

Proposal for a Ph.D. Program in Biotechnology New Mexico Institute of Mining and Technology

Executive Summary. New Mexico Institute of Mining and Technology (New Mexico Tech, NMT) proposes a multidisciplinary Ph.D. program in Biotechnology to begin in August 2016. The aims of this novel program are to prepare students at the highest level for solving societal problems and to create useful products and processes with the tools of biotechnology, e.g., biomolecular, biochemical, biomedical and bioengineering approaches. It is fully anticipated that this program will not only expand the biotechnological workforce in New Mexico but will also stimulate bioentrepreneurship. New Mexico Tech has placed this bio-related doctoral degree among its highest priorities in its Strategic Plan for 2015-2020. The new program will fill significant needs in the state of New Mexico and also within New Mexico Tech's research community. The new program will involve the Departments of Biology, Chemistry, Psychology, Computer Science, Mathematics, Earth and Environmental Sciences, Chemical Engineering, Mechanical Engineering, Materials Engineering, Environmental Engineering and Management. Faculty members in each of these departments have solid records in research grantsmanship and in publishing the results of their research. Being a STEM institution and as such both specialized and applied, the academic and research program at New Mexico Tech has very little overlap with New Mexico's other research universities or even at other universities in the region, such as Northern Arizona University and the University of Texas at El Paso. While some fundamental overlap is inevitable, New Mexico Tech's Biotechnology Program aims to complement the research and the coursework offered at the related Ph.D.-granting departments at the University of New Mexico and New Mexico State University. The new program will be a rigorous one, requiring a range of coursework from various disciplines, including four core courses in Biotechnology, along with completion of a significant body of research leading to a dissertation and first authorship on at least one accepted, peer-reviewed publication. Students will be recruited from within New Mexico and also nationally and internationally. We plan to ramp the program up gradually so as to begin graduating about two students per year in five years. Biotechnology Ph.D. students will be supported by existing and new teaching assistantships as well as by externally funded research assistantships. The physical facilities and library resources at New Mexico Tech are sufficient for at least the first five years of the program. New upper-level courses will be created, requiring additional faculty members. New Mexico Tech's administration has committed to one new tenure-track biotechnology-relevant faculty recruitment during year one, with further hires being projected as the program grows. Additionally, Biology is currently recruiting two new faculty members and is giving priority to applicants engaged in applied interdisciplinary research. A Biotechnology Advisory Panel consisting of one representative of each of the above-named departments will provide leadership for the program. The Biotechnology Graduate Faculty, consisting of faculty members eligible to advise Biotechnology Ph.D. students, will make decisions regarding acceptance of new students, changes in degree requirements, appeals of decisions, etc. The program will be assessed regularly for quality, both internally and with the aid of external reviewers.

A. Program Description and Purpose

(1) What is the primary purpose of the proposed program?

- The primary purpose of the proposed program is to prepare students for leadership positions in the field of biotechnology by providing a high-quality, interdisciplinary research-intensive doctoral level education.

What are its secondary purposes?

Secondary purposes of the program are the following:

- To connect and take advantage of the existing NMT-specific and STEM-focused expertise in the various fields of science and engineering and to create trans-disciplinary opportunities in the emerging fields of bioinformatics, bioprocess engineering, bio-robotics, chemical engineering, petroleum engineering, biopharmaceutical engineering and genetic engineering.
- To improve collaboration with other Ph.D.-level graduate programs in the state and region by encouraging exchange programs whereby students can spend time learning new techniques and carrying out research at another university and through cross-campus distance education courses. NMT and UNM have conducted a few such courses in the past, e.g., a geomicrobiology course (BIOL 589/GEOL 589) offered through both universities and taught by biologists and geologists in Fall 2011. A New Mexico-wide agreement implemented starting in August 2015 facilitates grad students from one institution to take coursework at the other institution. We envision expanding this intercampus program by offering specialized biotechnology-related courses.
- To increase the number of doctoral-level members of the New Mexico science, technology, engineering and medicine community from under-represented groups.
- To improve the economy of Socorro, the State of New Mexico, and the region by contributing to the scientifically and commercialization-trained workforce, and by generating new technologies that could turn into licensable patents, spin-off companies, etc.
- To improve the quality and quantity of biotechnological research carried out at New Mexico Tech across multiple science and engineering departments.
- To attract highly qualified applicants for faculty positions in the Biology Department and in other departments participating in the Biotechnology Ph.D. program.
- To improve undergraduate laboratory teaching by employing graduate teaching assistants who are Ph.D. degree-seeking students and thus more highly trained than typical students pursuing a M.S. degree.
- To improve graduate research by employing Ph.D.-degree-seeking students, who are typically more highly trained than M.S. degree seekers. Related advances will be seen in the quantity and quality of scientific publications and patentable inventions, leading to institutional financial gains in the form of increased funding and more patent licenses which will help support future students.

