

1. Cover Page

Title of the area: Genome Integrity and Cancer Initiative (GICI)

List of participating disciplines/academic units/departments at UNC Charlotte (a total of **40** faculty members including **2** Associate Deans, **3** Dept. Chairs, **4** Directors):

- (1) Dean's Office, College of Liberal Arts & Sciences (CLAS)
- (2) Department of Biological Science, College of Liberal Arts & Sciences (CLAS)
- (3) Department of Mathematics & Statistics, College of Liberal Arts & Sciences (CLAS)
- (4) Department of Physics & Optical Science, College of Liberal Arts & Sciences (CLAS)
- (5) Department of Chemistry, College of Liberal Arts & Sciences (CLAS)
- (6) Department of Psychological Science, College of Liberal Arts & Sciences (CLAS)
- (7) Department of Bioinformatics and Genomics, College of Computing and Informatics (CCI)
- (8) Department of Computer Sciences, College of Computing and Informatics (CCI)
- (9) Department of Software and Informatics Systems, College of Computing and Informatics (CCI)
- (10) Dean's Office, College of Health and Human Services (CHHS)
- (11) Department of Kinesiology, College of Health and Human Services (CHHS)
- (12) School of Social Work, College of Health and Human Services (CHHS)
- (13) Department of Mechanical Engineering and Engineering Science, College of Engineering
- (14) Center of STEM Education, College of Education
- (15) University Vivarium/Lab Animal Resources, Office of Research and Economic Development
- (16) ADVANCE Faculty Affairs and Diversity Office, Division of Academic Affairs

Faculty responsible for leading and organizing the collaborative cluster or research area:

- (1) **Lead:** Shan Yan, PhD, Professor, Department of Biological Sciences/CLAS
- (2) **Co-Lead:** Jun-tao Guo, PhD, Professor, Department of Bioinformatics and Genomics/CCI
- (3) **Co-Lead:** Didier Dréau, PhD, Professor, Department of Biological Sciences/CLAS

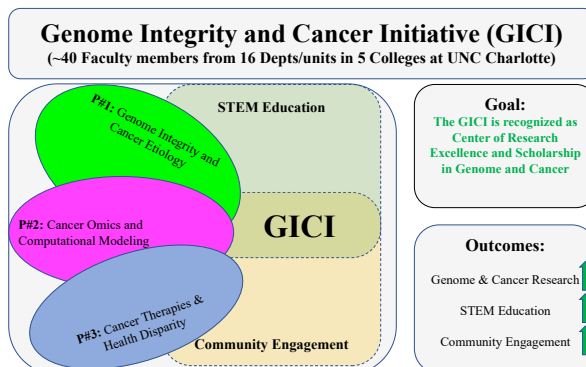
The target category for the submission: Existing and Emerging Excellence

Key words:

- (1) Genome integrity
- (2) Cancer omics/data visualization
- (3) Computational modeling
- (4) Cancer therapeutics/health disparities
- (5) STEM education/community engagement

2. Executive Summary

Synopsis of the thematic area: The **Genome Integrity and Cancer Initiative (GICI)** is composed of three programs: (1) Genome integrity and cancer etiology (Lead- Shan Yan); (2) Cancer omics and computational modeling (Co-Lead: Jun-tao Guo); (3) Cancer therapeutics and health disparity (Co-Lead: Didier Dréau) as well as STEM education and community engagement and outreach (see the diagram). The GICI will foster genome, omics, and cancer research, to support translational efforts to improve cancer treatment and community health, and promote STEM education and community engagement and outreach activities.



The GICI aims (1) to pursue excellence in cancer scholarship and research that address key fundamental cancer genetic, cellular and therapeutic challenges; (2) to pursue excellence in education by leveraging synergies between research and learning across our university community of scholars to offer undergraduate and graduate students both research experiences and innovative teaching; and (3) to promote community engagement and outreach activities in the local greater Charlotte region. Overall, GICI is fully committed to research excellence and scholarship as well as diversity with existing and emerging excellence. GICI will be recognized as a UNC Charlotte Center for Research Excellence and Scholarship in Genome Integrity and Cancer with national and/or international reputation.

Evidence supporting the nomination as area of research excellence and scholarship

***GICI is exceptionally well positioned to meet current and future cancer research challenges:**

We will capitalize on our distinctive strengths and the substantial gains established over the years, including (1) relevant research models and state of the art technological approaches (e.g., CRISPR/Cas9 gene editing); (2) externally supported research funding (68 grants/projects, ~\$27M as PIs and ~22M as Co-Is); (3) preeminence and distinguished track record of publications (in high IF journals such as *Nature*, *Cell*, *Science*, *PNAS*, *Immunity*, and *Cancer Research*); (4) an extensive culture of collaboration on (e.g., CEBS, ADVANCE, STEM Education) and off UNC Charlotte campus (e.g., Atrium Health, Discovery Place, NCBC, among >20 institutions); and (5) a scholarly community where learning advances discovery and discovery advances learning.

