

Facilities and Other Resources

I. Research Facility (Xue-Long Sun, PI)

Laboratory: The PI's laboratories consist of 2,300 square feet total of recently renovated spaces in the Science Research Building (SR382, SR382A, SR387D), and Science Building (SI303 and SI414) at Cleveland State University (CSU) campus. The SR 382 and 382A laboratories (1,000 square feet) are synthetic labs well equipped with chemistry specialized lab equipments. Five chemical hoods are available for chemical and enzymatic synthesis and purification experiments. The SR 387D is bioanalytical lab (500 square feet) well equipped with general analytical and biological specialized lab equipments. One chemical hood for biological experiments is available. The SI303 laboratory (300 square feet) is cell culture lab equipped with CO₂ incubator and biosafety cabinet, fluorescent microscope, centrifuge and other equipments. The SI414 laboratory (500 square feet) is molecular biology lab well equipped with recombinant protein expression and purification and characterization equipments. One chemical hood and one flow hood for biological experiments are available. All these will fully support the proposed research.

Animal: CSU has a centralized laboratory animal care and use program under the federal Animal Welfare Act (AWA) and Public Health Service (PHS) Policy for the Humane Care and Use of Laboratory Animals to the Institutional Laboratory Animal Care and Use Committee (ILACUC). The University program has Full Continued Accreditation by the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC-I) and has a Public Health Services (PHS) assurance # A3554-01. This Institution has established an Institutional Animal Care and Use Committee (IACUC), which is qualified through the experience and expertise of its members to oversee the Institution's animal program, facilities, and procedures. The IACUC consists of eight (8) members, and its membership meets the compositional requirements set forth in the PHS Policy at IV.A.3.b. A list of members is available through Office of Sponsored Program and Research (OSPR).

Clinical: N/A

Computer: The PI has a Z220 working station HP computer, which is used for office and experiment design works and internet communications with consultants and collaborators. The laboratories is equipped with two HP8000 Elite CMT, three HP8000 Series, two Gateway (E-4500D) and two DELL (Optiplex GX 620) computers used for processing data generated by the FTIR, Dynamic Laser-Light Scattering (DLS), UV-Vis spectrometer, Fluorescence Spectrophotometer, Microarrayer System, Surface Plasmon Resonance instrument and VistaVision™ Inverted Fluorescence Microscope. All PCs are available for word processing, ChemDraw, Excel, Origin, PDF, and other data processing software, online literature searching and experiment designing.

Office: The PI's office (300 square feet) is adjacent to the laboratories. All research associates have their own desks, and experiment benches and hoods in the laboratories.

Departmental Facilities: Common facilities are available at Chemistry Department: mass spectrometry center (LC-MS/MS Instruments), NMR center (400 MHz NMR), general analytical instrument center (HPLC, UV-vis, FTIR, Fluoremeter), dark room, cold room, liquid nitrogen generator and storage; at Biology Department: biosafety level 2 facilities, confocal fluorescence microscope and flow cytometry facility; at Physics Department: scanning electron microscope (SEM) facility; and at Chemical and Biomedical Engineering Department: atomic force microscope (AFM), transmission electron microscope (TEM) facilities at CSU.

Cleveland Clinic Facilities: The Chemistry Department at CSU has a joint Ph.D. of Clinical and Bioanalytical Chemistry Program with Cleveland Clinic, which is five miles far from CSU. The PI holds

an adjunct faculty position at Department of Molecular Cardiology, the Lerner Research Institute at Cleveland Clinic, which allows the PI to use all scientific facilities at Cleveland Clinic in their internal faculty rate and time frequency.

Case Western Reserve University (CWRU) Facilities: The PI had sabbatical leave during the 2013 fall semester as a Visiting Professor at the Department of Pathology at CWRU, which is five miles far from CSU. The PI have set up collaborative research with a faculty at CWRU, which allows the PI to use all scientific facilities at CWRU in their internal faculty rate and time frequency.

II. Information specific to the AREA program

II.1. Educational Achievement of the PI in the past twelve years:

The PI believes that research training is very critical for undergraduate students in chemistry and pharmaceutical science majors. The hands-on experience gained in the lab will inspire their interest of learning. This experience will be a benefit when they begin to look for jobs in chemistry and drug development related manufactory or research institutes. During the past ten years, the PI has trained about 30 students through Summer Research program, Independent Study (CHM379), and Senior Research (CHM489). He is developing a Chemical Biology lab course (CHM453) for the undergraduate students, which can provide more hands-on training opportunities to the students. The acquisition of the proposed proposal will allow the PI to continue his contribution to undergraduate education.

