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| RESOURCES |
| FACILITIES: Specify the facilities to be used for the conduct of the proposed research. Indicate the project/performance sites and describe capacities, pertinent capabilities, relative proximity, and extent of availability to the project. If research involving Select Agent(s) will occur at any performance site(s), the biocontainment resources available at each site should be described. Under “Other,” identify support services such as machine shop, electronics shop, and specify the extent to which they will be available to the project. Use continuation pages if necessary. |
| Laboratory:All of the faculty members included in this grant application are funded investigators, and each has his/her own independent laboratory with adequate resources and space to support the research activities of IMSD Scholars. In addition to these individual research laboratories, a significant factor that has contributed to the successful expansion of the research programs of the School of Medicine at UNC has been the development of a wide variety of sophisticated and state-of-the art core facilities. All of these core facilities are readily available to the IMSD Scholars. The effort to develop and organize these shared-use core facilities has been led primarily by the UNC-CH Centers and Programs dedicated to research. On the following pages we highlight the ***PhD-granting departments and curricula*** that are particularly relevant to our Scholars. We have also highlighted a number of the ***research-intensive centers*** that have a significant impact on the quality of the IMSD Scholar experience here at UNC. We have provided descriptions of the many ***Core Facilities*** that are critical to the success of UNC’s various research programs. Finally, we have described the various ***laboratory construction and renovation programs*** that are currently underway here at UNC. |
| Clinical:The University of North Carolina Hospitals is the principal venue for clinical activities at UNC-CH. Contained within the main hospital building is the Verne S. Caviness General Clinical Research Center, a 13,500 square foot, state-of-the-art inpatient-outpatient research facility supported by a $5 million per year GCRC grant from the NIH.  |
| Animal:The animal facilities at UNC-CH are fully accredited by the AAALAC. Additional information on the experimental animals program is contained in this section. |
| Computer:See attached below for description of the institutional, School of Medicine, and personal computing resources that are available to XX Scholars. |
| Office: |
| Other:***Didactic resources*** for the XX Program include the participating Schools, Departments, Centers, Curricula, and the library system of UNC-CH. These resources are all described in the following sections. |
| MAJOR EQUIPMENT: List the most important equipment items already available for this project, noting the location and pertinent capabilities of each.The standard research equipment that is used by the XX Scholars is provided by their individual faculty advisors. In addition, the major pieces of equipment that are available to them in the various shared-use ***UNC Core Facilities*** (e.g., devices for DNA and peptide sequencing and synthesis, microscopes and imaging systems, flow cytometers, etc.) are described in this section. In the following pages we outline the resources and facilities relevant to the XX Program including the Biological and Biomedical Sciences Program, UNC Departments and Curricula offering PhD degrees; the support provided by the Office of Postdoctoral Affairs; Research Centers; Core Facilities; and other research facilities including clinical resources, computing resources, and libraries. |

**The University of North Carolina at Chapel Hill**

Founded in 1792, the University of North Carolina represents the oldest public university in the United States. From these early beginnings, the University has grown to encompass a total of 16 institutions that together comprise the North Carolina consolidated university system. The University of North Carolina at Chapel Hill, referred to throughout this proposal as UNC, is consistently acknowledged as the flagship research institution within the state university system, and the leaders of the Chapel Hill campus have always set the very highest standards for excellence in education and research. The present chancellor at UNC is Dr. Carol Folt. UNC awards more than 400 Ph.D.s each year.

The University of North Carolina at Chapel Hill leads southeastern public universities in the amount of extramural support for its research programs. UNC’s research enterprise has doubled in the last decade, with research grants and contracts totaling $793 million in fiscal 2014. When ARRA funding for FYs 2010-2014 is removed, UNC funding has increased by 16% since 2010. Carolina’s research enterprise has doubled in the last decade, reaching nearly $800 million in FY 2014. In the most recent NSF rankings (2013), UNC ranked 8th in federal R&D expenditures (NSF, 2013) and 7th among both private and public universities nationwide for HHS funding, including NIH research funding to domestic institutions of higher education. The UNC School of Medicine received total funding of $431 million and $267.4 million in NIH funding for FY 2014, ranking 13th in the nation for NIH funding (Blue Ridge Ranking, 2014).

UNC is one of only four public universities that have all five schools of the health-related disciplines, Medicine, Dentistry, Pharmacy, Nursing, and Public Health. All of these are located on a single, contiguous campus at UNC-Chapel Hill. This arrangement encourages the formal and informal exchanges that enhance the concepts and resources of individual researchers, often resulting in new, cross-disciplinary collaborations. Unlike many institutions, in which the Medical Center is sited at a substantial distance from other campus components, UNC is truly one single university in that the Academic Affairs campus and the Health Affairs campus are immediately adjacent to one another. Such proximity fosters ongoing collaboration between faculty investigators from a wide variety of disciplines, a feature that should be apparent in this application. Among the disciplines under the Academic Affairs division, a number of departments have high rankings.

**The Biological and Biomedical Sciences Program (BBSP)**

*[Note: The text below is just a suggestion and needs personalized information for your program. You will most likely want to rearrange, shorten, lengthen, etc to fit your individual needs.]*

*Email Anna O’Connell to request a spreadsheet outlining faculty service to BBSP (admissions committees and FYG service)*

**The Biological and Biomedical Sciences Program (BBSP).** In 2007 UNC consolidated its graduate recruitment and first year training in the biological and biomedical sciences into a unified BBSP admissions/first year program, led by **Dr. Jean Cook.**  BBSP provides the mechanism through which students interested in any of the 15 participating PhD programs apply for graduate study. The BBSP provides first-year PhD students with opportunities to explore different research areas (through research rotations and courses) before making a final selection of a dissertation advisor and graduate program. Yet, it in no way impedes direct tracking of students who enter with a defined interest in a research area or degree program. In short, students participating in the proposed **“XXXXXX”** program will be admitted to graduate school at UNC via the BBSP and, at the end of their first year, will choose one of our training faculty as research advisor and they will choose XXXXXX PhD program.

**BBSP Admissions*:*** Evaluation of applicants and recruitment occurs through one of four admissions committees composed of faculty from the 15 PhD programs. The admissions committees are subdivided along broad scientific areas and applications are distributed to the appropriate committee based on information provided by the applicant. This information includes five research interest areas (selected from a list of 33) and a list of faculty members whose specific research is of interest to the applicant. Of relevance to our training program, the interest areas include x, y and z.The admissions committees evaluate the applications in depth, with at least two faculty assigned per application. Interview and admission decisions are made by individual committees in coordination with the BBSP Director (**Dr. Cook)**, keeping in mind the desired target number of matriculating students (~ 75-85 students for all 15 programs). Important to our efforts of recruiting outstanding students to our training program, many of our training mentors regularly serve on the admissions committees (**xxxxxx**).

**BBSP recruitment:** Students are invited to one of six recruitment weekends (January-March). During these visits, applicants interview with five faculty members, primarily of their own choosing, and they interact with current students and faculty in social settings. These weekends are organized around research areas (e.g. XXX), thus allowing faculty to focus their recruitment efforts. Nevertheless, a student can visit UNC during any weekend and be assured to meet individually with faculty representing their research interest. Students admitted through any admissions committee or recruitment weekend may ultimately join the **“XXXXX”**, but we anticipate that the majority of our students will come through during the “XXX” weekends. **The move to the BBSP admissions format has been extremely positive Application number increased (850 in 2007/pre-BBSP and average >1000 post-BBSP) and long-time admissions committee members agree that applicant quality is better: higher GRE and GPA scores, stronger research experiences and letters of recommendation.** The average GPA for the incoming BBSP class is 3.6 and the average GRE (V+Q) score is 286.5\* (\*note this is in the new GRE score format). Students from the first BBSP classes are enthusiastic about the program, as seen by their active participation in the recruitment weekends.

**Applicant Statistics Summary**

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| --- | --- | --- | --- | --- |
|  | **Total Applicants** | **Offers Made** | **Total # of students accepting our offer (# incoming)** | **Acceptance Rate** |
| 2015 | 1162 | 221 | 80 (81) | 36% |
| 2014 | 1221 | 187 | 65 (65) | 34.7% |
| 2013 | 1217 | 230 | 91 (89) | 39.6% |
| 2012 | 1443 | 251 | 85 (86) | 33.8% |
| 2011 | 1149 | 250 | 84 (83) | 33.6% |
| 2010 | 1128 | 213 | 76 (74) | 35.6% |
| 2009 | 1086 | 202 | 86 (86) | 42.7% |
| 2008 | 1111 | 261 | 121 (122) | 46.3% |
| 2007 | 850 |  | 93 | 37% |

**BBSP First Year Activities.** The program for all first-year PhD students consists of the following.

First Year Groups (FYGs): During their first year, BBSP students are part of small (14-16 students), interest-based groups led by four faculty members. Four peer mentors (graduate students at different stages of their career) are also assigned to each FYG. In this manner, all students have a cohort of faculty and peers that provide a supportive community for navigating the first year of graduate school when they have yet to join a degree-granting program. Groups build community interactions through social events within the group. These mandatory FYGs meet once a week for 1.5 hours. Skill-building activities in the FYGs include scientific presentations by the students (four research seminars are presented by each student), logic/critical thinking/literature appreciation, quantitative skills, and scientific writing. Responsible conduct of research training, plus training in rigor and reproducibility, also occurs within the FYG setting. FYGs also provide the structure for advising (i.e. selection of research rotations and courses) and the initiation of scientific discourse (e.g. through oral and poster presentations). Each of the FYG faculty members are assigned four students for whom they serve as the primary academic advisor. To help with advising, these faculty members are provided with all the course requirement information for each PhD program. Some of our training faculty participate as mentors in these FYGs (**XXXX**). Thus, even before students commit to a research program, they will be advised of appropriate courses and aided in the selection of rotations by mentors knowledgeable in departmental and training grant requirements.