***GICI is poised to make further strides in cancer research by harnessing the promises of** (1) unity of the connecting participants (40 Faculty from 16 Depts/Units in 5 Colleges); (2) targeted individual and cancer (e.g., exercise, diet, genetic) factors; (3) cancer literacy and community awareness through outreach; and (4) strengthen the relationships with other regional, state, and national institutions.

Overall, the GICI will build on cutting-edge cancer research and embrace new pedagogy that fosters innovation in cancer research and education toward a recognized top-tier genome and cancer research center of excellence, through (1) the development and nurturing of a diverse intellectual research team that promotes cancer research investigation using molecular, cell, organism, model and community approaches; (2) the support of multi- and inter-disciplinary research opportunities/applications including those addressing cancer health disparities; and (3) the active participation in transforming STEM education and student involvement in cancer research and addressing cancer challenges at the local and national levels.

3. Evidence of Strength and Excellence

Genome Integrity and Cancer Initiative (GICI) is composed of three research programs and various education and engagement activities:

Program #1: Genome integrity and cancer etiology - Lead- Shan Yan

Research interests: Deficiency of genome integrity maintenance has been implicated in the etiology of cancer. Research excellence in the topic of Genome integrity includes but is not limited to DNA damage, DNA repair mechanisms, DNA damage response pathways, DNA recombination and transposons, DNA replication and DNA replication stress, and DNA/RNA mechanisms of cancer. Genome integrity has been studied from a variety of model organisms (frogs, budding yeast, protist, bacteria and mammalian system, symbiosis between algae and cnidarian host) using cutting-edge technologies (e.g., CRISPR/Cas9) at the molecular, cellular, organismal, and ecological levels. In this area of research of **existing excellence**, scholars at UNC Charlotte have gained national reputation including publications in top-tier peer reviewed journals including *PNAS*, *Cancer Research*, and *Nucleic Acids Research*, and numerous externally funded grants (2 NIH R01, 1 NIH R25, 2 NIH R15, 1 NIH R03, and 1 NSF grant, and a pending \$12.5M NSF center grant proposal, among others). The NCBC-sponsored Charlotte Biology and Biotechnology (CBB) Exchange Group has promoted collaborations in this area via distinguished speaker series, and has fostered industry and academic partnership, economic development, and professional networking in the greater Charlotte region.

Topics in Program #1:

- 1) *Genome integrity, DNA repair, and DNA damage response* (Yan, Richardson, Truman, Tomida, Chakrabarti)
- 2) *DNA/RNA mechanism of cancer etiology* (Chakrabarti, Yan)
- 3) *Cellular signaling and molecular mechanisms* (Yan, Arthur, Marino, Turner)
- 4) *Organismal, ecological and environmental analysis of genome integrity* (Xiang, Chi, Yan)

Program #2: Cancer omics and computational modeling - Co-Lead: Jun-tao Guo

Research interests: With the decreasing costs of the next generation sequencing (NGS) approaches and the advancement of new technologies in the omics arena, a massive amount of cancer omics data have been generated and become available to the research community. For example, The Cancer Genome Atlas (TCGA) has sequenced over 20,000 primary cancer and corresponding normal samples covering 33 cancer types. These big data present a number of great challenges to the downstream analysis for cancer discovery, diagnosis, and treatment: (1) how to efficiently integrate the data and visualize them? (2) what are the common and unique signatures or patterns among different cancer types at various levels, such as genomics, transcriptomics, metabolomics, and structures, through data analytics? (3) can the discovery results help us better understand the cancer etiology (GICI Program #1) and be translated into novel ideas for developing cancer therapeutics (GICI Program #3)? We propose four topics in Program #2 by leveraging the collective expertise of faculty involved in this program and enhancing cancer discovery research.

Topics in Program #2:

- 1) *Cancer transcriptomic and metabolomic research* (Du, J. Guo, Li, Reid)
- 2) *Data analytics and mathematical modeling* (J. Guo, Khan, Jiang, Li, Niu, Pan, Sun)
- 3) *Data integration and visualization* (Lorraine, Yang)
- 4) *Structural bioinformatics and functional studies* (J. Guo, Nesmelova)

The cohort of the faculty members in program #2 have demonstrated excellence of their research

by securing many extramural grants with a total of current support of ~\$9.5M as PIs and completed recent support of ~\$4.8M as PIs. Participating faculty members have excelled at the national/international level. For example, Dr. Du leads a multi-institutional MPI grant for “Big Data Analytics for Computational Exposome”. Program members have demonstrated their collaborative spirit by working with investigators within and outside of the university. There are a number of ongoing collaborative research projects among the faculty in this program, evidenced by the joint publications.