(2) Is the proposed program consistent with the role and scope of the institution as set forth in its mission statement and interpreted by its governing board?

New Mexico Tech's Mission, as stated in the NMT 2015-2020 Strategic Plan (http://www.nmt.edu/images/stories/presidentsofficepages/NMT_Strategic_Plan_2015-2020_final.pdf), is the following: *"New Mexico Tech serves the state and beyond through education, research, and service, focused in science, technology, engineering, and mathematics. Involved faculty educate a diverse student body in rigorous and collaborative programs, preparing scientists and engineers for the future. Our innovative and interdisciplinary research expands the reach of humanity's knowledge and capabilities. Researchers, faculty, and students work together to solve real world problems. Our economic development and technology transfer benefit the economy of the state and create opportunities for success. We serve the public through applied research, professional development, and teacher education, benefitting the people of New Mexico."*

The Biology Department's Mission *"is to provide students with a relevant education for biomedical and biotechnological careers, to lead in molecular biology research, and to serve the university and the scientific community."*

The proposed Ph.D. Program in Biotechnology is therefore fully aligned with New Mexico Tech's long term mission which was approved by the NMT Board of Regents governing board in the Spring of 2015. NMT's documented history of high-quality research performance in diverse yet interconnected scientific and engineering fields offers justifiable expectations of success. For example, building on these expectations and fostering synergies between disciplines (including Biology) is reflected in the recently submitted, broadly collaborative "NRT-DESE: Transdisciplinary Data Science" proposal to NSF.

(3) What is the institution's priority for the proposed program, as indicated in its most recent plans, funding requests or other institutional documents?

New Mexico Tech's 2015-2020 Strategic Plan further specifically identifies:

- The development of a Ph.D. program in biology is a high-level priority in NMT's latest Strategic Plan. Task 2 under **Strategic Priority #4** : Ensure Intentional and Planned Quality Growth: Objective 2.1: Develop New Graduate Programs.
- Development of technology commercialization is also emphasized in the NMT's Strategic Plan under **Strategic Priority #3**, Goal 4: Build a culture of entrepreneurship to generate multiple income streams in support of the university's research and education mission. Objectives 4.1: Develop a university-wide technology commercialization infrastructure to standardize the process for developing and marketing innovations through the Center for Leadership in Technology Commercialization. Task 1: Establish policies and procedures for documenting inventions that may lead to new intellectual property, patents, and licensing. Task 2: Maintain and develop opportunities for venture capitalists and

other funding sources to review and support new innovations. Task 3: Support faculty, students, and staff in navigating the commercialization process. Task 4: Review the university's faculty and staff consulting policies to provide opportunities for additional research and teaching in support of technology commercialization.

- **Strategic Priority #7: Cultivate Transdisciplinary Education and Research.** Increase transdisciplinary research to tackle challenging real-world problems. Transdisciplinary research and education integrates the methods, theories, techniques, and perspectives of multiple disciplines to develop new approaches to solve complex, real-world challenges. Importance: Based on New Mexico Tech's history of interdisciplinary research and development and the increased national focus on research involving multiple disciplines, NMT is moving into the challenging arena of transdisciplinary programs. According to McGregor (2011) "the world is facing a polycrisis, a situation where there is no one single big problem—only a series of overlapping, interconnected problems. These interconnected, complex problems cannot be solved by disciplines working alone within the academy using independent, fragmented, disciplinary-focused knowledge." We must embrace transdisciplinary as a stimulus to creativity and productivity while still maintaining the rigor and strength of our disciplinary efforts. We will craft a transdisciplinary approach in order to better prepare our students to be leaders in multi-disciplinary problem solving and research."

New Mexico Tech's commitment to education and research in applied biology is also evidenced by the establishment of a new B.S. degree program in Biomedical Science (BMS) in January 2015. Faculty from nine different departments worked together to design this BMS Program in which students receive a purposefully broad yet personalized exposure to biomedical sciences. The new degree is broadly interdisciplinary; it allows the students to pick one of three science majors (Biology, Chemistry or Neuroscience) and combine it with one of four engineering minors (Biomechanical Engineering, Chemical Engineering, Bioinformatics or Biomaterials Engineering). This BMS BS degree additionally requires a full year of hands-on research under supervision of both the major (science) and the minor (engineering) advisor. There is already a very strong interest in and subscription to the program. As a consequence, we anticipate an expansion in our lower-level courses in Biology, including laboratory classes, for which more graduate teaching assistants will be needed.

(4) What is the curriculum for the proposed program? What types of courses and other degree requirements are needed for degree completion? What types of skills or competencies will students develop as a result of completing the degree program?
Describe the curriculum (including coursework and other degree requirements).