Laboratory Rotations:All BBSP students are required to complete three laboratory rotations: 11 weeks in the fall, 13 weeks in the winter (spans winter break), and 11 weeks in the spring. This is the mechanism by which students evaluate and decide upon a thesis laboratory and by which faculty evaluate and recruit students. At the end of each rotation, students present their rotation research to the UNC research community as a poster (rotation 1), written report (rotation 2) or short talk (rotation 3). Students select a thesis laboratory in April, after the third rotation. To support first-year students in their choice of laboratory rotations, information sessions are conducted by each PhD program before classes start in the fall.

Quantitative Skills Enrichment: BBSP students are required to take a biostatistics short course that is integrated within their FYG and presented in four sessions. This course is led by instructors from the Biostatistics Department (UNC School of Public Health) and covers statistical analysis skills for both continuous and discrete experimental outcomes found to be generally required in all dissertation research. The four sessions focus on: 1) biochemical data analysis, 2) morphological data analysis, 3) animal models, and 4) genomics and microarrays.

**BBSP Financial Support.** Funds for administration, recruitment and first year support (i.e. stipend, tuition, health insurance) come from intramural sources in the School of Medicine, the College of Arts and Sciences and from an annual “payback” mechanism in which each of the participating departments and centers contribute based on the number of students that matriculate in a particular unit. Once students join a lab in year two they are supported by individual principal investigators or by training grants, such as the one we propose. The first year financial support of students by BBSP is advantageous to our process of selecting students for the training program. It enables a competitive selection process to identify the best students for T32 support by taking into account performance from the first year of graduate school. It also allows us to support those students that are most interested in xxxxx *per se*, because second year students have completed a year of graduate school and have decided on the area of research to pursue for their thesis work. With first year support, even with the best of intentions, it is not always possible to make the most appropriate selections with respect to these two issues.

**Departments and Curricula Offering Graduate School Programs/Degrees**

UNC-Chapel Hill benefits from the availability of 14 PhD granting programs in the biological and biomedical sciences, each of which has a strong research portfolio. In past years, together, these programs enrolled over 100 new graduate students, and together, they maintained a steady-state level of approximately 500 students in their graduate-level training programs. These departments and curricula include: seven participating departments from the School of Medicine; two departments from the College of Arts and Sciences; the School of Pharmacy; and four University-wide, PhD-granting curricula. These are described below – all representing research-intensive resources available to the UNC scholars. In fiscal year 2014 the School of Medicine received $431M in funded awards, which is 54.3% of the UNC sponsored research for that year. All five health affairs schools are in the top 20 for NIH funding. Based on the most recently available aggregate award data from the Blue Ridge Institute for Medical Research, the School of Medicine ranked 13th nationally in NIH funding for FY2014. Only 5 public university Schools of Medicine ranked higher.

**Departments in the School of Medicine**

*Department of Biochemistry and Biophysics*

Under the leadership of ***Dr. Leslie Parise*** (Department Chair), the Department of Biochemistry received $16.3M in NIH funding in fiscal year 2014, ranking 5th in NIH funding to Biochemistry departments. The Department's 29 full-time tenured and tenure-track faculty members include a unique blend of biophysical, biochemical, and molecular genetic specialists. Among the primary faculty are two members of the National Academy of Sciences: ***Dr. Richard Wolfenden*** elected in 2002 and ***Dr. Aziz Sancar*** elected in 2005. In recent years, department faculty members have been recipients of prestigious awards from the Keck, Beckman, Sloan, Pew, and Searle foundations; in 2007, Dr. Leslie Parise was elected as a Fellow of the American Association of the Academy of Sciences and Dr. Aziz Sancar was a recipient of the Koc Prize (Turkey’s highest scientific honor). In 2015 Dr. Sancar shared the Nobel Prize in Chemistry. Armed with potent tools, experience, and a wealth of new information, these scientists are positioned to solve fundamental issues of biology and disease.

The Department has close ties to other UNC programs and departments, including the Lineberger Comprehensive Cancer Center, the Neurosciences Center, the Integrative Program for Biological & genome Sciences, the Cystic Fibrosis Center, the McAllister Heart Institute and the Center for AIDS Research. Areas of research excellence within the department include studies of genomic integrity, the dynamic biochemistry of chromatin, cell signaling and cell cycle control, proteomics, and enzymology. The Department co-sponsors the Macromolecular Interactions, Proteomics/Mass Spectrometry, Structural Bioinformatics, Structural X-Ray, and UNC Biomolecular NMR core facilities.

A vibrant, pan-campus Program in Molecular and Cellular Biophysics that unites faculty from multiple departments, including Physics, Chemistry and Computer Sciences, is also centered in this department. Faculty members teach modules in this program, and also teach courses in the Curriculum in Genetics. The Department currently has approximately 59 graduate students and 26 postdoctoral fellows.

*Department of Cell Biology and Physiology*

In the summer of 2012 the departments of Cell & Developmental Biology and Cell & Molecular Physiology merged to form the Department of Cell Biology and Physiology. A nation-wide search led to the appointment of UNC’s own ***Dr. Kathleen Caron*** as the founding Chair of the new department. In FY 2013 the department received $15.3M in NIH funding, ranking 2nd for NIH funding. This department has brought together over 50 faculty, plus over 30 postdoctoral fellows and approximately 40 graduate students. **Faculty in the department previously developed a highly successful ‘Virtual Microscope’ for Histology instruction to medical students and graduate students, and are developing outstanding (and pioneering) instruments for delivery of Human Gross Anatomy educational content.**

Research interests of the combined faculty include cardiovascular biology, neurobiology, endocrinology, cell shape motility and adhesion, imaging technology, cytoskeleton, membrane trafficking, cell polarity, protein quality control, and GI, renal and respiratory physiology. **Faculty members are closely affiliated with a number of UNC Centers including: Lineberger Comprehensive Cancer Center, Bowles Center for Alcohol Studies, Center for Gastrointestinal Biology and Disease, Center for Thrombosis and Hemostasis, Comprehensive Center for Inflammatory Disorders, Cystic Fibrosis/Pulmonary Research and Treatment Center, the Laboratories for Reproductive Biology, the Neuroscience Center, and the Neurodevelopmental Disorders Research Center.** This breadth of research interests allows the department to offer students a unique exposure to physiology and modern experimental techniques at the molecular, cellular and systems levels.

**The new department includes a number of important recruitments. *Dr. Ben Philpot***, recruited from a faculty position at MIT, studies the basis for synaptic plasticity in the visual cortex of mice. ***Dr. Mark Zylka***, recruited from Caltech, uses genetic approaches to study peripheral-to-cord pain circuitry in mice. ***Dr. Kathleen Caron*** came from Oliver Smithies’ group (our 2007 Nobel Laureate) and studies the role of adrenomedulin in lymphatic development and the placental vasculature. In 2010 Dr. Caron was appointed as an SOM Assistant Dean for Research, working with the Vice Dean for Research, Dr. Terry Magnuson. ***Dr. Eleni Tzima*** trained at the Scripps Institute and studies endothelial cell signaling induced by shear stress.

*Department of Genetics*

***Dr. Terry Magnuson*** was recruited to UNC-Chapel Hill in July of 2000 to develop a foundation for research and training in the genome sciences to propel UNC- Chapel Hill to the forefront of the genomic revolution in the 21st century. Because this new knowledge will form the basis for novel, individualized treatment and prevention strategies for human disease (pharmacogenomics), and thus have a profound effect on how medicine will be practiced in the future, a critical part of the plan was the creation of the Department of Genetics in the School of Medicine (<http://genetics.unc.edu/>). The department acts as a springboard from which mammalian/human geneticists serve as the translational arm for genomic medicine, bringing practical applications from genomics into the clinical arena. The campus-wide effort in building genomic capabilities resulted in forty-five new faculty being recruited to the UNC-Chapel Hill campus, each of whom have established successful new research programs.

Under the leadership of Dr. Magnuson, the Department of Genetics is focused on mammalian and translational genomics. The faculty share interests in elucidating the genetic basis of human disease with each providing unique perspective and expertise in areas of human genetics, mouse models, epidemiology, and statistics. Maximizing the interplay among these highly complementary approaches is critical to success and will provide unprecedented opportunities to advance human health. The faculty study the role of genes implicated in human disease such as congenital heart disease and cystic fibrosis; inflammatory processes involved in allergic responses, asthma and arthritis; diabetes and breast cancer; psychiatric disorders such as depression and schizophrenia; colon cancer, lymphoma, brain carcinoma, and neurodegenerative disorders including dementia, motor neuron disease and parkinsonism; alcoholism and nicotine dependence; and birth defects. In fiscal year 2014, the department brought in $21.8M in NIH funding and ranked 5th.