Program #3: Cancer Therapeutics and Health Disparity - Co-Lead: Didier Dréau

Research interests: Targeted therapies have become the encouraging approaches to prevent cancer progression. However, disparity in tumors’ sensitivity and patients’ responses and access to such treatments remains a challenge. Through investigations using relevant models (e.g., genetically engineered animals, immunocompetent mouse models, 3D cultures), the Cancer Therapeutics and Health Disparity program assesses innovative targeted therapies including immunotherapies, their delivery, diagnostic and monitoring. Moreover, measurement and interventions aim at reducing disparities in cancer treatment and survivorship modeled on efforts that limit diabetes and metabolic disease in the community will be extended to underrepresented cancer patient cohorts. Program #3 will extend the current and budding synergies of involved faculty to further cancer therapy research. In this area of research, scholars at UNC Charlotte have gained national reputation as an existing excellence, evidenced by publishing at top-tier peer reviewed publications including in *Cancer Res*, *Oncogene*, *Biochem J.*, and many externally funded research grants [~\$5.9M (NIH, DOD and foundations) as PIs (and ~\$11M as completed PI support) and multiple pending grant proposals, among others]. Those collaborations will be strengthened through networking, annual meetings and industry-academic partnerships in the greater Charlotte region in part through the Center for Biomedical Engineering and Science (CBES).

Topics in Program #3:

1. *Tumor microenvironment & Signaling* (Arthur, Dréau, Lee, Marino, Marriott, Mukherjee, Nesmelova)
2. *Targeted therapy including immunotherapy* (Dréau, Mukherjee, Tomida, Trammell, Vivero-Escoto, Williams)
3. *Nanotechnology & targeted drug delivery* (Dréau, Egusa, Mukherjee, Johnson, Vivero-Escoto)
4. *Cancer disparity, cancer survivorship and community health* (Bellar, Bennett, Y. Guo, Marino, Ring, Turner)

STEM education and community engagement (Bullock, Huet, Pugalee, Richardson, Sell): The benefits of STEM education on the overall learning experience and academic success of undergraduate/graduate students are well documented. The proposed GICI will include the development of course-based research experiences (CURES) including dissemination of research findings, research internships (e.g., GICI Scholars) and professional development modules. GICI also incorporates multiple STEM education initiatives (e.g., the NSF REU and faculty/student professional development). Moreover, GICI faculty are actively engaged in STEM education and outreach with the community through various outreach programs including Discovery Place (public engagement) and HBCUs such as Johnson C. Smith University and NC A&T University (targeted recruitment of graduate students). STEM education and community engagement activities developed by GICI are critical for establishing a large, diverse talent pool to meet the ever-increasing national demand for scientists in this field.

Overall, beside unique faculty research distinctions, the above evidence supports GICI as a key existing and emerging area of research and scholarship excellence at UNC Charlotte.

4. Alignment with Regional and National Priorities

The GICI aligns well with the University's mission as North Carolina's urban research university. Grant/proposal activities of the GICI will focus on several federal and private funding agencies including the NSF, NIH, DOD, among others.

NSF: In response to the NSF Biology Integration Institutes (BII) program (NSF-20-601), Lead Dr. Yan, with the support of the [Chancellor Sharon Gaber](#), submitted an NSF center grant proposal titled "[BII: Biology integration Institute for Genome integration \(BIG\): Maintaining Genome Stability in Redox Environments](#)" (\$12.5M; 09/01/21-08/31/26) together with 4 Co-PIs, 13 senior personnel from five departments in three colleges at UNC Charlotte. The NSF BIG institute will address the overarching theme of eukaryotic genome preservation and protection from environmental stress at the molecular, cellular, organismal, evolutionary, and environmental levels. The BIG institute will connect with a unique network of interdisciplinary researchers in [12 scientific sub-disciplines](#) (molecular, computational, organismal, developmental, environmental, chemical, and structural biology, genomics, genetics, microbiology, biochemistry, and mathematics) at [15 research and education institutions and community partners](#) including the NIH/NCI, U. of Chicago, USC, UT Austin, UNC-CH, and Discovery Place. Our GICI fits well within the 2021 *Understanding the Rules of Life: Emergent Networks (URoL:EN)* - Predicting Transformation of Living Systems in Evolving Environments (NSF-21-560), and the *NSF INCLUDES* "the Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science" (NSF-20-569), two of the NSF 10 Big Ideas.

