic and associated health disparities.

¹ https://www.onehealthcommission.org/en/why_one_health/what_is_one_health/

Evidence of Strength and Excellence

We have assembled an interdisciplinary network of faculty, their teams, and University professionals to develop an area of excellence guided by the ONE HEALTH approach and led by the BRC (Table 1; brc.uncc.edu/directory). The selection of this nomination would continue the growth of this center into a unique research and education investment for the University as UNC Charlotte positions itself for R1 status and national recognition. Below is a summary of our leadership in funding, publications, infrastructure, operations, education, broader impacts, faculty recruitment, media, and civic engagement.

Funding and publications: Collectively, faculty in this network have received over \$18.66 M in extramural funding as Principal Investigators (NORM 2/11/16-2/11/21 exclusive of CARES) and published over 713 papers in the last 5 years (Google Scholar and Research Gate). BRC Co-Director, Dr. Janies has performed under contract for DARPA and DTRA in response to infectious diseases, received over \$1.846 M of extramural funding, and published 58 papers in the last five years. Dr. Janies works closely with Dr. S. Chen, Dr. Tang, and Dr. Demelle in modeling infectious diseases and socioeconomic factors in the burden of vector-borne diseases. Dr. S. Chen is the recent recipient of an NIH-NIGMS award and an NC Biotechnology grant. Drs. S. Chen, Janies, and colleagues have published four papers in 2020-21 focused on combatting SARS-CoV-2 and misinformation. BRC Co-Director, Dr. Reitzel has received over \$1.896 M of extramural funding through a combination of state (NC Sea Grant with Dr. Janies), federal (multiple NSF and NIH) and international (Human Frontiers) awards, is in negotiations for new funding (\$800K) and has published 77 papers in the last 5 years. These awards are related to the assembly and stability of bacterial and viral communities. These examples highlight the productivity of our research network and are just a few examples of many projects ongoing in the BRC.

Leadership in infrastructure: In partnership with University leadership, we have fostered significant investments, including 25,000 sq ft of research space being built to accommodate our growth. Dr. Janies serves as a Faculty advisory board member to the University Research Computing (URC) group and the One IT service advisory committee. This work entails planning for policy, funding, purchasing, and execution of upgrades. This work impacts all on campus and is crucial to R1 status given the need for cyberinfrastructure for research productivity and funding success. Close work between faculty and the URC/One IT is being accelerated by the new director of the URC, Dr. Chris Maher. Dr. Maher is leading, with several BRC faculty as co-PIs, for a proposal to NSF to build a science network that will serve high demand bandwidth and storage use cases, such as pathogen genomic sequencing. This work is a testament to the collaborative culture center and exemplifies how we work to achieve R1 status.

Leadership in campus operations: The environmental modeling laboratory that supports the wastewater surveillance project has broad capabilities to detect and sequence SARS-CoV-2 and any pathogens of concern to address issues such as food safety. Dr. Munir is a funded member of a state-wide collaboration tracking novel coronavirus outbreaks in water. Dr. Gibas, Dr. Schlueter, Dr. Janies are partnering with the Dr. Martins' in house SARS-CoV-2 testing laboratory to develop capacity for high-throughput sequencing and computational analysis of SARS-CoV-2 variants. The team also involves faculty with expertise in geographic information and spatiotemporal modeling (Dr. Tang and Dr. Demelle), watersheds (Dr. Rice-Boayue), optimization (Dr. Akella), and information modeling (Dr. D. Chen).

Leadership in Education: Building on success in training awards from the US Department of Education of \$493 K led by Dr. Gibas, Drs. Gibas and Reitzel are leading a T32 training grant proposal to the NIH for Student Enhancement in Data intensive Biomedical Science for underrepresented minority students in STEM. The program will provide a flexible training model and reduce barriers for interdisciplinary approaches leading to a prepared biomedical science workforce. Members of the BRC are conducting research education for undergraduates through the HHMI SEA-PHAGES program for the discovery of novel viruses and for transfer students to UNC Charlotte through the SPARC4 research opportunities funded by NSF. Dr. Reitzel is co-lead with faculty from CLAS, CHHS, and COED on proposals for training and education grants related to graduate student STEM education. Dr. Janies and Dr. Shaikh are currently funded by the Office of Naval Research to train students to detect and combat misinformation. Building on this, we have formed a larger team from Computer Science (Dr. Dou and Dr. Shaikh), Education (Dr. Binns, Dr. Lambert, and Dr. Sadaf), and Bioinformatics (Dr. Janies) to respond to the NIH's Science Education Partnership Award to train future teachers to fight misinformation that undermines public health messaging at the K-12 level.