A significant educational component of the two units includes three graduate programs: the Curriculum in Genetics & Molecular Biology (85 predoctoral trainees); the Curriculum in Bioinformatics & Computational Biology (19 predoctoral trainees); and the Genetics Medical Residency Program. The Curricula are PhD degree-granting programs. Our graduate programs train students to be creative, sophisticated research scientists prepared to pursue careers focused in genetics and genomics working in academic science, government, or commercial positions. Students conduct their dissertation research using diverse experimental approaches, from classical genetics to the most modern molecular methods, to address a broad range of contemporary problems in biomedical science. Our relatively new Curriculum in Bioinformatics and Computational Biology stands at the frontier of modern science by integrating mathematical approaches with experimental genetics. The 28 Genetics postdoctoral fellows are housed in the Department.

*Department of Microbiology and Immunology*

The faculty of the Department of Microbiology and Immunology focus on topics related to infectious diseases, studying both the pathogens that cause infection (bacteria, viruses, fungi) and host defenses against infection. Infectious diseases remain the largest cause of global mortality, providing compelling justification for studies aimed at understanding pathogen:host interactions and for developing knowledge that will lead to better ways of preventing and treating infectious diseases. The research being done in the laboratories in the department ranges from basic research on the molecular biology of bacteria and viruses to translational or clinical projects concerning different infectious diseases. Several investigators focus on the molecular basis of the immune system or on disorders of the human immune system (such as autoimmune disorders). The department Chair, ***Dr. William E. Goldman***, moved to UNC from Washington University in September 2008. The department increased NIH funding from $8.5 million in 2007 to $22.7M in 2014, ranking 4th. The increase in NIH funding from 2013 to 2014 rose by 60%. The department has 49 faculty members involved in graduate student training; of these, 27 have their primary appointment in Microbiology and Immunology. Most of the 22 faculty members with joint appointments in the department have primary appointments in one of the clinical departments of the School of Medicine. The research laboratories of the department are organized into four informal groups: Immunology, Microbial Genetics and Pathogenesis, Virology, and Molecular Biology. There is considerable overlap of research interests, and different labs frequently collaborate on specific research projects. The collegial and collaborative atmosphere in the department ensures that trainees have the opportunity to interact with numerous faculty members and to learn to use research techniques and approaches from different laboratories. The department currently has 65 graduate students and 24 postdoctoral fellows.

*Department of Pathology and Laboratory Medicine*

As led by ***Dr. J. Charles Jennette, MD*** (Department Chair), the three coequal missions of the Department of Pathology and Laboratory Medicine are to: 1) provide exceptional, comprehensive, clinically effective and cost effective pathology and laboratory medicine services; 2) teach clinical and scientific concepts of pathology and laboratory medicine, and mechanisms of disease to a wide variety of learners; and 3) advance the practice of pathology and laboratory medicine, and the knowledge of diseases and disease mechanisms through innovative research spanning the spectrum from basic to translational to clinical. The department is both a basic science department with substantial extramurally funded research (average annual grant funding over the past 4 fiscal years of $5 million) and a strong clinical department with widely acclaimed excellence in providing cutting edge pathology and laboratory medicine services. It is home to ***Dr. Oliver Smithies***, Nobel Laureate (2007) in Medicine. The Department oversees important core research facilities including the Microscopy Services Laboratory, Anatomic Pathology Translational Core Laboratory, Experimental Animal Clinical Laboratory, and Gene Expression Laboratory.

The Department’s residency and clinical fellowship programs currently have ~30 trainees. The Department’s Graduate Program in Molecular and Cellular Pathology currently has 20 outstanding students. Department faculty (42 tenured and tenure-track faculty), post-docs (15), and graduate students are involved in a wide array of basic, translational, and clinical research. The current leading areas of research emphasis are cancer, vascular pathobiology, thrombosis and hemostasis, and translational molecular genetic pathology. Faculty, trainees and students are involved in most interdisciplinary centers in the School of Medicine, with major representation in the McAllister Heart Institute, Cystic Fibrosis/Pulmonary Research and Treatment Center, Gene Therapy Center, Kidney Center, Lineberger Comprehensive Cancer Center, and Integrative Program for Biological & Genome Sciences.

*Department of Pharmacology*

The Department of Pharmacology has grown under its current Chair, ***Dr. Gary L. Johnson***, to being ranked 4th since 2011 in NIH funding for medical school pharmacology departments, with approximately $17.5 million. There are 16 full-time tenure-track faculty, as well as 17 joint appointees representing the Departments of Medicine, Physiology, Psychology, Biochemistry & Biophysics, Chemistry and the Schools of Dentistry and Pharmacy. The Department of Pharmacology is unique among the biomedical sciences. Although it is firmly rooted in fundamental laboratory investigation, the long-term goal of pharmacological research is to provide new therapies for human disease. Thus, the discipline of Pharmacology occupies a key nexus between basic biological science and the clinical sciences. The Department of Pharmacology at UNC-Chapel Hill clearly provides one of the nation's most dynamic environments for pharmacological research and training. A major theme of the Department is to understand the receptors and signaling networks that are critically involved in the actions of drugs, neurotransmitters and cytokines. There is exceptional strength in neuropharmacology, structural biology, live cell imaging, proteomics and systems biology. Faculty in Pharmacology play major leadership roles at UNC-Chapel Hill in emerging new disciplines including nanomedicine, bioinformatics, computational biology, chemical biology and drug discovery. Pharmacology faculty are broadly involved in collaborative research in most of the institution’s Centers, particularly the Lineberger Comprehensive Cancer Center, McAllister Heart Institute, Alcohol Center, and Gene Therapy Center. Currently the department has 38 graduate students, 25 postdoctoral fellows, and 16 research-track faculty.

**Departments in the College of Arts & Sciences Campus**

*Department of Biology*

Under the leadership of ***Dr. Victoria Bautch***, the Department of Biology has over 40 faculty members with research interests that span the entire scope of modern biology from the disciplines of cell, molecular, and developmental biology through the areas of ecology, physiology and behavior. The department consists of research-active faculty (56) and was ranked 5th (up two spots) in R&D funding from the NSF in FY 2009. The department received $8.9M in total extramural funding for FY 2014, $7.3M in NIH funding. Currently Biology occupies four buildings, with construction of the newest building, dedicated to genomic sciences, finished in the Spring of 2012. Faculty moved into the new labs over the summer of 2012. The Genome Sciences Building houses an interdisciplinary collection of scientists from biology, chemistry, physics and computer science.

Just over half of the Department of Biology faculty members work in the areas of molecular, cellular and developmental biology. Together, they form a very interactive group that fosters an environment emphasizing research collaboration and resource sharing. This has been instrumental in developing a state-of-the-art microscopy facility and a microarray facility. In addition, there are many formal and informal research ties among the diverse groups within the department. Notable among these are a group of investigators focused on understanding the dynamics of chromosome behavior ranging from the biochemistry and genetics of DNA repair/recombination to the movement of whole chromosomes during mitosis/meiosis as well as a group of investigators devoted to understanding the molecular aspects of developmental biology. Importantly, the department's investigators use a wide variety of approaches to attack important biological problems and often work on model biological systems -- single cell organisms such as *E. coli* or the budding yeast *S. cerevisiae*, model multicellular animals including the nematode *C. elegans*, the fruit fly *Drosophila* and the mouse, and model plants such as *Arabidopsis*. The genomics revolution has provided access to the complete DNA sequence of each of these organisms which, in turn, is offering access to all of the cell's biological machinery. The Department's faculty and students are taking advantage of this new information as they continue to focus on fundamental biological problems. The knowledge we gain in these model systems not only provides answers to these fundamental questions, but also, because all organisms share much of their cellular machinery, provides direct insight into the cellular defects that underlie human disease. ***Dr. Corbin Jones*** is the Faculty Advisor to the UNC High-Throughput Sequencing Core facility, which in only six years has developed into a major facility used by faculty across campus.

The Department of Biology provides a bridge between the biology-oriented research ongoing in other basic science departments such as chemistry, physics, and computer science and the biomedical research community located in the Medical school. The department has a very active undergraduate research program that trains a significant fraction of our undergraduate majors for future careers in research and medicine. The formal ties between Biology and the Medical School include joint participation into two interdepartmental graduate training programs. Most of the Department of Biology faculty members who are involved in molecular, cellular and developmental biology research participate in both of these interdepartmental graduate training programs. The Department is home to about 69 graduate students and approximately 35 postdoctoral fellows.

*Department of Chemistry*

The Department of Chemistry is under the leadership of ***Dr. Joseph Templeton,*** and has a distinguished faculty of 37 that includes five members of the National Academy of Sciences, six members of the American Academy of Arts and Sciences, a past president of the American Chemical Society, a Priestly Medal recipient, and numerous recent recipients of other national and international awards. The research program is one of the strongest in the country with more than 300 publications published annually and over 100 patents filed within the last 10 years. Current faculty bring in over $21 million in external funding to the department annually. The Department supports six areas of research including analytical chemistry, chemical biology, inorganic and organometallic chemistry, organic chemistry, materials/polymers/nanoscience, and physical and theoretical chemistry. ***Dr. Joseph DeSimone*** leads the Carolina Center of Cancer Nanotechnology Excellence, which includes members from the College of Arts & Sciences and Schools of Medicine and of Pharmacy. Research discoveries by faculty in the department include ultramicroelectrodes in neuroscience for *in vivo* electrochemical measurements and sensors for in vivo healthcare monitoring. Faculty members collaborate with both the Lineberger Comprehensive Cancer Center and the McAllister Heart Institute. The graduate Chemistry program has a long-standing tradition and is one of the largest and oldest in the country with the first Ph.D. degree in Chemistry awarded in 1883. The department currently has 234 graduate students and ~40 postdoctoral fellows.