Based on his undergraduate mentoring achievement, the PI was awarded the **2015** and **2019** Golden Apple Award from Cleveland State University Alumni Association. Below is a list of the undergraduate students who participated in the PI's lab during the past thirteen years.

Table 1. Summer research (20-40 hours/week, three months) of undergraduate students in the PI's laboratory

Student name	Summer	Student achievement
Valentinas Gruzdys	2011	Vallentinas is a CSU Honor Student, presented his work at several conferences including National and Mini ACS conference. Joined the PI's group and completed his Ph.D. degree of Clinical and Bioanalytical Chemistry, now is pursuing his Clinical Chemistry Fellowship at University of Utah School of Medicine
Joshua Whited	2011	Joshua is a US Army veteran and had served for the country for five years, including two years in Iraq, presented his work at several conferences including Midwest Carbohydrate Symposium and Mini ACS conference, joined the graduate program as a Ph.D. student at the PI's group in 2012.
Rhonda Jones	2012	Rhonda is a minority student, worked in the summer and then fall and spring semester. She got an industry job in the R&D department (COVENTYA) in 2013.
Johnny Dang	2014	Johnny did summer research and moved onto graduate program at Case Western Reserve University in 2015.
Ali Naserallah	2014	Ali is a minority student, did summer research and moved onto Pharm D. graduate program at College of Pharmacy of Northeast Ohio Medical University (NEOMED) in 2015.
Henry Wang	2015	Henry did summer research and continued in the fall semester, graduated in 2016 summer.
Czharena Rama	2016	Czharena is a minority student, did summer research and is continuing her research in the fall semester.
Joseph Keil	2017	Joseph was supported by CSU Summer Research Program and continued in

		the fall semester, was awarded for Best Undergraduate Summer Research Award at CSU, serves as the third authorship in a manuscript submitted.
Isaac Turan	2018	Isaac was supported by NIH R15 grant and continued in the fall semester, serves as the second authorship in a manuscript in preparation
Taryn Boslett	2019	Taryn was supported by CSU Summer Research Program, presented a poster at CSU Research Day.
Bradley Arjune	2019	Bradley was supported by NIH R15 grant. Some results will contribute to a manuscript in plan.
Garrett Rafn	2021	Garrett was supported by CSU Summer Research Program and continued in the fall semester, was awarded for Best Undergraduate Summer Research Award at CSU, serves as the second authorship in a paper.
Garrett Rafn	2022	Garrett was supported by NIH R15 grant. Some results will contribute to a manuscript in plan
Christopher Garrett	2022	Chris was supported by CSU Summer Research Program, presented a poster at CSU Research Day.
Sophie J McIntyre	2023 2024	Sophie was supported by NIH R15 grant. Some results will contribute to a manuscript in plan, was awarded for Best Undergraduate Summer Research Award
Morgan Pychowycz	2024	Morgan is supported by CSU Summer Research Program

Table 2. Students registered with Independent Study (CHM379) and Senior Research (CHM489) in the PI's laboratory in the past seven years.