The Biotechnology Ph.D. degree will require completion of:

- 48 credit hours of graduate coursework, post-bachelors degree. Up to 30 credit hours from an appropriate M.S. degree may be applied to this 48-credit hour requirement. These 48 credit hours shall include the following core Biotechnology courses:
 - BIOT 5XX Molecular Biotechnology, 3 credit hours
 - BIOT 5XX Biochemical Technology, 3 credit hours
 - BIOT 5XX Biophysical Technology, 3 credit hours
 - BIOT 5XX Biomechanical Technology, 3 credit hours
- Graduate seminar (1 credit hour per semester) should be taken every semester when a student is in residence at New Mexico Tech. Up to two of these credits can be counted toward the 48-hour requirement.
- 24 Credit hours of Dissertation (BIOT 595)
- Preliminary exam
- Candidacy exam
- Research proposal and defense of research proposal
- Dissertation defense
- Publication requirement – one peer-reviewed paper accepted for publication with the student as first author.

Discuss any new courses and the impact of the curriculum on existing courses, including courses in other departments.

The following new 500-level courses (six) and existing 500-level courses (eight) will be taught in the specialized areas of expertise of participating faculty members. The first four are core Biotchnology courses, which will be offered on a regular basis; the others are elective courses that will be offered on demand.

- **BIOT 5XX Molecular Biotechnology**, 3 cr, 3 cl hrs. A lecture-supported, laboratory-based course on molecular biotechnology of microbial and mammalian systems. Techniques used in prokaryotic and mammalian molecular biotechnology. Recombinant DNA methodologies (DNA/RNA isolation and manipulation, restriction mapping, cloning, PCR, site-directed mutagenesis, DNA sequencing, CRISPR/CAS editing) combined with classical biochemical protein (SDS-PAGE protein gels, ELISA, Western blotting, enzyme assay) techniques. Textbook: Molecular Biotechnology by Glick & Pasternak. *This will be a new course but based on existing BIOL 333 & BIOL 333L.*
- **BIOT 5XX Biochemical Technology**, 3 cr, 3 cl hrs . After an introduction to basic biochemistry and cell biology this course covers biotechnology routes to foods, drugs, polymers and fuels. Fermentation reactions with immobilized enzymes, bacteria, fungi, plants and animal cells are covered; also separation and purification. Offered mostly online with occasional in person classes. *Existing Materials course, Bioprocess Engineering (MATE 489) offered during Fall 2015 by Calvert.*

- BIOT 5XX **Biophysical Technology**, 3 cr, 3 cl hrs. Covers biomedical materials and devices including properties of hard and soft tissue, orthopedic implants, cardiovascular devices, skin, cartilage and tendon, eye and ear implants, neural prosthetics, cyto- and biocompatibility. Offered as an online course with occasional meetings. *Existing Materials Course (MATE 599) course, last offered spring 2015 by Calvert.*
- BIOT 5XX **Biomechanical Technology**, 3 cr, 3 cl hrs. The mechanical functionality of the human body. Covers mechanics of cells, fluid mechanics of blood, respiration and lymph, muscle bone and joints, gait analysis, exercise, injury and orthopedic fixtures, eyes and ears. *Existing Materials Biomechanics (MATE 599) course, last offered spring 2014 by Calvert.*
- BIOT 5XX **Applied Microbiology**, 3 cr, 3 cl hrs. Principles of applied and industrial microbiology and microbial technology. Application of microbes in various products and processes, biofermentors and scale-up of microbial culturing, molecular engineering of microbes, bioenergy. Prerequisite: BIOL 341 or BIOL 343 or equivalent, graduate standing or consent of instructor. *New Course.*
- BIOT 5XX **Experimental Cell Biology with Lab**, 3 cr, 3 cl hrs +1 cr, **3 cl hr lab**. This advanced course explores in detail the methodological tools of experimental cell biology. These include prokaryotic and eukaryotic cell culture, cloning and gene transfections, biochemical studies of signaling pathways, membrane behavior and analysis of changes in gene expression; (SEM, TEM, fluorescence, confocal) microscopy, electrophoresis, fractionation, microbiological assays (MIC/MBC), transgenic animals, preclinical studies for drug development as well as finding and interpreting methodologies available in the literature and other resources. Preq. BIOL 331 (cell Biology) and BIOL 333 and BIOL 333L (Molecular Biology with lab) *Previously offered as BIOL 489 by Rogelj.*
- BIOT 5XX **Drug Delivery**, 3 cr, 3 cl hrs. Focus is on current developments in drug delivery techniques, with only a brief discussion of common clinical techniques. The first portion of the class focuses on various delivery mechanisms and the tools needed to validate successful targeted drug delivery (both in vitro, in vivo and diagnostic tools). The second part of the course focuses on current developments in drug delivery based on published research articles. Students will read, digest, and critically analyze scientific work from leading research laboratories. Students will also gain valuable communication tools, as each student will present an article of interest to the class. Finally, the third part of the course focuses on important materials characterization methods such as biological sample prep, SEM, TEM, DSC, flow cytometry, fluorescence microscopy, ELISA assays. Shares lecture with MATE 576 but is graded separately. Extra Work for Grad-level credit. *Tartis existing course CHE 476 Drug Delivery Techniques,*