***School of Pharmacy***

The Eshelman School of Pharmacy (ESOP) at The University of North Carolina at Chapel Hill offers both a professional pharmacy program leading to the Pharm.D. degree and a graduate program in Pharmaceutical Sciences (PHRS) leading to the Ph.D. degree in a research-intensive environment. The ESOP ranks 3rd among Schools of Pharmacy based on the research funding awarded by the National Institutes of Health, $10.3M in FY2014. Over the last seven years, the graduate program has grown both in scope and in size. The number of students enrolled in PHRS has increased from 55 to 94 students. Over the same period, the number of tenure-track faculty in the ESOP has grown 30% to a total of 70. The School’s proximity to the Research Triangle Park and other research campuses spurs collaboration and partnerships in academia and with industry. Research in ESOP has spawned a number of spin-off companies and in 2009, the School led the University with 26 invention disclosures. The PHRS Ph.D. program is an umbrella program as the ESOP is organized into five Divisions based on research and/or practice emphasis: Medicinal Chemistry and Natural Products (MCNP), Molecular Pharmaceutics (MOPH), Pharmacotherapy and Experimental Therapeutics, and Pharmaceutical Outcomes and Policy, and Pharmacy Practice and Experiential Education. Each Division offers a track within the PHRS Ph.D. program, and MCNP and MOPH faculty participate in the BBSP. The respective tracks are designed to train students in a specialty area of drug discovery and experimental biology (MCNP) or drug delivery, formulation, and metabolism (MOPH).

MCNP and MOPH comprise dynamic, multifaceted scientific disciplines dedicated to the improvement of human health through hypothesis-driven biological research as well as pharmaceutical discovery and development. The MCNP and MOPH divisions are chaired by ***David Lawrence*** and ***Leaf Huang***, respectively. A major faculty recruitment effort has brought several high-profile individuals to the ESOP, including ***Bryan Roth****,* ***David Lawrence****,* ***Stephen Frye*** and ***Bill Janzen*** in MCNP, and ***Xiao Xiao****,* ***Russell Mumper****,* ***Michael Jay***and ***Rudy Juliano*** in MOPH. Faculty in MCNP and MOPH play major leadership roles at UNC-Chapel Hill in emerging new disciplines including nanomedicine, bioinformatics, computational biology, chemical biology and drug discovery. As part of the emerging focus of the ESOP on translational research the School has recently established the **Center for Integrative Biology and Drug Discovery**, which is directed by Stephen Frye, a former global head of Medicinal Chemistry at GlaxoSmithKline, and the **Center for Nanotechnology in Drug Delivery**, which is directed by Russell Mumper. PHRS faculty are broadly involved in collaborative research in many of the university’s other Centers, including the Lineberger Comprehensive Cancer Center, Carolina Center of Cancer Nanotechnology Excellence, Gene Therapy Center, Program in Molecular Therapeutics, and the Gates Foundation Program on Infectious Diseases. PHRS faculty also participate in other curricula and hold joint appointments with many other departments, including Chemistry, Biochemistry and Biophysics, Pharmacology, Biomedical Engineering, the Cell and Molecular Biophysics Program, the Curriculum in Toxicology, and the training program in Material Science and Engineering.

**University-wide Curricula**

There are also four University-wide, PhD-granting curricula, each of which is available and highly relevant to our XX Scholars.

*Curriculum in Bioinformatics and Computational Biology*

The Predoctoral Training Program in Bioinformatics and Computational Biology (BCB) was established at UNC-Chapel Hill in Fall 2002 to address the need for expertise in two related disciplines, bioinformatics and computational biology. These are the disciplines that can analyze and interpret the large, complex datasets which have emerged in the last decade as genomics, proteomics, systems biology, and other high-throughput approaches have become more feasible. Bioinformatics and computational biology utilize techniques from applied mathematics, informatics, statistics, and computer science to solve biological problems. In 2007 the training program transitioned to the Ph.D. Curriculum in Bioinformatics and Computational Biology. The goal of the Ph.D. Curriculum is to train the next generation of scientists who can develop and apply quantitative/analytical tools to driving biological problems. The Ph.D. curriculum provides the necessary latitude to prepare students with the right balance of quantitative skills (e.g., mathematics, statistics, and computer science) and experimental approaches (e.g., genetics, cell biology, molecular biology) for making important contributions to modern biological research. There are currently 13 full professors, 9 associate professors, and 11 assistant professors among the 33 mentoring BCB faculty. Additionally there are 11 resource faculty. The Ph.D. curriculum consists of four key components: formal coursework, research rotations, Ph.D. research and a colloquium. The coursework includes three tiers of training: foundational courses, core modules, and advanced courses. Eight specialized core modules have been developed that cover major areas of bioinformatics and computational biology, such as information theory, machine learning, sequence comparison, phylogeny, data management, ontology, data mining, biostatistics, biomolecular structure/function prediction, and modeling of complex systems. In addition to the PhD candidates, the program also offers graduate students getting their PhD in another department or curriculum the opportunity for certificate level training, which would concentrate in a specific area. There are currently 19 predoctoral students in the curriculum.

*Curriculum in Genetics and Molecular Biology*

The Curriculum in Genetics and Molecular Biology is an interdepartmental PhD program directed by ***Dr. Jeff Sekelsky*** of the Department of Biology that was established in 1963 and has had continuous NIH T32 support since 1975. The goal of the program is to train students to be creative, sophisticated research scientists in the disciplines of genetics and molecular biology. The training emphasizes the acquisition of basic knowledge in genetics and molecular biology, the accumulation of laboratory skills, and the development of the ability to formulate experimental approaches to solving contemporary problems in the biological and biomedical sciences. The Curriculum in Genetics and Molecular Biology is the only UNC-Chapel Hill program that specifically emphasizes genetics, and has enabled many faculty with superb research programs to train predoctoral students in this discipline. The 84 training faculty have appointments in all of the basic science departments in the School of Medicine as well as the Department of Biology in the College of Arts and Sciences. These faculty members participate in student training by acting as dissertation sponsors, serving on dissertation committees, teaching in Curriculum sponsored courses, inviting speakers for the Curriculum's seminar series, and serving on administrative committees such as the Written Qualifying Exam Committee. There are currently 85 students enrolled in the Curriculum and they are training in over 50 different laboratories on the UNC-CH campus. Student research in the Curriculum is quite broad, with particular strengths including the generation and characterization of mouse models of human diseases, the characterization of molecular mechanisms of replication, recombination and repair, gene therapy, the control of gene expression, and the genetic basis of cancer.

*Curriculum in Neurobiology*

The Curriculum in Neurobiology stresses a multi-disciplinary approach to the study of neurons, the brain, behavior, and neuropsychiatric disorders. The Curriculum is co-directed by ***Drs. Garret Stuber and William Snider*** and includes more than 55 faculty members in 13 departments and 5 specialized research centers. The faculty is highly competitive in receiving extramural grant support, with over $42 million in funding to UNC neuroscientists (as of April, 2007). These funds help to support individual research laboratories as well as impressive core facilities available to faculty and students. The curriculum facilitates communication between neuroscientists across departmental barriers and promotes better understanding among students and researchers of the conceptual and technical approaches in different disciplines. In 2001, the Curriculum in Neurobiology moved into the newly constructed Neuroscience Research Building, which also houses the UNC Neuroscience Center. A central conference room, computing, administrative, and student office space is located near the labs of many of the primary faculty in the training program, creating a real neuroscience community. Forty-three students are currently enrolled in the Curriculum in Neurobiology.

*Curriculum in Toxicology*

The Curriculum in Toxicology is an interdisciplinary graduate program that brings together UNC-Chapel Hill faculty members with research and teaching interests in toxicology. The Curriculum administers the graduate training program leading to the PhD degree in toxicology. Faculty members in the Curriculum are drawn from the UNC-Chapel Hill Schools of Medicine, Pharmacy, and Public Health, and from organizations within the nearby Research Triangle Park, such as the Chemical Industry Institute of Toxicology, the Environmental Protection Agency, and the National Institute of Environmental Health Sciences. The Curriculum is currently led by ***Dr. Ilona Jaspers.***

The goal of the program is to develop trainees that are knowledgeable in the basic principles of toxicology with in-depth experience in the development, execution and publication of research relevant to toxicology. Students are exposed to general techniques that cut across disciplines, such as molecular biology, genomics, animal models and biomarkers of exposure. The six general areas of emphasis are molecular and cellular toxicology, carcinogenesis, neurotoxicology, pulmonary toxicology, reproductive and developmental toxicology. Currently there are 20 predoctoral trainees in the curriculum.

**Office of Postdoctoral Affairs (OPA)**

This nationally-recognized postdoctoral initiative, founded in a collaborative effort between Academic Affairs and Health Affairs at UNC-Chapel Hill, is now directed by ***Sibby Anderson-Thompkins***, who joined this program in January 2007 bringing ten years of experience in higher education research, policy, and administration. In conjunction with the UNC Postdoctoral Association (PDA), the Office of Postdoctoral Affairs has a campus-wide mandate that engenders a strong sense of community among all young researchers at UNC and promotes their professional development. The OPA works with the Office of the Provost, the School of Medicine, the College of Arts and Sciences, the Office of Graduate Education and individual Centers and Departments to provide a series of career and professional development programs for postdoctoral fellows at UNC and at neighboring institutions. Because postdoctoral fellows and graduate students share many career and professional development needs, all of the OPA programs are also open to graduate students.