Student name	Time	CHM*	Credit	Research Topic
Jayme Jones	Spring 2016	CHM489H	4	Glyco-Analysis by LC-MS
Czharena Rama	Spring 2016, Fall 2016	CHM379	2, 3	Lectin Mimetics and Evaluation
Aicha Quamine	Fall 2016	CHM379	3	Protein Site-Specific Modification
Aicha Quamine	Spring 2017, Fall 2017	CHM379	1, 1	Protein Site-Specific Modification
				Monocyte Differentiation and Evaluation
Paul Lungu	Fall 2017	CHM379	3	Synthesis of Sialic Acid Derivatives
Joseph Keil	Spring 2017, Fall 2017	CHM489H	2, 3	Cell surface re-engineering
Joseph Keil	Spring 2018	CHM489H	3	Recombinant protein expression
Daniel Andre	Fall 2017, Spring 2018	CHM379	3, 2	Synthesis of Carbohydrate Derivatives
Isaac Turan	Fall 2018, Spring 2019	CHM379	3, 1	Cell Culture and Protein Expression
Paul Lungu	Fall 2018, Spring 2019	CHM489	3, 3	Glycomics of Cell Surface
Jumoke Olowu	Spring 2019	CHM489	3	
Abay Suleimenov	Spring 2019, Spring 2020	CHE598	1, 2	Glycopolymer Synthesis
Joseph Kalout	Spring 2020	CHM379	3	Recombinant protein expression
				Synthesis of Carbohydrate Derivatives
Masai Tate	Spring 2020	CHM379	3	Cell Surface Protein Profiling
Mario Alberto	Spring 2020	CHM479	2	Recombinant protein expression
Hareet Kaur Chauhan	2022 Fall, 2023 Spring	CHM379	1	
	Spring 2023	CHM379	1	
Sophie J McIntyre	Fall 2023	CHM489	4	Synthesis of Sialidase Inhibitors
	Spring 2024	CHM479	4	
Jonathan Nitardy	Spring 2023	CHM379	1,1	Synthesis and characterization of Glycopolymers
	Fall 2023			Quantifying Sialidase Activity in Monocytes
Elizabeth Zadinsky	Spring 2023	CHM379	1	Profiling Sialidase Expression in Macrophages
Morgan Pychowycz	Spring 2024	CHM379	1	

*Students registered with Independent Study (CHM379) and Senior Research (CHM489) in Xue-Long's laboratory during the past five years. The students in these courses spend 5-6 hours per week in the laboratory with Xue-Long and graduate students to work on the research projects. They are mentored with experimental design, data collection and interpretation,

which is different to the regular lab courses. Depending on their interests, Xue-Long provides them with different research techniques including organic synthesis, analytical technique, chemical biology, recombinant protein expression, western blotting assay, etc. Xue-Long also contacts local industry partners to search for internship opportunities for the students, which are very helpful for the students who look for a job before graduation.

PI has the following manuscripts published and in preparation with the undergraduate students listed as co-author.

- Y. Ma, H. Zhang, Valentinas Gruzdys and Xue-Long Sun*, Azide-Reactive Liposome for Chemoselective and Biocompatible Liposomal Surface Functionalization and Glyco-Liposomal Microarray Fabrication. *Langmuir* 2011, 27, 13097-13103.
- Y. Ma, Irena. Sobkiv, Valentinas Gruzdys, H. Zhang and Xue-Long Sun*, Liposomal Glyco-microarray for Studying Glycolipid-protein Interactions. *Analytical and Bioanalytical Chemistry* 2012, 404, 51-58.
- L. Wang, V. Gruzdys, Nan Pang, F. Meng, Xue-Long Sun*, Primary Arylamine-Based Tyrosine-Targeted Protein Modification. *RSC Advances*, 2014, 4, 39446-39452.
- J. Whited, Czharena Rama, Xue-Long Sun.* Synthesis and Evaluation of Protein-Phenylboronic Acid Conjugates as Lectin Mimetics. *ACS Omega* 2018, 3, 13467-13473.
- J. M. Keil, Garrett R. Rafn, I. M. Turan, M.A. Aljohani, R. Sahebjam-Atabaki, Xue-Long Sun*, Sialidase Inhibitors with Different Mechanisms, *Journal of Medicinal Chemistry (Perspective Review)* 2022, 65, 13574-13593.
- V. Gruzdys, L. Wang, D. Wang, Rachel Huang, and Xue-Long Sun*. Investigation of Cofactor Activities of Endothelial Microparticle-Thrombomodulin with Liposomal Surrogate. *Biochemical and Biophysical Research Communications* 2023, 651, 79-84.

Awards of the undergraduate students doing research in the PI's lab.