- **BIOT 5XX Principles of Drug Design**, 3 cr, 3 cl hrs. Principles in Drug Design course provides an overview of the multilayered and multidisciplinary processes involved in starting from a potentially drug-responsive problem and ending with a novel clinically-used drug. This includes molecular or phenotypic target identification, compound design (including computational, combinatorial chemistry and structure-based drug design methods), drug synthesis, development of model assays, discovery of a lead, optimization of the lead, identification of mode of action, kinetics of molecular targeting, prodrug design and drug development from this in vitro analysis via preclinical studies to clinical studies and introduction of new drugs into clinical practice. Regulations pertaining to each of these steps will be discussed. *New course, co-taught between Chemistry (Frolova, Tello-aburto) and Biology (Rogelj)*
- **BIOT 5XX Behavioral Neuroscience**, 3 cr, 3 cl hrs +1 cr, **3 cl hr** lab. Study of the neural bases of behavior, including functional neuroanatomy of sensory and motor system, and clinical correlates of neurological abnormalities. Behavioral neuroscience (Elliott) plus directed review and discussion of current research in application of biotechnology in the neurosciences (Thompson). *New Psychology Course*,
- **BIOT 5XX Cell and Molecular Neuroscience** 3 cr, 3 cl hrs. A study of the molecular and cellular basis of the nervous system, covering fundamentals of cell biology, principles of neuronal signaling and neuronal courses, and cell and molecular approaches to the investigation, diagnosis and treatment of the diseases of the nervous system. Applications of emerging technologies. *Existing course PSY 409*.
- **BIOT 5XX Entrepreneurial Biotechnology**. 3 cr, 3 cl hrs. Rules and regulations governing product development and post-approval marketing from medical devices and pharmaceuticals. From cGMP compliance to federal regulations. Introduction of students to the creation of a company; from pitching a concept and securing funding as a venture capital investment. Current research and industrial trends in the evolution of a biotechnological idea to a biotech venture. Strategic and tactical approaches for marketing of biotechnological products and services. *New Course, offered by Management Department (Anselmo and Reinaw)*
- **BIOT 5XX Bioinformatics**, 3 cr, 3 cl hrs. Computer analysis of biological sequence data used to perform in silico experiments. Students will design and perform experiments using public domain software and databases. Prerequisite: BIOL 311 or consent of instructor. *Existing course: BIOL 535, Bioinformatics*.
- **BIOT 5XX Bio-inspired Design**, 3 cr, 3 cl hrs. Tartis will provide description ASAP. *Dr. Tartis' previously offered, highly successful Chemical Engineering course.*

- BIOT 5XX **Biomaterials** (3 credit hours): Description to be provided ASAP. *Dr. Calvert and Dr. Tartis are currently preparing this course to be taught in the Spring 2016.*
- Biotechnology 595 Dissertation, cr to be arranged.

Example topics for BIOT Seminars (1 cr):

- Ethical Issues in Biotechnology
- Legal Issues in Biotechnology
- Technology of Medicine
- Biotechnology for Pharmaceutical Industry/Process Biotechnology
- Biotechnology vs. Environment
- History of Biotechnology
- BIOT to Feed & Fuel the World
- Forensic Biotechnology
- Biological Cleanup of Environmental Pollution
- Microbial Technology
- Stem Cell and Organ Culture
- BioTechnology By JoVE

Ethical ramifications of the course-covered knowledge and technology will be purposefully discussed and specifically addressed in every BIOT course.

The impact of the new courses on curricula in the participating departments will be minimal. There is a normal turnover of topics offered in specialized graduate courses as new topics emerge in a particular field, as the interest of the faculty shift, and especially as new faculty members with new areas of research expertise are hired. These new Biotechnology courses will reflect these changes in research interests and faculty expertise.

Learning Outcomes:

Students in the Biotechnology Ph.D. Program will develop the following skills and competencies:

- critical thinking
- problem solving
- communication (written and oral)
- breadth of knowledge, ability to function well in an interdisciplinary, multi-disciplinary enterprise
- depth of knowledge in one or more areas of research
- knowledge and hands-on skills in a broad range of laboratory techniques and use of a wide range of scientific instruments
- conceptual ability to design and technical ability to implement a complex science- and engineering-spanning research project
- understanding the entrepreneurial mindset, including intellectual property laws, biotechnology commercialization and marketing approaches

- appreciation of ethical issues and potential consequences associated with biotechnology

Draft Catalog Copy

Doctor of Philosophy in Biotechnology

Students of exceptional ability, as demonstrated in previous courses or in a master's degree program, may pursue a program leading to the doctoral degree.