Examples of career services and professional development programs coordinated by the OPA include seminars on jobs in patent law, presentations to foster an understanding of intellectual property issues, interviewing skills, negotiating skills, resumes and CVs, public speaking skills, and nontraditional careers in science. The evolution of this unique UNC postdoctoral initiative and its development of a comprehensive training program have gained national recognition and was described in an article published by the educational committee of the American Society for Cell Biology. In 2005, UNC was voted “Best Place to Work for Postdocs” among all U.S. academic institutions in *The Scientist* magazine’s annual survey of the nation’s postdoctoral population, and a particular mention was made of the strength of the programming provided by the Office of Postdoctoral Affairs.

**UNC Research Centers**

While all faculty members have a primary appointment in a Department, most also are members of the large number of centers and programs dedicated to research at UNC. These Centers help provide space, staff affiliated with core facilities and specialized services for faculty members and their trainees. A selected group of centers that are particularly relevant to the X Scholars are listed below and then briefly described in the text that follows.

**Table of Selected Research Centers and Institutes at UNC-CH**

| *Name* | *Admin Unit* | *Director* | *Primary Funding**Source* | *Number of Members [including non-UNC members]* |
| --- | --- | --- | --- | --- |
| Center for AIDS Research (CFAR) | SOM | Ronald Swanstrom, MD | NIH/NICHD;NIAID;NCI; CIDA; NIMH;NHLBI | 350 |
| AIDS Clinical Trial Unit (ACTU) | SOM | Joseph Eron, MD | NIH, HRSA, SPNS, SAMSHA, FRAM | 11 |
| UNC Center for Infectious Diseases | UNC | Myron S. Cohen, MD | NIH | 105 |
| Lineberger Comprehensive Cancer Center | SOM | Norman Sharpless, MD | NCI | 320 |
| McAllister Heart Institute | SOM | Nigel Mackman, PhD | NHLBI | 125 |
| Gene Therapy Center | SOM | Jude Samulski, PhD | NIH | 5 |
| Cystic Fibrosis/Pulmonary Research and Treatment Center | SOM | Richard Boucher, MD | NIH | 40 |
| Nutrition Obesity Research Center | SPH | Steven Zeisel, MD | NIH/NIDDK | 60 + over 40 affiliates |
| Center for Gastrointestinal Biology and Disease | SOM | Robert Sandler, MD | NIH | 33 members38 associates |
| Bowles Center for Alcohol Studies | SOM | Fulton T. Crews, MD | NIH | 22 |
| Thurston Arthritis Research Center | SOM | Joanne Jordan, MD | NIH NIAMS | 49 |
| Carolina Population Center | UNC | Philip Morgan, Ph.D. | NIH NICHD | 68 |
| Cecil G. Sheps Center for Health Services Research | UNC | Timothy Carey, MD | NIH, Other Federal  | 214 |
| Center for Environmental Medicine & Lung Biology | SOM | David Peden, MD | US EPA Cooperative Agreement; NIH | 23 |
| Carolina Institute for Developmental Disabilities | SOM | Joe Piven, MD | NIH NICHD | 62 Research faculty |
| Neuroscience Center | SOM | William D. Snider, MD | NIH | 37 |
| Center for Aging and Health | SOM | Jan Busby-Whitehead, MD | NIH HRSA | 26 |
| Biomedical Research Imaging Center (BRIC) | SOM | Weili Lin, PhD [Interim] | NIH | 9 |
| Carolina Center of Cancer Nanotechnology Excellence | SOP | Leaf Huang, PhD | NIH | 8 |

Abbreviations: SOD = School of Dentistry; SOM = School of Medicine; SPH = School of Public Health; UNC = UNC-CH and/or the consolidated university

***UNC Center for AIDS Research (CFAR) -*** The purpose of the UNC Center for AIDS Research (CFAR) is to provide the multidisciplinary environment and infrastructure to support investigation of the HIV/AIDS epidemic using clinical and behavioral research, HIV biology and pathogenesis at the molecular level, and educational outreach. The UNC CFAR is a consortium of three complementary institutions: UNC-Chapel Hill, Research Triangle Institute, and Family Health International. Seven core section/laboratories support researchers. Members are from multiple institutions around the world.

***AIDS Clinical Trials Unit -*** The AIDS Clinical Trials Unit (ACTU) is dedicated to carrying out and developing research on HIV infection and its associated opportunistic infections and providing access to promising clinical protocols to persons living with HIV. This Center, established and continuously funded since 1987, is one of the most productive ACTUs in the nation. Among its areas of focus are antiretroviral therapies, immunomodulators, opportunistic infections, HIV-related malignancies, the wasting syndrome, neurologic complications of HIV, and HIV-related GI illnesses. Patients are enrolled in clinical trials in cooperation with 36 other centers. The Retroviral Research Laboratory is housed in the Department of Laboratory Medicine and Microbiology and Immunology.

***University of North Carolina Center for HIV/STDs and Infectious Diseases (CID) -*** Recognizing that human beings live in balance with microbes and parasites, researchers at the CID work in a context of constantly evolving, emerging disease models. The research strategy at the center is to combine efforts of many scientists drawn from different disciplines but united in the common goals of coordination and collaboration toward furthering basic and applied research.

***Lineberger Comprehensive Cancer Center -*** Established in 1975, this is one of 41 National Cancer Institute (NCI)-designated Comprehensive Cancer Centers. Researchers from more than 25 academic departments participate in the center and currently hold $65.7 million in federal grants. The center sponsors 10 research programs:

* The five Basic Laboratory Science programs in Cancer Cell Biology, Immunology, Molecular Carcinogenesis, Molecular Therapeutics, and Virology investigate the molecular and genetic basis of carcinogenesis and progression.
* The Clinical Science programs in Clinical Research, Breast Cancer, and Radiobiology and Imaging encompass multidisciplinary translational research, clinical trials, and innovative clinical applications of computer science in radiation oncology.
* The two Public Health Science programs are Cancer Prevention and Control, and Cancer Epidemiology (including Biostatistics).

In addition to these 10 programs, the Center hosts one of the nation's eight Specialized Programs of Research Excellence (SPORE) in breast cancer funded by the National Cancer Institute.

The ***McAllister Heart Institute***’s mission is to solve fundamental questions regarding cardiovascular disease through basic, preclinical and applied research including new tools for diagnosis and treatment. Founded in 2000 and now headed by ***Dr. Nigel Mackman***, the Center’s 40 members have brought $8 million new NIH funding to UNC. Active programs include angiogenesis, atherosclerosis, cardiovascular development, integrative physiology, vascular wall biology, cardiac function, and clinical/translational research.

***UNC Gene Therapy Center*** – The School of Medicine created this Center in 1996 with the goal of merging molecular genetics research with healthcare delivery. The Center provides important resources to investigators through its Vector Core, which was created to support basic and preclinical gene therapy studies. Critical expertise was established to develop and produce first generation vectors for pre-clinical studies. The facility functions to share expertise among researchers at UNC and also provides a GLP facility for human cell culture and manipulation. The Vector Core produces research vectors, primarily focused on adeno-associated virus (AAV). The core participates in ongoing research of AAV in order to exploit the unique features of this virus to develop an efficient viral vector system for use in human gene therapy.

***Cystic Fibrosis/Pulmonary Research and Treatment Center*** - This center houses one of the largest clinical programs in cystic fibrosis in the country. The Center carries out basic research and with a multidisciplinary team is focusing on the pathogenesis of and therapy for this genetic disease. Center investigative teams have research emphases including: gene therapy, airway epithelial cell biology, transgenic animals, gene therapy for CF lung disease, airway epithelial mucin secretion biology, mediators of inflammation in airway epithelial ion transport, mucociliary clearance, and extracellular nucleotide receptors. The most recent multidisciplinary effort involves clinicians, biomedical investigators, physicists and applied mathematicians working to understand the physical basis of lung clearance. Through mathematical modeling and experimental projects relating to the physics and chemistry of mucus, the group is working to understand the interactions between cilia and mucus, and the role of the airways epithelium in maintaining an environment appropriate for effective clearance, with the goal of eventually being positioned to understand how the system goes wrong.

***Nutrition Obesity Research Center*** - is one of only twelve centers in the country funded by the NIDDK that is specifically designed to provide expertise and support for scientists studying the role of nutrition and obesity in public health. Since our inception in 1999, we have adapted and translated expertise in community, population-based and clinical studies to facilitate the cross-disciplinary transfer of ideas and information to the laboratory, and vice versa for the development of cutting-edge nutritional sciences and obesity-related research.

***Center for Gastrointestinal Biology and Disease*** - This center promotes research and teaching on aspects of GI biology, physiology, and epidemiology with special emphasis on inflammatory bowel disease. Members of the center are drawn from the School of Arts and Sciences, the School of Medicine, and the School of Public Health as well as the NC State University's School of Veterinary Medicine. Cores dedicated to development and production of gnotobiotic animals, molecular imaging, advance cell technology and immunotechnology, gene delivery and biostatistics support the broad program in inflammation, proliferation, fibrogenesis and epidemiological/clinical research.