NIH: The participants in the GICI serve as PIs in 16 active NIH grants (out of a total of 34 awards received by UNC Charlotte), which include [4 R01](#) (Yan, Truman, Loraine), [2 U01](#) (Du), [1 R03](#) (Richardson), [9 R15](#) (Lee, Marriott, Guo, Richardson, Song, Nesmelova, Egusa, Truman, Sell), and [1 R25](#) (Richardson). The [NIH BRIDGE Fellow Program](#), directed by Christine Richardson, promotes undergraduate success in biomedical sciences from local community colleges such as Gaston College and Rowan-Cabarrus Community College. To develop a diverse pool of scientists earning a PhD and transitioning into careers in the biomedical research workforce, [8](#) participating faculty members within the GICI are working closely with the PhD programs in Biology and Bioinformatics to seek the support from the [NIH G-RISE \(Research Training Initiative for Student Enhancement\) T32](#) training program. In addition to the traditional investigator-initiated grant mechanisms (R01, R03, R15, R21, R25, R35, MPI), the GICI will target the NIH Program Project Grants/Center Grants (P01, P30, and P50 mechanisms) to seek support for the innovative and collaborative research projects within the participants' laboratories.

Other federal funding agencies including DOD and NASA: Several grant programs for cancer research in the DOD's CDMRP (Congressionally Directed Medical Research Programs) and NASA-NC Space Grants.

Societies, foundations, non-profits, and local organizations: The GICI aligns well with grant programs offered by non-profit societies and foundations including but not limited to (1) [American Cancer Society \(ACS\)](#) grant programs including Research Scholar Grants, Health Equity Research in Cancer Control & Prevention, and Institutional Research Grants (IRG); (2) [American Association for Cancer Research \(AACR\)](#) grants for research training and fellowships, career development awards, and independent research grants; (3) [Susan Komen Breast Cancer Awards](#); (4) [North Carolina Biotechnology Center \(NCBC\)](#) grant programs including Flash Grant, Innovation Impact Grant, Translational Research Grant, and Event and Meeting Grants; (5) [Levine Cancer Institute](#) at Atrium Health; and (6) [UNC Research Opportunities Initiative \(ROI\)](#).

5-Supporting Documents

List of Lead/Co-Leads and participating faculty members in this R1 proposal:

No.	Name	Title	Department/Unit	Contribution/Expertise
5.1	Yan, Shan	Professor	Biological Sciences/CLAS	Lead for P1 . Genome integrity and cancer etiology
5.2	Guo, Jun-tao	Professor	Bioinformatics and Genomics/CCI	Co-Lead for P2 . Structural bioinformatics, cancer bioinformatics, computational biology
5.3	Dréau, Didier	Professor	Biological Sciences/CLAS	Co-Lead for P3 . Tumor microenvironment, oncology, immunotherapy, immunology
5.4	Arthur, Susan	Associate Professor	Kinesiology/CHHS	P1, P3 . Cellular signaling and cancer cachexia
5.5	Bellar, David	Professor, Chair	Kinesiology/CHHS	P3 . Community health and health disparities, physiology and kinesiology
5.6	Bennett, Jeanette	Associate Professor	Psychological Science/CLAS	P3 . Stress & health, social determinants of health
5.7	Bullock, Sharon	Senior Lecturer	Biological Sciences/CLAS	EC . DNA repair, and STEM education and pedagogy
5.8	Chakrabarti, Kausik	Assistant Professor	Biological Sciences/CLAS	P1 . RNA mechanism, genome integrity, DNA repair, telomere and telomerase
5.9	Chi, Richard	Assistant Professor	Biological Sciences/CLAS	P1 . Yeast genetics, cellular signaling, protein structure and function
5.10	Du, Xiuxia	Professor	Bioinformatics and Genomics/CCI	P2 . Bioinformatics, metabolomics, data processing and analytics
5.11	Egusa, Shunji	Assistant Professor	Physics & Optical Science/CLAS	P3 . Cancer therapeutics, nano-technologies
5.12	Guo, Yuqi	Assistant Professor	School of Social Work/CHHS	P3 . Community health and health disparities
5.13	Huet, Yvette	Professor, Director	Kinesiology/CHHS; ADVANCE	EC . Recruitment and development of faculty and students, STEM education, kinesiology
5.14	Jiang, Jiancheng	Professor	Mathematics & Statistics/CLAS	P2 . Mathematic and statistical modeling