Broader impacts: The activities of BRC members positively impact decision-making regarding health and education. For example, Drs. Lo and Janies hold an award from NIH to assess malaria transmission. Drs. Lo and Janies jointly advise graduate students from Africa, domestic undergraduate and graduate students in projects on malaria testing and vaccination. Tools developed during this work in malaria are being translated to ascertain the effects of SARS-CoV-2 variants on transmissibility, pathogenicity, and vaccine evasion - which is a major concern globally and locally. As a result of excellent education and scholarship, combined with work in our laboratories, we have placed several medical school applicants (MD), graduate school applicants (Ph.D.), postdoctoral fellows, and tenure track faculty from UNC Charlotte in leading Universities.

Faculty recruitment: We have hired new faculty to further our vision of ONE HEALTH research. Dr. Dornburg holds an award from NSF for comparative genomics of SARS-CoV-1 and 2 as applied to the molecular evolution of zoonosis. Dr. White holds a sequencing award from the DOE Joint Genome Institute. Dr. Cooper recently submitted a proposal to NIH investigate genetic links between mosquitoes that carry West Nile Virus and outbreaks. Dr. Xiang has recently submitted proposals to NIH MIRA and Moore Foundation to investigate mechanisms of host-symbiont interaction and evolution. Dr. Xiang and Dr. Reitzel are currently preparing an NSF proposal to bridge gaps in the mechanisms for symbiosis in environments impacted by climate change. Each of these proposals includes significant portions for training students and postdoctoral fellows as well as outreach to the community locally and globally.

Media and civic engagement: This interaction and others in the ONE HEALTH community have formed our practice and execution of careful public health messaging. We have been repeatedly featured in many local, national, and international media outlets (brc.uncc.edu/news). For example, Dr. Gibas and the wastewater team have been featured in the New York Times. Dr. Janies team's paper on big data and antibiotic resistance has been featured in a commentary in Nature. Dr. Janies has been a frequent guest on "Charlotte Talks" and has appeared repeatedly on television (WBTV, WSOC) to discuss coronaviruses over the past 14 months. Dr. Reitzel works with Discovery Place for outreach on ecosystem health and was featured by CLAS for this partnership. We work closely with University leadership to make sure the message is consistent with the values, policies, and interests of the University, our partners, and public health.

Alignment with Regional and National Priorities

Pandemic response and preparedness are top campus, state, national, and international priorities. As we come closer to controlling the outbreak of SARS-CoV-2, there will likely be a sense of normalcy. However, with a return to normal activities such as travel, we will again be exposed to new viral and bacterial threats. As such, our research and infrastructure efforts align with emerging federal efforts that strive for health equity while rebuilding America's scientific leadership in pandemic response and preparedness. Work from our BRC research cluster exemplifies how a ONE HEALTH approach can not only align with regional initiatives but also position BRC members to rapidly respond to emergent regional or national health threats.

For example, Dr. Gibas has developed a collaborative team involving faculty in Civil Engineering, Biological Sciences, Geography, and Earth Sciences that focuses on the impact of treated wastewater release on urban streams. Given the rapid pace of urbanization in North Carolina, this work is well-aligned with regional priorities. However, by crossing academic boundaries, this team positioned to meet the University's need for SARS-CoV-2 monitoring when the pandemic began. Drs. Gibas, Schlueter, and Janies have recently been invited to participate in the Sequencing for Public Health Emergency Response, Epidemiology, and Surveillance (SPHERES) network. SPHERES is a community of practice for genomic surveillance of infectious diseases led by the United States Centers for Disease Control and Prevention (CDC). There is currently bicameral legislation being proposed entitled "Tracking COVID-19 Variants Act". This act aims to fund the SPHERES network to restore the United States system of genomic surveillance through state, local, and academic partnerships.

Furthermore, NSF has recently launched a series of workshops in which BRC faculty participated. The tone of these workshops "Predictive Intelligence for Pandemic Prevention" and reporting in Science indicate that there will soon be funding calls for highly interdisciplinary responses. This anticipated funding call is consistent with NSF's ongoing interdisciplinary research priorities ('Big Ideas') for integrative projects through the Rule of Life, Integrative Systems, and others to which BRC members actively apply.