The prospective doctoral candidate in Biotechnology should develop a good background in biology, chemistry, and mathematics plus at least one of the following: computer science, mechanical engineering, chemical engineering, or materials engineering. Additionally, students should achieve a high level of competence in the field of specialization defined by their dissertation research. Additional information is found in the Graduate Catalog.

Research fields appropriate for the biotechnology candidate include bioengineering, molecular biology, microbiology, tissue engineering, pathogen detection, drug discovery, drug delivery, medical instrument development, neuroscience, and biochemistry. Interdisciplinary projects are strongly encouraged.

Degree Requirements

- Up to 30 credit hours from an appropriate master's degree, excluding thesis and S/U courses, may be included.
- Students are normally expected to take BIOT. 501 each semester that they are in residence on the New Mexico Tech campus.
- 48 hours of coursework approved by the student's advisory committee, to include:
 - Core Biotechnology courses:
 - BIOT 5XX Molecular Biotechnology
 - BIOT 5XX Biochemical Technology
 - BIOT 5XX Biophysical Technology
 - BIOT 5XX Biomechanical Technology
 - 12 hours of upper-division or graduate-level coursework outside the Biology Department.
- Dissertation (24 credit hours): BIOT 595
- Preliminary exams in microbiology, molecular biology, cell biology, and biochemistry are usually taken in the third semester, or in the second semester for students who already have a master's degree. Students may, if necessary, repeat one or more exams the following semester. Students who do not receive satisfactory scores after two attempts will be dropped from the Ph.D. program.

Admission Requirements

Completion of a bachelors degree in a relevant field (e.g., biology, biotechnology, chemistry, biochemistry, bioengineering, biophysics, computer science with a biology minor, etc.) or the expectation of completing such a degree before the beginning of the first semester of graduate study. Students are expected to have competencies in math,

chemistry, and physics equivalent to those required for completion of a B.S. degree at New Mexico Tech. Students who are deficient in one or more of these areas will be required by their advisory committee to complete undergraduate coursework in the area(s) of deficiency. Students should have an academic record that indicates a good potential for success in a doctoral program. An undergraduate GPA of 3.0 or higher is used as a general guideline in New Mexico Tech's graduate program.

B. Justification for the Program

(1) Evidence of Need

- The biotechnology industry is expected to expand substantially in the coming decades. The U.S. Bureau of Labor Statistics projected a 10% growth in biotechnology jobs from 2012 to 2022 (<http://www.bls.gov/ooh/life-physical-and-social-science/biological-technicians.htm>). Genetic Engineering News projected a 27% increase in jobs for biomedical engineers during the same period, nearly three times average job growth (<http://www.genengnews.com/insight-and-intelligence/top-10-biotech-jobs-most-in-demand-over-the-next-decade-2014-edition/77900156/>). These job projections are not all for Ph.D.-level biotechnologists. However, graduates with doctoral degrees are required to train B.S.- and M.S.-level biotechnologists and Ph.D.-level personnel are the most likely to be successful in high-level research, including the innovation of new processes, products, etc.
- New Mexico has a developing biotechnology industry that should be supported by degree programs at all levels. A listing of biotechnology-related firms in New Mexico can be found at <http://www.thebiosciencecenter.com/nm-bio-companies/> and <https://nmbio.org>. NMT aims to be a major player in this field by contributing to the generation of a highly trained workforce and by generating new knowledge, products, and services through doctoral-level graduate research. This graduate level research is also anticipated to lead to new start-up biotechnology companies within New Mexico.
- The New Mexico Department of Workforce Solutions' 2015 State of the Workforce Report (http://www.dws.state.nm.us/Portals/0/DM/LMI/NM_2015_State_of_the_Workforce_Report_032015.pdf) projects an 8.8% increase in Professional, Scientific, and Technical Services jobs during the period from 2012 to 2022. Doctoral/Professional-level jobs are expected to grow by 14% in the same period.
- [The document Technology²¹, Innovation and Technology in the 21st Century, Creating Better Jobs For New Mexicans, A Science and Technology Roadmap for New Mexico's Future](http://www.nmspacegrant.com/files/tiny_mce/file_manager/funding_opps/Science%20and%20Technology%20Roadmap%20for%20NMs%20Future.pdf) (http://www.nmspacegrant.com/files/tiny_mce/file_manager/funding_opps/Science%20and%20Technology%20Roadmap%20for%20NMs%20Future.pdf) generated by the Governor's Office and the Office of Economic Development

identifies Bioscience as one of five Innovative Clusters for economic development in New Mexico. The report states that “Biotechnology has seen rapid growth in New Mexico and is a prime source of high-tech economic development. Investments are needed to provide an even broader base of bioscience related jobs in bioenergy, human health, animal health, and agriculture.” The report also recognizes that biotechnology offers an environmentally clean opportunity for economic growth and that “In New Mexico, bioscience-related jobs are high-paying with an average salary of \$51,700 compared to \$30,000 in the rest of the private sector. Furthermore, the number of jobs grew 25% from 4,700 to 5,900 from 2001 to 2004.” Education, including graduate-level education, is identified as a key area for investment in order to further grow the biotechnology industry in New Mexico.