- ***Selected Twenty Poster Presentations*** from all Ohio universities in the 6th Annual BioOhio Student Poster Competition at 2009 BioOhio Annual Conference (Dublin, Ohio, September 30, 2009), Undergraduate student Valentinas Gruzdys (Immobilized membrane mimetic system with glycans).
- ***Best Oral Presentation Award***: Undergraduate student Valentinas Gruzdys, 2010 American Chemical Society Cleveland Section Meeting, Cleveland, Ohio, March 17, 2010.
- ***American Institute of Chemists (AIC) Foundation Outstanding Senior Award***: Undergraduate student Valentinas Gruzdys, Cleveland State University, Cleveland, Ohio, May 6, 2011.
- ***Undergraduate Research Award***: Rachel Troyan was awarded for Undergraduate Research Award from Department of Chemistry, Cleveland State University May 8, 2015
- ***Undergraduate Research Grant Award***: Jayme Jones was awarded for Undergraduate Research Grant Award from Cleveland State University Research Office (\$1,000, 01/19/2016-05/13/2016).
- ***American Institute of Chemists (AIC) Foundation Outstanding Senior Award***: Undergraduate student Jayme Jones, Cleveland State University, Cleveland, Ohio, May 8, 2016.
- ***Undergraduate Research Grant Award*** from Cleveland State University Research Office (\$1,000, 01/19/2017-05/13/2017). Aicha Quamine
- ***2016 American Institute of Chemists (AIC) Outstanding Senior Award***, Cleveland State University. Jayme Jones
- ***2016-2017 Undergraduate Research Award*** of the Department of Chemistry, Cleveland State University. Joseph Keil
- ***Undergraduate Research Grant Award*** from Cleveland State University Research Office (\$1,000, 01/19/2018-05/13/2018). Joseph Keil
- ***2017-2018 Undergraduate Research Award*** of the Department of Chemistry, Cleveland State University, Joseph Keil
- ***2019 American Institute of Chemists (AIC) Outstanding Senior Award***, Cleveland State University, Paul Lungu

- **Second Place of Poster Award** of 2021 Undergraduate Summer Research, Office of Research, Cleveland State University, Garrett Rafn
- **2021-2022 Undergraduate Research Award** of the Department of Chemistry, Cleveland State University, Garrett Rafn
- **Second Place of Poster Award** of 2023 Undergraduate Summer Research, Office of Research, Undergraduate student Sophie J McIntyre.
- **2023-2024 Undergraduate Research Award** of the Department of Chemistry, Cleveland State University, Sophie J McIntyre

II.2. Impact of an AREA Award on Investigator's Research Program:

The PI is a well-trained medicinal chemist and chemical biologist. Since joined CSU, he led a team of CSU investigators with expertise in medicinal chemistry and chemical biology to collaborate with multiple biologists in Big Cleveland area, Dr. Qingyu Wu at Cleveland Clinic Lerner Research Institute, Sihe Wang at Cleveland Clinic Biochemistry Laboratory, Wenquan, Zou at Case Western Reserve University School of Medicine. They have multiple joint publications and grant submission resulted from the collaborations. The PI and Dr. Wu (co-PI) were funded by Ohio Research Scholar award by The Ohio Board Regents to develop antithrombotic agent in 2010. At CSU, the PI is collaborating with Dr. Aimin Zhou (Clinical Chemistry) on a research project on glycobiology of macrophages upon activation, with Dr. Geyou Ao (Biomedical Engineering) on macro-glycoligand-functionalization of nanotubes and accomplished an NSF grant together recently. All these activities demonstrated that the PI is a very active researcher in the local research community. His expertise in medicinal chemistry and chemical biology are greatly needed by the local biologists focusing on different research areas. The extramural funding, as applying for the AREA award, is critical for the PI to continue his research. He will be able provide his expertise to other investigators in Northeast Ohio and provide training opportunities to undergraduates.

- a) The funds will allow more interaction of medicinal chemist, biomedical engineer, and molecular biologist within and outside the university, and create an interdisciplinary research environment for the students in biomedical sciences.
- b) The funds will allow for the training of additional undergraduate students in the PI's laboratory, completing portions of the research described in the present proposal. The goal is to have two to three undergraduates each semester (including summer), working on short or long-term projects, depending on their goals and availability. CSU is an affordable and often only opportunity for our student population to pursue higher education. It is important that our students have the opportunity to work with the same caliber of research-active faculty as those students who are in a position to attend more elite institutions. The PI is committed to this concept and chose CSU as his workplace based upon this principle. Extramural support will allow him to maintain a rigorous research program so that the undergraduate students are exposed to and can participate in a true research experience.
- c) Undergraduate students work closely with the graduate students in the laboratory under the PI's direct supervision. These funds will provide strong research support for graduate students, who will take on two to three undergraduate students per semester so as to expand the number of undergraduates working in the lab. There are currently four graduate students are involved in the PI's project. In addition to their own research, they will play an important role in the undergraduate student research mentoring and training.
- d) Another major objective of this proposal is to provide cutting-edge research projects and resources for graduate students training, particularly women and those from racial minority groups, who choose to pursue Ph.D. degrees in the chemical and biomedical sciences. The PI's lab is particularly poised to accomplish this objective. Since started at CSU in 2006, the PI has advised thirteen graduate students earned their Ph.D. degrees and three graduate students earned their master degrees in the PI's lab. Currently, the PI is advising four Ph.D. students