At the federal state juncture, the BRC was the recipient of CARES act funding allocated through NC House Bill 1105. Pandemic response funds from this bill enhanced the wastewater program as well as cyber and genomics infrastructure to prepare for future biological threats. We will leverage these capital investments into further alignment with state, national, and international priorities.

For example, the "National Security Memorandum on United States Global Leadership to Strengthen the International COVID-19 Response and to Advance Global Health Security and Biological Preparedness" memorandum affirms that preparation for and response to biological threats are top national security priorities. As such we anticipate the rapid development of many new regional and national initiatives that require subject matter expertise. In closing, this proposal is a brief summary of BRC faculty who are not only excellent scientists for regional and national priorities but also, educators, fundraisers, and communicators actively collaborating under a ONE HEALTH approach. Our ONE HEALTH initiative closely aligns with the core values at the heart of UNC Charlotte's mission. It is our vision that investment in this research initiative will, in turn, raise the status of UNC Charlotte and its students as a regional, national, and global leaders guiding research, education, and actionable policy that is reverent of the connections between pathogenic and beneficial microbes, wildlife, ecosystems, and health.

Researcher/PI (First)	Researcher/PI (Last)	Title	College/Unit	Contributions specific to project
Daniel	Janies	Carol Grotnes Belk Distinguished Professor, Co-Director BRC	CCI	Zoonotic and Vector Borne disease
Adam	Reitzel	BRC	CLAS	Ecosystem health
Srinivas	Akella	Professor	CCI	Optimization of sampling in wastewater surveillance
Ian	Binns	Associate Professor	COED	Combatting misinformation with nature of science instruction
Shi	Chen	Assistant Professor	CHHS, SDS	Machine Learning applied to epidemiology and socioeconomic burden of disease
Don	Chen	Professor	COE	Information modeling in wastewater surveillance
Elizabeth	Cooper	Assistant Professor	CCI	West Nile virus spread by mosquitoes
Agampodi Swarnapali	De Silva Indrasekara	Assistant Professor	CLAS	Nanomaterials as applied to point-of-care diagnostics, global health
Eric	Delmelle	Associate Professor	CLAS	Socioeconomic vulnerabilities to health disparities
Alex	Dornburg	Assistant Professor	CCI	Vaccine and therapeutic efficacy as SARS-CoV-2 evolves
Wenwen	Dou	Assistant Professor	CCI	Combatting misinformation with visual analytics
Cynthia	Gibas	Professor	CCI	Detection and genomic sequencing of wastewater borne pathogens
Richard	Lambert	Professor	COED	Educational measurement and evaluation
Shaoyu	Li	Assistant Professor	CLAS	Transcriptional changes that are associated with human diseases
Eugenia	Lo	Assistant Professor	CLAS	Global health, assessment of malaria transmission, testing, and vaccination
Chris	Maher	Director of University Research Computing	OneIT	Cyberinfrastructure and high-performance computing support for research and teaching
Angelica	Martins	Director of Research protections and COVID-19 testing	RED	SARS-CoV-2 clinical testing and preparation for genomic sequencing
Mariya	Munir	Assistant Professor	COE	Detection of SARS-CoV 2 and antibiotic resistant bacteria and genes from water
Rajib	Paul	Associate Professor	CHHS, SDS	Statistics of environmental, epidemiological, and health policy-related problems
Jacelyn	Rice-Boayue	Assistant Professor	COE	Watershed modeling
Ayesha	Sadaf	Assistant Professor	COED	Improving technology integration in the classroom
Monika	Sawhney	Associate Professor	CHHS	Health equity local and global
Jessica	Schlueter	Associate Professor	CCI	Genomic sequencing of SARS-CoV-2
Todd	Steck	Associate Professor	CLAS	Antimicrobial resistance
Way	Sung	Assistant Professor	CCI	Mutation of viruses, bacteria, and parasites
Wenwu	Tang	Associate Professor	CLAS	Cyberinfrastructure and high-performance computation in geosciences
Juan	Vivero-Escoto	Associate Professor	CLAS	Novel therapeutics to combat infectious microorganisms
Richard	White III	Assistant Professor	CCI	Novel therapeutics, pathogen communities
Tingting	Xiang	Assistant Professor	CLAS	Ecosystem health

Table 1. Faculty and University Professionals (n=29) and their contributions to our push to R1 status through One Health.