- NMT is one of the three research institutions in the state system and is the only one that is exclusively STEM. The lack of a Ph.D.-level program in a life sciences field is a major void in our portfolio and is holding back other NMT programs that are already developing biotechnology-related research.
- A large proportion of our own B.S. and M.S. grads are leaving the state to enter Ph.D. programs. Some of these would like to stay in New Mexico and even at NMT.
- The large number of faculty, staff, etc. at NMT and its ancillary research groups (Bureau of Geology, EMRTC, NRAO, etc.) generates a need for STEM education - as well as faculty and staff level employment - for spouses, family members, etc. This includes a need for a Ph.D. program in a biology-related field. In other words, the new Biotechnology Ph.D. program will contribute to recruitment and retention of STEM faculty and staff at New Mexico Tech and in the Socorro area. The increased level of research and the creation of spin-off companies is envisioned to create local jobs for some of these graduates.
- Access to education and training in the entrepreneurial process as part of a STEM doctoral Program would be unique to any biology-related degree available in NM

(2) Duplication

- The proposed Biotechnology Ph.D. program differs fundamentally from doctoral programs at the University of New Mexico, at New Mexico State University, and at other universities in the region by its strong emphasis on applied biological innovation. We recognize that programs at other schools do include some applied biological research. However, our program will be unique in the region for its focus on interdisciplinary problem solving to address societal problems through scientific insight, engineering, and entrepreneurship. NMT has a 50-year history of research in biotechnology, starting with James Brierley’s development of novel biohydrometallurgy processes in the 1960s-1980s, and the spin-off company Advanced Mineral Technologies. The well-known nicotine patch was also invented at NMT. For instance, current biotechnological research includes robotics and haptic technologies by Dr. David Grow, drug discovery by Dr. Snezna Rogelj and her colleagues,

development of novel drug delivery methods by bioengineer Dr. Michaelann Tartis, and collaborative preclinical efficacy testing of gene replacement therapies by neuroscientist Dr. Stewart Thompson.

- While the core coursework in the Biotechnology Ph.D. Program will lay a broad foundation for further study and research in biotechnology, the research carried out in the program will necessarily be focused in specific areas, largely defined by the expertise of the affiliated faculty. Emphasis will be placed on interdisciplinary research, e.g., in biochemistry, bioengineering, biomaterials, etc.
- The specialized nature of graduate-level research means that there is very little overlap in research areas between researchers at other universities in New Mexico and even the region. Faculty members at UNM, NMSU, and NMT are seldom in direct competition with each other for funds from federal agencies, foundations, etc. They compete nationally for major research funding but they also cooperate locally. For example, NMT has actively participated in the NIH-funded NM-wide INBRE (New Mexico IDeA Networks of Biomedical Research Excellence) Program for over 13 years. This program partners ten (large & small) NM universities and champions innovative, supportive and sustainable research environments for faculty and students conducting biomedical research. The specialized areas of research expertise of the participating NMT faculty do not currently overlap with those of researchers at UNM and NMSU and we expect that to continue to be the case and that the expertise of the various biologically-oriented faculty at the three universities will complement each other. We plan to take advantage of this through graduate courses offered through distance education and through graduate student exchanges in which students from one university can spend time in the lab of another researcher at one of the other universities. In fact, an undergraduate version of such an exchange is already taking place as part of the 2014-2019 funding cycle (NM-INBRE Summer Experience NISE). By way of different example, NMT's Entrepreneurial Biotechnology may be a particularly unique offering available to this NM-wide pool of graduate programs via distance education.

(3) Inter-institutional collaboration and cooperation.

C. Clientele and projected enrollment.

(1) Clientele

We will recruit from within New Mexico, as well as regionally, nationally, and internationally for students in the Biotechnology Ph.D. program, so we expect to have students from educationally and culturally diverse backgrounds. We also expect that

many of our students will come from within New Mexico. Many of our own NMT graduates go on to pursue Ph.D.s. In fact, New Mexico Tech is rated the 14th highest in the U.S. for the percentage of its baccalaureate graduates earning Ph.D.s in science and engineering, according to a 2013 NSF report (<http://www.nsf.gov/statistics/infbrief/nsf13323/nsf13323.pdf>). In fact, NMT is #1 among the publically supported institutions, including "Public Ivies" on that list. It would be great to keep just a few of these excellent students in our own research labs to make the most of their exceptional abilities. We also anticipate that some of our students will be returning to school from industry and government laboratory jobs, some of them in New Mexico. Some of these may even be supported during their graduate program by their employers.