The ***Bowles Center for Alcohol Studies*** conducts, coordinates, and promotes basic and clinical research on the causes, prevention and treatment of alcoholism and alcohol abuse. The Bowles Center is one of 14 Alcohol Research Centers supported by the National Institute on Alcohol Abuse and Alcoholism (NIAAA). The Center's research into the causes and mechanisms of addiction provides tomorrow's best hope for improved treatments and, ultimately, finding a reliable cure. Researchers investigate the mechanisms of alcohol tolerance, dependence and withdrawal, as well as damage to the brain, liver, and fetus. Investigators at the Center develop more compounds to be used, alongside standard therapies, to alleviate withdrawal and reduce relapse. The interaction of genetics and environment are studied to better understand the causes of addiction.

***Thurston Arthritis Research Center*** – This Center studies issues relevant to arthritis and other musculoskeletal diseases including autoimmunity. Researchers associated with the center are conducting studies focused on genetics, peptide/MHC structure function relationships, the repertoire of T cell receptor and Ig genes and their role in autoimmunity, inciting agents in autoimmunity (bacterial cell walls, heat-shock proteins, mercury chloride), the biochemistry of osteoarthritis, and studies of inflammation processes and therapy in experimental arthritis, among others.

***Carolina Population Center*** - For decades the Carolina Population Center has served the research and training needs of faculty who wish to conduct population research, both national and international. The Center's elected faculty fellows have primary appointments in a number of Departments and Schools and Colleges across UNC. Support services provided by the Center include: access to computer networks; information services support including access to an in-house population library collection; support for appropriate research applications using the Geographic Information Systems methodology; statistical consultation; editorial and graphics support for professional publications and presentations; and assistance in preparation of grant proposals.

***Cecil G. Sheps Center for Health Services Research*** - The Sheps Center seeks to understand the problems, issues, and alternatives in the design and delivery of health care services with the goal of improving the health of individuals, families and populations through this analysis. The center has an interdisciplinary program of research, consultation, technical assistance and training focused on timely and policy-relevant questions concerning the adequacy, cost, and effectiveness of health care services. The center was one of the early sponsors of research into rural health needs. The center presently holds an AHRQ grant to develop a Center of Excellence on Overcoming Racial Health Disparities in conjunction with NC Central and Shaw Universities. The causes and contributing factors leading to racial inequities in access to health care and health outcomes for prostate cancer, HIV and STD infections, and high blood pressure are studied.

***Center for Environmental Medicine and Lung Biology*** - This long established center integrates multidisciplinary approaches and sophisticated technology to study the effects of inhaled agents on diseased and healthy human subjects following in vivo exposures in environmental chambers. Human cells and cell lines are studied in vitro. The center is led by ***Dr. David B. Peden***. In addition to applied and basic research programs, the Center offers educational and research training opportunities for graduate students and postdoctoral fellows. The Center, which is housed in a dedicated building on the Health Affairs campus (EPA/UNC Human Studies Facility), also facilitates access to the sophisticated animal environmental exposure facilities of the Environmental Toxicology Division of the U.S. Environmental Protection Agency (EPA), located in Research Triangle Park. Twenty-five investigators from several departments in the Schools of Medicine and Public Health have been involved in center activities. Most collaborate closely with EPA scientists in the Human Studies Division, who have adjunct faculty appointments at UNC.

***Carolina Institute for Developmental Disabilities –*** is a comprehensive program for services, research, and training relevant to individuals with developmental disabilities and their families., the Carolina Institute provides a continuum of clinical services from complex, interdisciplinary evaluations on-site to more limited and selected clinical services and training in all 100 counties in North Carolina. The Institute conducts research and research training related to understanding the pathogenesis and treatment of neurodevelopmental disorders. Funded in 1967 by a P30 grant from the National Institute of Child Health and Development (NICHD), the CIDD is one of 14 research centers in the U.S. funded to conduct research on mental retardation and developmental disabilities. Funding from the NICHD grant provides support for four research cores that provide cutting edge services to NDRC investigators conducting research relevant to the mission of the center. The Center currently includes over 42 externally funded investigators in research areas ranging from basic developmental neurobiology to translational studies of the pathogenesis and treatment of selected neurodevelopmental disorders such as autism and fragile x syndrome, to basic and applied studies of child development.

***UNC Neuroscience Center*** - The mission of the UNC Neuroscience Center is to promote neuroscience research with a specific emphasis on developmental, cellular, and disease-related processes. In the fall of 2001, resident scientists of the UNCNC moved to laboratories in the new Neuroscience Research Building on the School of Medicine campus. Additional neuroscience research groups in both basic (Cell and Molecular Physiology) and clinical (Neurology) departments remain closely associated with the center. The center researchers are organized into Research Working Teams, each of which includes basic and disease-related interests. The goal is to integrate work in the neuroscience field to advance understanding and to identify and study treatment approaches over a broad group of neurological functions. The center supports several internal core facilities including a Morphology and Imaging Core that provides confocal microscopy and other imaging modes.

***Center for Aging and Health*** *-* hosts an interdisciplinary group of professionals. In addition to clinical research, the Program provides protected research time for junior faculty engaged in basic and translational research related to aging. From providing patient care to finding ways to bring evidence-based research and training to improving clinical care, our faculty, clinicians, researchers, and educators all work to improve the quality of life for our aging population.

***Biomedical Research Imaging Center –*** the Biomedical Research Imaging Center (BRIC) was formed in 2005 to support image-based biomedical research across the UNC System. The BRIC will be a statewide resource serving researchers across the state of North Carolina in a central facility that will handle the acquisition, processing, analysis, storage, and retrieval of images. Building on internationally-recognized programs in medical imaging at both Chapel Hill and NC State, the goals of the BRIC are to provide an environment that promotes multi-disciplinary/multi-departmental research interactions that can more effectively address problems in biomedical imaging.

**Core Research Facilities**

The University of North Carolina has made a major effort to make easily available the essential core research technologies required by our students and faculty. Recognizing the importance of these facilities to the research enterprise, the School of Medicine appointed ***Dr. Michael Topal*** as Assistant Dean for Translational Technologies. The Office of Translational Technologies monitors the effectiveness of core facilities, plus makes recommendations for support of the facilities and provides some institutional resources for their general support and improvement. The philosophy of each core facility is straightforward. It provides access to the appropriate technology for the entire campus essentially on a first-come, first-served basis. There is a recharge mechanism that recovers a majority of the costs of the facility. Those expenses that are not covered from the recharge mechanism are covered by the School of Medicine from various funds. Additionally, many core facilities have substantial core funding from various Center and Program core grants. Each core facility is directed by a skilled professional (usually a Ph.D.) who is not a tenure-track faculty member, and whose job is to manage the core. These facility managers are a critical resource and they routinely participate in teaching and training students and fellows in the technology, attend appropriate scientific meetings and are often involved in collaborative research with faculty. Listed below are a number of the long-standing successful core facilities that enrich the research environment of our X Scholars:

The **UNC-CH Genome Analysis Facility** generates DNA sequence data on automated DNA sequencing machines from DNA templates and primers provided by the user. The Sequencing Facility provides long read lengths (700-800 nucleotides) that are stored directly to computer files accessible via the Web, facilitating further analysis. Other services exist to support the primary service. These include providing: standard vector primers known to work well in DNA sequencing; information for the preparation of samples for optimal results; help in interpreting the sequence results obtained from the Sequencing Facility; access and information about software for sequence; data interpretation; large project sequencing with the facility designing subsequent reactions and delivering a completed sequence. In the fall of 2007, the Core added an Illumina Solexa Genome Analyzer.

The **Flow Cytometry Facility** at UNC-CH exists to provide biomedical investigators with all aspects of research flow cytometry -- analytical and high speed sorting instrumentation, data analysis, and expertise. The Facility instrumentation has been obtained with funds primarily from The North Carolina Biotechnology Center, The School of Medicine, The Lineberger Comprehensive Cancer Center, The Department of Microbiology and Immunology, The Gene Therapy Center, The Center for Gastrointestinal Biology and Disease, and The Thurston Arthritis Research Center. Operating support is provided by The Lineberger Comprehensive Cancer Center and The Department of Microbiology and Immunology. The Facility supplies access to flow cytometry instrumentation either in an investigator-operated format or Facility staff-operated format. Training to become competent in design of flow cytometry experiments, in operation of certain of the equipment, and in data analysis and interpretation is an essential component of the Core’s goals. Equipment includes a 2 Becton-Dickinson FACScans, a FACSCalibur, a Cytomation MoFlo, a Laser Scanning Cytometer (LSC), an Intelligent Imaging Innovations Digital Deconvolution Microscope, and PC and Mac off-line data analysis computers with a variety of flow cytometry data analysis software. The FACScan and FACSCalibur instruments are available to be run by the user, following appropriate training. This core has recently purchased a Reflection from iCyt Visionary Bioscience that will be devoted to use with human cells, expanding our translational capabilities. This April (2015) the core received an NIH SIG to purchase an ImageStreamX Mark II.

The **Confocal and Multiphoton Imaging Facility** makes available the LeicaTCS-SL Laser Scanning Confocal and the Zeiss LSM 510 microscopes. The confocal microscope is hosted by the Cell and Molecular Physiology Department and is available for use by members of the neuroscience and research communities at the University of North Carolina.