II.3. A profile of the students of the applicant institute:

Cleveland State University (CSU) is an urban university with an enrollment of over 17,000 students. The student body is representative of the region's demographic profile. Over 92% of CSU students come from Greater Cleveland. Underrepresented minorities (URMs) comprise more than 37% of all graduating students. Academic programs are aligned with the emergence of Science, Technology, Engineering, and Mathematics (STEM) disciplines as an economic driver. CSU has invested heavily in STEM initiatives, including establishing the Center for Innovation in STEM Education, the CSUTeach STEM Teacher Preparedness Program, and the new **CSU MC²STEM high school campus, a public school in the Cleveland Metropolitan Public School District (11th & 12th grade) that features an MIT Fab Lab and provides STEM education to a diverse student body (74% African American, 16% Caucasian, 8% Latino).**

The Department of Chemistry at CSU has 120 undergraduate students for Chemistry majors and 60 undergraduate students for Pharmaceutical Sciences majors now. The Chemistry and Pharmaceutical Sciences graduates have obtained employment at companies and labs such as Lubrizol Corporation, NASA Glenn Research Center, BASF Corporation, Dow Chemical, big pharmaceutical companies including Merck, Pfizer, Eli Lilly, Procter & Gamble, and Johnson & Johnson. Others have been accepted into prestigious graduate programs in chemistry or professional schools of medicine, law, or optometry at universities such as: Case Western Reserve University, Cleveland Clinic, and Ohio State University. Some students became local school teachers, and play very important roles in educating next generation scientists.

One of the major objectives of this proposal is to provide more hands-on training opportunities to students, particularly women and those from racial minority groups who choose to study in the chemical and biomedical sciences, and get involved in the research activity.

The PI expects to attract more female and minority students in the STEM majors with the project, and provide more chances to our next generation of scientists.

The following table is the current total enrollment of CSU by ethnicity and gender

Total students	Undergraduate		Graduate		First professional	
	M	F	M	F	M	F
Gender/ethnicity						
American Indian/Alaska Native	8	16	1	3	2	1
Asia	164	162	65	65	11	6
Black/African American	763	1572	179	550	15	28
Hispanic/Latino	254	326	35	84	12	10
White	3629	4056	1154	1620	247	216
Hawaiian or Other Pacific Islander	4	10		1		
Two or more races	118	202	23	33	2	6
Non Resident Alien	480	155	440	363	5	5
Unknown	228	212	69	106	7	7
Total	5648	6711	1966	2825	301	279
Combined	12359		4791		580	
Grand total	17730					

II.4. A description of the special characteristics of the applicant institute. The core mission of CSU and the department is to provide undergraduate education to an urban and non-traditional population of students. One goal of CSU's Strategic Plan is to engage these students in a nationally competitive research program. CSU has made substantial progress toward this goal and currently offers a vibrant and growing research environment. In 2015, the Chronicle of Higher Education ranked CSU first in the nation for increases in total research spending and in federal research dollars spent between 2004 and 2013. CSU currently ranks 94th in the nation for R&D expenditures in the biological sciences according to the NSF Higher Education Research and Development Survey (http://ncesdata.nsf.gov/herd/2013/html/HERD2013_DST_41.html).

CSU has numerous internally funded programs to support undergraduate and graduate research and to include underrepresented minorities and disadvantaged students in the research enterprise. Several initiatives aim to increase the participation of these students in STEM research.