(2) Projected Enrollment

Table 1. Projected enrollment for the Biotechnology Ph.D. Program.

| | year 1 | year 2 | year 3 | year 4 | year 5 | year 6 |
|------------------------|--------|--------|--------|--------|--------|--------|
| new students | 2 | 2 | 2 | 2 | 2 | 2 |
| Ph.D. graduates | 0 | 0 | 0 | 0 | 2 | 2 |
| total students | 2 | 4 | 6 | 8 | 8 | 8 |

D. Institutional readiness for the program.

(1) Is the teaching faculty adequate in number and qualifications to initiate the program? If not, what additional faculty are needed? To what extent will the program rely upon graduate assistants to free faculty time for graduate instruction in the proposed program?

The faculty members who will participate in the program are spread across eleven departments:

Biology Department

Dr. Snezna Rogelj (Chair) – cell and molecular biology, drug discovery, biomaterials

Dr. Thomas L. Kieft – microbiology

Dr. Kevin Kirk – environmental toxicology

Dr. Rebecca Reiss – genetics, bioinformatics

open position – currently recruiting, teaching expertise will include anatomy and physiology, looking for biotechnology-related research interests

open position – currently recruiting, looking for biotechnology-related research interests

Chemistry Department

Dr. Sally Pias – biochemistry, molecular modeling

Dr. Menake Piyasena – pathogen detection, chemical sensing, and diagnostics

Dr. Rodolfo Tello-Aburto - anti-cancer drug design and synthesis

Dr. Liliya Frolova - drug design and synthesis, modified metallic surfaces for compound separation, removal of uranium from drinking water

Psychology Department

Dr. Taffeta Elliott – neuroscience

Dr. Stewart Thompson – neuroscience, inherited disease, translational research

Computer Science Department

Dr. Subhasish Mazumdar – bioinformatics
Earth and Environmental Engineering Dept.
Dr. Penelope Boston – geobiology, astrobiology
Mathematics Department
Dr. Oleg Makhnin – bioinformatics
Dr. William Stone – mathematical biology
Chemical Engineering Department
Dr. Corey Leclerc – biofuels
Dr. Michaelann Tartis – bioengineering, drug delivery, biomedical imaging
Dr. Pabitra Choudhury – atomistic modeling and simulations, 2D materials and
bio-molecules interactions
Dr. Sanchari Chowdhury – plasmonic nanomaterials, nanoparticles
biomolecules interaction; Single molecule microscopy, proton transport
membranes
Dr. Paul Calvert – bioengineering, biomimetic materials, soft electronics
Mechanical Engineering Department
Dr. David Grow – haptic technologies, robotics, dynamic modeling
one new position in biological or biomedical engineering
Materials Engineering Department
Dr. Nikolai Kalugin – graphene for chemical separations
Environmental Engineering Department
Dr. Frank Huang – bioengineered water treatment
Management Department
Dr. Frank Reinow - biotechnology marketing
Dr. Peter Anselmo - biotechnology intellectual property & commercialization

(2) Are the library and other academic support resources sufficient to initiate the program? If not, what additional resources are needed?

The most important role of the library in supporting graduate research is in providing electronic access to peer-reviewed literature through search engines and by online subscriptions to journals. The New Mexico Tech library is performing extremely well in this area. Many research databases are available on the library's web site, with Web of Science (http://apps.webofknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=1E1RFQYZNC7eAUxqJ2y&preferencesSaved=) being the most powerful and relevant to biotechnology. The library provided electronic access to thousands of relevant journals. Interlibrary loan provides secondary access. The New Mexico Tech Library's catalog of biotechnology-related books is extensive, and a book-buying budget is allocated each year to each department. The formula for allocating these funds gives preference to Ph.D.-granting departments, so the budget for book purchases in support of biotechnology will increase with approval of this program. Please see attached statement on behalf of the NMT library from Dr. William Stone, Dean of Arts and Sciences, who is chairing a search committee to fill the currently vacant position of Librarian.

(3) Are the physical facilities of the institution adequate for the first five years of the program?

Will additional space or modifications of existing space be required within the first five years of program operation?