5.15	Johnson, Brittany	Assistant Professor	Biological Sciences/CLAS	P3. RNA biology, nanotechnology, immunology
5.16	Khan, Taufquiar	Professor, Chair	Mathematics & Statistics/CLAS	P2, EC. Mathematic and statistical modeling, STEM education
5.17	Lee, Charles	Associate Professor, Director	Mechanical Engineering and Engineering Science & Center for Biomedical Engineering and Science/College of Engineering (CBES)	P3. Bioengineering, biomedical, mechanical engineering
5.18	Li, Shaoyu	Assistant Professor	Mathematics & Statistics/CLAS	P2. Mathematic and statistical modeling, cancer genomics and genetics
5.19	Lorraine, Ann	Associate Professor	Bioinformatics and Genomics/CCI	P2. Bioinformatics, genomics, splicing, data visualization
5.20	Marino, Joseph	Associate Professor	Kinesiology/CHHS	P1, P3. Cellular signaling, cancer therapeutics
5.21	Marriott, Ian	Professor	Biological Sciences/CLAS	P3. Immunology
5.22	Mukherjee, Pinku	Professor, Associate Dean	CLAS Dean's Office	P3. Cancer, immunology, Mucin-1, immunotherapy
5.23	Nesmelova, Irina	Associate Professor	Physics & Optical Science/CLAS	P2. Biophysics
5.24	Niu, Xi	Associate Professor	Software and Information Systems/CCI	P2. Computational modeling, data analytics
5.25	Pan, Yinghao	Assistant Professor	Mathematics & Statistics/CLAS	P2. Mathematic and statistical modeling, data analytics
5.26	Pugalee, David	Professor, Director	Center for STEM Education/COE	EC. STEM education and assessment
5.27	Reid, Robert	Assistant Professor	Bioinformatics and Genomics/CCI	P2. Bioinformatics, genome assembly
5.28	Richardson, Christine	Professor, Chair	Biological Sciences/CLAS	P1, EC. Genome integrity, cancer therapeutics, STEM education
5.29	Ring, Brian	Assistant Professor	Kinesiology/CHHS	P3. Community health and health disparities
5.30	Sell, Susan	Professor, Associate Dean	CHHS Dean's Office	EC. Bioinformatics, health, and STEM education

5.31	Song, Bao-hua	Associate Professor	Biological Sciences/CLAS	P3. Cellular signaling, population genetics, cancer therapies
5.32	Sun, Yanqing	Professor	Mathematics & Statistics/CLAS	P2. Mathematic and statistical modeling, data analytics
5.33	Tomida, Junya	Assistant Professor	Biological Sciences/CLAS	P1, P3. Genome integrity, cancer therapies
5.34	Trammell, Susan	Professor	Physics & Optical Science/CLAS	P3. Biophysics and cancer therapies
5.35	Truman, Andrew	Assistant Professor	Biological Sciences/CLAS	P1. Molecular chaperones, DNA damage, post-translational modifications, proteomics
5.36	Turner, Michael	Associate Professor	Kinesiology/CHHS	P1, P3. Genomics and genetics, health
5.37	Vivero-Escoto, Juan	Associate Professor	Chemistry/CLAS	P3. Nanotechnology, nanomedicine, drug delivery
5.38	Xiang Tingting	Assistant Professor	Biological Sciences/CLAS	P1. Ecological and environmental analysis of genome integrity, symbiosis
5.39	Yang, Jing	Professor	Computer Sciences/CCI	P2. Data analytics and visualization
5.40	Williams, Chandra	Vivarium Director	University Vivarium/Research and Economic Development	P3. Animal studies and cancer therapies

Notes:

1) **A quick summary** of research/education administrators involved in the GICI: **Two** Associate Deans (Pinku Mukherjee @CLAS; Susan Sell @CHHS); **Three** Dept. Chairs (Christine Richardson @Biological Sciences; Taufiqar Khan @Mathematics & Statistics; David Bellar @Kinesiology); **Four** Center Directors (Charles Lee @CBES; David Pugalee @Center for STEM Education; Yvette Huet @ADVANCE; Chandra Williams @Vivarium)

2) **Number and rank of participating faculty members in the GICI:**

Ranks	Professor/adjunct Professor	Associate Professor	Assistant Professor	Senior Lecturer	Total
Participating faculty (#)	16	11	12	1	40

3) Abbreviations: **P1: Program #1; P2: Program #2; P3: Program #3; EC: Education and Community engagement**; CLAS: College of Liberal Arts & Sciences; CHHS: College of Health and Human Services; CCI: College of Computing and Informatics