- As one of only 151 institutions nationwide awarded funding through the US Department of Education **TRiO/McNair Scholars Program**, since 2008 CSU has provided or is currently providing undergraduate research opportunities to nearly 100 URM/Disadvantaged students. Many McNair scholars have graduated from CSU and have completed or are working toward M.S. (21), Ph.D. (7), or M.D. (2) degrees.
- A **\$3.5 million NSF AGEP-T** grant was recently awarded to CSU and an alliance of neighboring institutions including Case Western Reserve University, Kent State University, the University of Akron, the University of Toledo, Youngstown State University, and Bowling Green University. The goal of this grant is to increase URM involvement in graduate STEM education. GRHD Director Dr. Anton Komar is co-PI and Site Director for CSU. This award will provide 4-years of stipend support as well as travel and research support for URM students in CSU doctoral programs in Regulatory Biology, Clinical and Bioanalytical Chemistry, and Applied Biomedical Engineering.
- Moreover, the new **CSU MC²STEM high school campus** described above (opened Fall 2013) together with these initiatives would assemble a continuous path for high school students to financially-supported undergraduate programs and then graduate programs, all on the CSU campus.

II.5. Research and Educational Environment at CSU:

CSU is ideally located in one of the top biomedical and health care cities in the US: Cleveland is identified as the nation's new healthcare innovation destination: http://www.bioenterprise.com/images/company_assets/512F1C7F-0D64-4A5E-9D91-785DC064755F/2010VentureCapitalReport_b23b.PDF

1.5a. CSU Strongly Supports Research: CSU's aggressive research agenda is mirrored in the fact that 39% of the 17,000 students at the University are enrolled in graduate programs. In partnership with the Cleveland Clinic, the College of Sciences and Health Professions (COSHP) offers 3 outstanding PhD programs: Regulatory Biology (Department of Biological, Geological and Environmental Sciences), Clinical-Bioanalytical Chemistry (Department of Chemistry), Adult Development and Aging (School of Health Sciences). With 271 students enrolled in COSHP Doctoral programs, number of PhD students in our College increased by 113% in the past 5 years. CSU has a well-supported Honors program, serving the educational needs of academically talented undergraduate students, and providing them with a strong grounding in research.

At the university level, CSU faculty members are offered many incentives and opportunities to develop their research programs. CSU Office of Sponsored Programs of Research (OSPR) offers a considerable variety of research support to CSU faculty and students. This includes a portfolio of internal funding opportunities, including a **Dissertation Research Award** (up to \$5,000), **Faculty Scholarship Initiative** (\$5,000), **Faculty Research Development** (up to \$25,000); **Graduate Faculty Travel Award Program**, as well as **Reduced Teaching Research Facilitation Program**, the latter providing faculty with protected time from teaching and service, in order to devote time to writing research grants and focus on funded research projects. The **Faculty Innovation Fund (FIF)** recently launched by OSPR, offers grants of up to \$40,000 to stimulate innovative research and strengthen faculty members' ability to compete for extramural funding. OSPR has a Technology Transfer Office, which assists researchers to establish university-industry collaborations, to evaluate commercial potential of intellectual property (IP), and to take necessary steps to commercialize university-derived innovation, through protection of IP and subsequent licensing activities.

1.5b. Research Excellence in the CSU Center for Gene Regulation in Health and Disease (GRHD): The PI is a member of GRHD, an Ohio Board of Regents recognized Center of Excellence. GRHD is currently composed of 15 highly research active faculty members from Biology, Chemistry,

and Physics. GRHD members conduct research on diverse topics in cell and molecular biology, including chromosomal biology, protein translation and folding, signal transduction, apoptosis, aging, and cancer.

- GRHD faculty members are currently training more than 50 graduate students pursuing their doctoral degrees in Regulatory Biology and/or Clinical-Bioanalytical Chemistry.
- More than a dozen undergraduate students are currently performing Honors and Scholars research projects in GRHD laboratories.
- GRHD has recently been featured in a WebsEdge video aired at the American Society of Human Genetics meeting: <https://www.youtube.com/watch?v=Owo-aji9yNw>
- **The GRHD External Advisory Committee** consults annually with the GRHD Planning Committee, the CSU VP of Research, and the Provost regarding research directions and goals. EAC Members include:
 - ✓ Dr. George Stark, Ph. D., Cleveland Clinic Lerner Research Institute, NAS member
 - ✓ Dr. William M. Baldwin M.D., Ph.D. , Cleveland Clinic Lerner Research Institute
 - ✓ Dr. Stephen J. Benkovic, Ph.D., Pennsylvania State University, NAS member
 - ✓ Dr. Carlos J. Bustamante, Ph.D., University of California, HHMI Investigator, NAS member
 - ✓ Dr. Paul E. DiCorleto, Ph.D., Kent State University
 - ✓ Dr. Harry F. Noller, Ph.D., University of California, Santa Cruz, CA, NAS member
 - ✓ Dr. Roy L. Silverstein, M.D., Blood Center of Wisconsin, Milwaukee, WI
- GRHD provide the Dr. John C. Vitullo Pilot and Bridge Funding Program for GRHD members a one-time grant of up to \$10,000 for pilot studies or bridge funding of existing projects. Recently, the PI was awarded for the Dr. John C. Vitullo Pilot and Bridge Funding Program (\$10, 000, October, 20160)
- GRHD labs share several core facilities that, together with the equipment in the PI's lab, make available every piece of equipment required for the research proposed here, which we will do through collaborations (see letters of support).