The UNC **Macromolecular X-ray Crystallography Facility** provides resources and training to UNC macromolecular crystallographers for single crystal data collection and processing. They facilitate and assist UNC researchers not trained in X-ray crystallography in carrying out simple crystallographic analyses (including crystallization) of their biological molecule. Equipment includes R-Axis IV++ detector/Rigaku RUH3R generator/Osmic Confocal Blue Optics, R-Axis IV detector/Rigaku RU-200 generator/Osmic Confocal Blue Optics, R-Axis Iic detector/Rigaku RU-200 generator/Osmic Confocal Blue Optics, and a high throughput Crystallization Workstation for 96-well plates. The Protein Expression and Purification Core is under the same direction and specializes in the production of pure, functional proteins for structural, biophysical, and biochemical studies. It is specifically designed as a “front-end” interface to other components of the Center for Structural Biology.

The **Macromolecular Interactions Facility** provides instrumentation and resources for biophysical characterization of interactions of biological macromolecules. The capabilities include measurement of affinity, stoichiometry, kinetics and thermodynamics of interactions among proteins, DNA and their cognate ligands. Resources exist for analyzing the biophysical characteristics of molecular weight, shape, and conformations of proteins and DNA; and for exploring bimolecular interactions in real-time. The facility is directed by ***Dr. Ashutosh Tripathy***, who assists investigators in the design and performance of experiments and interpretation of the results. Often the students (and faculty) do not have the appropriate biophysical background to easily develop these analyses themselves and thus the facility has been broadly useful to a large number of research groups. The students are trained to use the instrumentation and the Director regularly gives presentations to interested groups explaining the types of problems applicable for investigation using the instrumentation in the facility. Equipment available in the Macromolecular Interactions Facility includes a Biacore 2000, 3 Beckman Analytical Centrifuges (XL-I, XXL-F and XL-A), SLM-Aminco 8100 Fluorimeter, Microcal VP-ITC Isothermal Titration Calorimeter, Microcal VP-DSC Differential Scanning Calorimeter, Applied Photophysics and AVIV CD Spectropolarimeters, and Wyatt Multi-angle Light Scattering Equipment

The **Animal Models Facility** assists investigators in creating both transgenic and “knock-out” mice. The Animal Models Facility is part of the UNC Mutant Mouse Resource, funded by an NIH Regional Resource Grant and closely affiliated with Jackson Laboratories. Directed by ***Dr. Dale Cowley***, the facility also develops new approaches to creating genetically defined mice and is currently involved in learning the technology to clone mice, which will expand its capabilities. Other services of the Animal Models Facility include transgene fragment isolation, targeted ES cells for PCR screen or for Southern, homozygous ES cells, Cre or Flp treatment of ES cells, karyotyping of ES cells, pronuclear microinjection, gene-targeted chimeras, tail DNA purification, PCR screening, Southern blot, embryo cryopreservation, embryo thaw and implant, sperm cryopreservation, in vitro fertilization with implant, and ovary transplant.

The **Mouse Histopathology** facility, directed by **Drs. Virginia Godfrey** and **Qing Yang**, provides histopathology analysis—high-quality processing of fixed tissues into hematoxylin and eosin-stained paraffin slides as well as preparation of frozen tissue sections -- for investigators studying various mouse mutants and genetic models. The facility also provides immunocytochemistry, standard histochemistry, and in situ hybridization techniques. It is very common for a “gene knockout” to have unexpected or subtle phenotypes and the typical investigator, student or postdoctoral fellow may not be able to interpret the abnormalities in the animals, especially if the phenotype is expressed in an unexpected tissue. The facility provides consultation as well as technical services allowing interpretation of the experiment. With the increasing use of animal models for studies of gene function, this facility has been invaluable in assisting UNC investigators in analyses of the phenotypes of mice and will continue to be so in the future. Jointly supported by the UNC Lineberger Comprehensive Cancer Center, the Division of Laboratory Animal Medicine and the Center for Gastrointestinal Biology and Disease, the Histopathology Core also helps educate inexperienced researchers regarding the appropriate harvesting and fixation of tissues, histopathologic procedures, stains, etc.

The **Genomics and Bioinformatics Microarray Core Facility**, scientific advisor ***Dr. Michael Topol***, was partially funded by the HHMI grant for Genetics, as well as several external grants and internal funds. It can make and analyze microarrays for measuring expression (mRNA) levels of large numbers of genes simultaneously. It contains a Genome Systems Microarrayer for printing chips containing up to 12,000 genes per slide, and an Axion scanner for analysis of the data. We offer expression analyses of five species: yeast, Drosophila, Arabidopsis, Mouse and Human. Currently we have prepared the DNAs for the 6000 yeast ORFs as well as for 40,000 human genes. In 2004 the GBCF instituted stringent quality control measures; the arrays are certified by the GBCF for quality and reproducibility among arrays and across different printing batches. Improved GBCF production capabilities have been matched by improved hybridization methods. The GBCF now offers RNA amplification services in addition to standard hybridization methods. The amplification extends our standard input amounts from the 10 µg range of total RNA required down to the 0.5 µg range. The GBCF has also initiated development of dye-swap analysis for our users. Dye-swap analysis is not required for gene expression profiling studies, but is an important statistical control for gene identification studies. In addition, the facility in 2004 initiated an upgrade to the robotic printer to enable higher density 30,000-gene human and mouse arrays to be printed. We are also providing the necessary computer support for the analysis of the data. The UNC Microarray Database currently houses over 4000 experiments and has 147 registered users. The GBCF bioinformatics group will also grow to include archiving and analysis of High Throughput Genotyping data (SNP analysis), to improve upon gene annotation and curation efforts, and will expand into proteomic data analyses. The Neuroscience Center also has an Affymetrix reader for analysis of commercial oligonucleotide based arrays located in the Neuroscience Research Building.

The **Mammalian Genotyping Core** is a high-throughput facility. Its primary goal is to assist researchers in elucidating genetic components of complex diseases. Two genotyping platforms offer flexibility to type a wide range of SNPs, from 1 to 1,000 at a time. The two platforms are the ABI TaqMan SNP genotyping for single-plex SNP genotyping and the Illumina BeadArray for multi-plex SNP genotyping. The TaqMan can do both pre-design/validated assays and custom designed assays. The facility services both human and mouse analyses.

The **Functional Genomics Core** is a heavily used facility serving the entire research campus at the University of North Carolina-Chapel Hill. Currently this core provides the only Affymetrix platform on the UNC-Chapel Hill campus. Expression profiling with Affymetrix arrays allows investigators to study the expression pattern of an entire genome at one time. This powerful tool enables researchers to study everything from transcriptional changes during development to disease progression. In addition to continued usage of expression arrays, this facility has seen a dramatic increase in the number of single nucleotide polymorphism (SNP) mapping arrays being used. These arrays have many uses including identifying specific mutations in the population that track with a particular disease or the differential effects of a particular drug on a patient population. We are also in the process of developing novel applications for analyzing homozygosity and copy number in disease pedigrees. The Applied Biosystems 7500 real-time PCR instrument, also contained in the Core provides a tool to verify expression levels of individual genes identified from the microarray analyses as well as quantitative expression studies in a variety of tissues. The newest acquisition is the Affymatrix Gene Titan.

The **Mouse Behavioral Phenotyping Laboratory**, directed by ***Dr. Sheryl Moy***, provides investigators with a wide variety of mouse behavioral tasks to analyze targeted gene mutations relevant to basic research and models of human diseases, inbred strains, pharmacological treatments, gene therapies, etc. Initial testing includes a standardized battery for measures of general health, home cage behavior, and neurological reflexes. Sensory abilities and motor functions are evaluated with a sequence of simple tasks. Multiple tests are available to evaluate mice in specific behavioral domains, including social interaction, learning and memory, and prepulse inhibition.

The **Bioinformatics** **Center** provides assistance to students and faculty in dealing with the immense influx of new information coming from the genome projects. ***Dr. Hemant Kelkar*** is the Core director and helps promote the use of computational tools for molecular biology, genetics, protein chemistry, and biochemistry research at the University of North Carolina. The center instructs in-depth workshops on topics ranging from DNA, RNA and protein sequence analysis to database searching, genomic predictions and molecular modeling. The center also contributes to selecting and providing computational programs, through Academic Technologies and Networks (ATN), such as GCG, SYBYL and Insight II/Discover. As a bioinformatics analysis resource, the UNC-CH Center for BioInformatics also provides expert analysis on database searching, phylogenetics, protein structure prediction, sequence analysis and molecular modeling. ***Dr. Brenda Temple*** directs the **Structural Bioinformatics Core** where she assists students in molecular graphics for analysis of structures of proteins, and in “threading” techniques for deducing the structure of protein based on known structural homologues. Hemant and Brenda serve as liaisons to the central computing facility at UNC-CH, and are responsible for maintaining a large set of program licenses that are available to all UNC investigators. These facilities have been invaluable to researchers in accessing the vast amount of data now available.

The **Michael Hooker** **Proteomics & Mass Spectrometry** **Facility** under the direction of ***Dr. Lee Graves*** provides UNC with a state-of-the-art facility to identify proteins and to assist in the characterization of protein modification and differential expression. The core serves the greater university community by providing a resource for training, education, and consultation in modern proteomic techniques. Services include protein Identification (identification of separated proteins and identification of proteins in 1 and 2-D gels), protein characterization (molecular weight, and characterization of posttranslational modifications such as phosphorylation and glycosylation) and protein quantitation (differential gel electrophoresis using cy-dyes and 2D-PAGE). Equipment includes a Triple-Quad electrospray mass spectrometer, a MALDI and QTOF spectrometers, 2 MALDI-TOF-TOFs, and an LTQOrbitrap.

The **Hooker Imaging Core** provides users access to advanced light microscopy, digital image acquisition and image processing capabilities under the co-direction of ***Dr. Jerry Gordon and Robert Curri***n. Users receive thorough instruction on how to setup and use the required instrumentation with emphasis targeted to the specific requirements of their experiment. Careful attention is also paid on how to optimally obtain accurate data. The newest acquisition is the Zeiss 880 confocal microscope. Other instruments include: Olympus FV100 confocal, Zeiss LSM 510 Meta Confocal, Nikon 2000E inverted widefield microscope and Leica MZ16FA fluorescence stero macroscope.

The **Rodent Advanced Surgical Models Core Lab,** under the direction of ***Dr. Brian Cooley***, provides a variety of established and experiment-specific animal surgical/microsurgical models and non-invasive procedures for a broad range of research applications. Standard procedures include heart injury models (e.g. LAD ligation/ischemia-reperfusion, transaortic constriction) and echocardiography, vascular repair/grafting/injury models, physiologic recordings (e.g. BP, pressure/volume loops, ECG, pulse-oximetry, laser Doppler tissue perfusion, and vascular flowmetry), many models for thrombosis and hemostasis assays, several types of organ transplantation and/or partial/complete resection, and custom-designed models.

The **Vector Core** was created to ensure that investigators would have promising gene vectors available in the quality and quantities needed for preclinical studies. Research in the laboratory has centered on the molecular biology of adeno-associated virus (AAV) in order to exploit the unique features of this virus to develop an efficient viral vector system for use in human gene therapy. Continued efforts in understanding the mechanism of viral replication and integration for both wild-type and recombinant AAV and Adenovirus vectors are being pursued in order to create more efficient gene transfer vectors.

**Biospecimen Processing Facility** provides a centralized facility to process biospecimens from population, clinical and other studies. While the there is an emphasis on DNA isolation, the facility also provides blood product separation and other specimen processing. Additionally, the facility is facilitating the establishment of a UNC-wide DNA Bank.

The **Zebrafish Facility** provides resources for UNC investigators to use zebrafish as a model organism. Services offered include stock maintenance, quarantine facility, embryo production, microinjections (morpholino and mis-expression), transgenesis and phenotypic evaluation.

The **High Throughput Sequencing Facility,** under the supervision of ***Dr. Piotr Mieczkowski,*** was established in 2008 in reaction to fast developing sequencing technology that is currently in high research demand. Deep sequencing technology allows performing applications like *de novo* genome sequencing, genomes re-sequencing, chip-seq, cDNA sequencing, digital expression and microRNA. HTSF gives UNC researchers an access to this edge-cutting technology by delivering to them about 200 million sequences of 36 nucleotides per week. This result is obtained primarily on 6 Illumina GAII sequencers, and supported by long reads sequencing using a Roche Genome Sequencer FLX 454. The facility stays responsive for any updates of the technology the market offers, and plans for constant growth to assure delivery of top quality data. Data produced by Illumina and Roche instruments are processed and returned to end users by the UNC Bioinformatics Center.

The **UNC Microbiome Core Facility** was also established in 2008 under the direction of ***Dr. Andrea Azcarate*** to provide the research community with the expertise to characterize complex microbial communities in a variety of environments. Instruments inclue Qiagen BioRobot Universal System, Genetix QPix2 XT Colony Picker System, Applied Biosystems Real-Time PCR System, Roche Genome Sequencer FLX System and Ion Torren Personal Genome Machine. Services include library preparation, clone library creation and barcoding; RNA, small RNA and mRNA sequencing; and large-scale, real-time qPCR analysis

**Renovation/Construction of Laboratory Space**

A major new building and renovation program is continuing in the School of Medicine. During the past 10 years, we have opened a new Genetics Medicine Building, new Neuroscience Research Building, new Medical Biomolecular Research Building, new Bioinformatics (office) Building, new Physicians Office Building (office), renovated Taylor Hall (research) and Bondurant Hall (offices and classrooms) and provided more than $1 million for renovation of the Department of Biochemistry laboratories. When added to the construction program underway for the UNC Health Care System, the combined facilities available for research and clinical studies as shown in the attached table has dramatically increased capacity and state-of-the-art technology for UNC researchers. Currently under construction in the School of Medicine is the Imaging Research Building that will provide new research space, 10 floors, for the Biomedical Research Imaging Center (BRIC) and the joint UNC-NCSU Biomedical Engineering department, among other groups. The College of Arts and Sciences built the Genomic Science Laboratory Building, 210,000 sq ft of laboratory and office space. It opened in 2012 and houses many non-SOM faculty working on biomedical research.

## School of Medicine Construction Programs (Recently Completed)

|  |  |  |  |
| --- | --- | --- | --- |
| **Project** | **Sq. Footage** | **Completion** | **Cost** |
| Carolina Living & Learning *(NEW)* |  5,000 |  2001 | $ 1.4 M |
| Bioinformatics Building  |  153,000 |  2002 | $ 33 M |
| Medical Biomolecular Research  |  229,000 |  2003 | $ 65 M |
| Community Health Bldg *(NEW)* |  40,000 |  2005 | $ 18 M |
| Glaxo/MBRL Bldg |  26,500 |  2004 | $ 1.8 M |
| Med Science Research Bldg |  82,000 |  2005 | $ 12.9 M |
| Burnett-Womack Bldg  |  171,000 |  2005 | $ 25 M |
| Bondurant Hall  |  82,000 |  2007 | $ 12.9 M |
| Genetic Medicine Research *(NEW)* |  220,000 |  2008 | $ 65 M |
| Marsico Hall *(NEW)* |  342,000 |  2014 | $240M |

**Animal Research Resources**

The animal care and use program at the University of North Carolina School of Medicine is centered in the Division of Laboratory and Animal Medicine, which houses animals in eleven separate buildings on the Chapel Hill campus. The Division's program is reviewed semi-annually by the Institutional Animal Care and Use Committee, and has been accredited by the Association for the Assessment and Accreditation of Laboratory Animal Care International (AAALAC) since 1973. DLAM and the University also meet U. S. Department of Agriculture and Public Health Service standards and regulations. A major responsibility of the Division's four veterinarians, four veterinary technicians and two laboratory technicians is the health care and humane use of all animals. As laboratory animal specialists they provide a comprehensive program of veterinary care, offer technical advice and assistance, and provide needed laboratory and pathology services for diagnostic and research purposes. A support staff includes 45 animal husbandry personnel. All orders for research animals from vendors or other institutions must be arranged through DLAM. Training for responsible conduct in research using animals is described elsewhere in this application.

**Computing Resources**

***UNC-Chapel Hill*** - The University offers a full range of extensive computing resources through Information Technology Services (ITS), including: Application Development and Support, Communication and Collaboration, Community-Hosted Services, Customer Support and Engagement, Enterprise Information Security, Identity and Access Management, Infrastructure Services (including 10 Gigbit network backbone, virtual server infrastructure, and enterprise storage), Learning Management, Production Services, Research Computing, Software Acquisition, Training, and Enterprise Content Management.

***School of Medicine Computing* -** The Office of Information Systems (OIS), a division of Medical School Administration, provides centralized computer services and information systems resources for the entire School of Medicine community, from medical students to faculty to administrative staff. Services provided by OIS include: central network and server infrastructure support, applications support for administrative and clinical applications, applications development, helpdesk support, Information Security, resources supporting research activities, support for departmental Local Area Networks (LANs) and network access to resources available on campus and the Internet. OIS also provides extensive web/graphics development and support, including design and development of the primary School of Medicine web site (www.med.unc.edu) and development of numerous web-based database projects. Other services include a variety of digital media services including video conferencing, support of classroom video systems, still digital photography and video recording, production and editing.

***Personal Computing*** – Wireless network access is available in many common areas throughout the school and dataports are available in all laboratories.

**Other Didactic Resources**

**Library**

The UNC Library system comprises nearly three dozen libraries, including the Walter Royal Davis Library, which is the main Academic Affairs library, the House Undergraduate Library, and the Health Sciences Library, which is the main Health Affairs library. Campus libraries have more than three hundred staff, and the library’s combined holdings exceed 5,000,000 volumes, 4,000,000 microforms, 2,000,000 printed government publications, 16,000,000 manuscripts, hundreds of thousands of audiovisuals, maps and photographs, and thousands of electronic titles. In scope, campus libraries cover most areas of the fine arts, biomedical and physical sciences, humanities, law, and social sciences.

The **UNC Health Sciences Library (HSL)**, part of the UNC Library system, has a superb staff (65 full-time positions), facilities, and collections and is considered to be among the best medical school libraries in the United States and Canada. The six-story building has seating capacity for 716 users. The HSL has a total of 333,493 volumes, 4,116 periodicals, and 1,442 electronic resources. The number of electronic resources held has doubled since the 1997-98 academic year. A total renovation of the library building was completed in early 2005. The HSL is now fully wireless and equipped with 42 public computer workstations, 19 small group study rooms, 2 Media Kitchens, 2 teaching labs with a total of 45 workstations and a campus equipped computer lab with 28 workstations. The HSL and the School of Medicine’s Office of Information Services jointly support multiple databases. These systems are available free of charge to all members of the University health affairs community and are easily accessible from any location on or off campus. One of the HSL online systems provides information about material available at the other area institutions of higher learning. Information about other resources and databases can be obtained at the library’s Internet Desk, which is staffed on a full-time basis by technical experts. The HSL is also a participant in faculty and student education related to the retrieval of electronic information and use of specific computer applications software.