II.5c. The Department of Chemistry: The CSU Chemistry Department offers a Ph.D. in Clinical and Bioanalytical Chemistry in conjunction with the Lerner Research Institute (LRI) of the Cleveland Clinic. Currently, there are 80 Ph.D. students enrolled in the Ph.D. program. A Cellular and Molecular Medicine Specialization offers opportunities for doctoral students wishing to apply modern cellular and molecular approaches to understanding disease causes and disease mechanisms and spans Clinical/Bioanalytical Chemistry, Regulatory Biology and Biomedical Engineering. The Chemistry Department also offers thesis and non-thesis M.S. degrees of Chemistry. Currently, there are 70 M.S. students enrolled in the program. The Chemistry Department also offers research experiences to a large number of undergraduates, many of whom are in the CSU Honors/Scholars or McNair Scholars programs (<http://www.csuohio.edu/sciences/bges/undergraduate-student-research-0> and see below)

In terms of undergraduate education, the Department of Chemistry has offered BS of chemistry for many years. There are three tracks of the chemistry major including, Certified B.S. Degree, B.S. Degree with Pre-Professional Training, and B.S. Degree with Teaching Licensure. These different tracks provide flexibility to students with different career plans. In 2009, Ohio Board of Regents has approved the Bachelor of Science in Pharmaceutical Science (BSPS) at Department of Chemistry at CSU. The new program further concentrates the department's research interest in biomedical sciences. Currently, there are **50** students involved in the BSPS program, and the enrollment of students in the program has increased significantly over the past several years. These students are interested about drug discovery and are looking for opportunities to strengthen their knowledge and skills in pharmaceutical sciences.

An active drug discovery and chemical biology laboratory will be a very good complement to the current research activities of the department. It will significantly strength the department's biomedical research power. The potential R15 support would enhance the research collaboration between biologist and drug discovery scientist at CSU. It will also improve the interdisciplinary research environment of CSU, and greatly benefit the educational programs and provide drug discovery

research opportunities to the graduate and undergraduate students.

II.6. Institutional support for the proposed research project:

The PI receives a 9-month salary from CSU. GRHD, the Office of Research, and the College of Science and Health Professions (COSHP) at CSU offer faculty many incentives and opportunities to develop their research programs. Most relevant to this proposal:

- An agreement between COSHP and GRHD allows teaching loads to be maintained at 3-6 SCH/year for labs with significant extramural funding (e.g., R01, R15, NSF, etc.).
- The GRHD/COSHP Reduced Teaching Research Facilitation Program provides faculty with protected time from teaching and service in order to write research grants and papers.
- Students' stipend and tuition costs may be covered by teaching assistantships.
- The Graduate Faculty Travel Award Program helps defray the cost of travel to national and international meetings, up to \$1,200 per year.
- The Dr. John C. Vitullo Pilot and Bridge Funding Program allows GRHD members to apply for a one-time grant of up to \$10,000 for pilot studies or bridge funding of existing projects.
- The provost office provides Undergraduate Summer Research grant for faculty with undergrad students doing research during the summer, which can be used for student summer salary and research related expending up to \$10,000.
- Office of Sponsored Programs of Research (OSPR) offers Dissertation Research Award (up to \$5,000) for Ph.D. student doing dissertation research.
- Office of Sponsored Programs of Research (OSPR) offers Undergraduate Research Grant Award (\$1,000) for undergraduate students enrolled in Independent Study (CHM379) and Senior Research (CHM489) course in the lab.