The Biology Department currently occupies 12,000 square feet in Jones Annex (constructed in 1999). This space includes 6 research labs, 2 shared-equipment labs, 2 walk-in cold rooms, 1 walk-in freezer, 3 teaching labs, 1 teaching lab prep room, 3 graduate student offices, meeting areas, and a graduate lounge. We expect the Biology Department to grow with the development of the Biotechnology Ph.D. program and we have a plan for that expansion. The Chemistry Department is scheduled to occupy a new building in 2-3 years and will thus vacate their part of the second floor of Jones Annex. Biology will expand into this 4500-square foot area and thus gain two research labs, one teaching lab, one analytical equipment room, one storage room, and four offices. This additional space for Biology will be sufficient for projected growth of the Department, including Biotechnology-associated growth for at least the next six years.

(4) Are the institution's equipment and technological resources adequate for the first five years of the program? What, if any, additional equipment will be needed?

New Mexico Tech is already well equipped for biotechnology research. In addition, the Biology Department and other biotechnology-relevant departments yearly receive funds from New Mexico Tech's President's Office for acquisition of major pieces of research and teaching equipment. New faculty members typically receive ~\$100,000 in start-up funds for research and the bulk of this goes toward purchase of research equipment. Additionally, the faculty in these departments have secured extramural research funding from the National Science Foundation, the National Institutes of Health, the Department of Energy, and other agencies, and these funds have supported the purchase of research equipment.

New Mexico Tech has recently refurbished a 200 sq. ft. animal care facility, with separate rooms for maintaining and performing experiments with multiple vertebrate animal species under climate-controlled conditions.

Major pieces of analytical and experimental equipment include the following:

Biology Dept.

- confocal microscope
- flow cytometer
- real-time PCR machine
- thermal cyclers (several)
- UV-Vis and Vis plate readers (several)
- gel electrophoresis rigs and power supplies (many)
- ultracentrifuge
- liquid scintillation counter
- anaerobic glove bag
- Nanodrop spectrophotometers (2)
- UV-Vis scanning spectrophotometer
- gel documentation systems (3)
- phase-contrast/epifluorescence microscope with cameras

incubators (5-50°C) (many)
ultra-low (-86°C) freezers (3)
walk-in cold room/incubators (4-40°C)
walk-in freezer (-20°C)

Chemistry Dept.

NMR
HPLC

Psychology Dept.

animal care facility, climate-controlled, multiple rooms, HH approval-ready

Chemical Engineering Dept.

high-end fluorescence microscope
dynamic light scattering, with particle sizing and surface potential measuring capability
3D biological printer
fluorimeter
UV-Vis spectrophotometer
total internal reflection fluorescence (TIRF) microscope
lyophilizer

Materials Engineering Department

Transmission electron microscope
Scanning electron microscope
Atomic force microscope

(5) Are other operating resources adequate to initiate the program? For example, will additional clerical or specialized personnel be needed?

Current operating resources should be adequate for the program. Departmental administrative assistants and secretaries, especially in the Biology Department, should be able to handle the modest increase in graduate student-related administrative duties.

(6) Are there existing external facilities that will be used? Have agreements been established to ensure use of those facilities? For example, if you are offering a nursing or allied health program have you established a partnership with local hospital(s) and other clinical settings?

New Mexico Tech has ongoing collaborations with other biotechnology research groups within New Mexico and it is anticipated that these will continue and be strengthened by the Biotechnology Ph.D. Program. For example:

- The NMT Biology Department collaborates with the National Center for Genome Research (NCGR) in Santa Fe. NMT was instrumental in securing funds for one of NCGR's first DNA sequencing instruments. Since that time, NCGR has provided high-throughput DNA sequencing and bioinformatics services for approximately 10 NMT research projects, including studies of metabolic syndrome, animal microbiomes, and

deep groundwater microbes. NCGR and the NMT Biology Department are currently exploring opportunities for teaching by NCGR staff scientists.

- Sandia National Laboratory (SNL) has provided research opportunities for several NMT faculty members and students. Currently, a Ph.D. student in Materials Engineering supervised by Dr. Michaelann Tartis receives research advising and financial support from SNL staff.
- Los Alamos National Lab (LANL) scientists collaborate with NMT researchers, in some cases through the New Mexico Consortium. Currently one NMT Biology 5-year B.S./M.S. student is working on a project under the direction of Dr. Momchilo ("Momo") Vuyisich.

E. Projected cost of the program

(1) New costs for program start-up. The proposal should provide a clear indication of new costs that must be met in order to begin the program and to sustain it during its first five years. The analysis must address at least the following cost categories:

(a) Additional faculty needed for the program, fulltime and part-time.

- Two replacement faculty in Biology starting in August 2016. These hires will not actually incur new costs, since they're replacement positions.
- One new tenure-track Biology faculty member to begin in August 2017. This will be a new expense, but the new position is in line with institutional priorities and should be justified by expanded enrollment and formula funding
- One or more new engineering positions. These new positions are in line with NMT's strategic priorities and should be justified by enrollment increases.

(b) Additional library resources needed for the program. The proposal should include a statement from the university librarian, indicating the cost of these new resources and the schedule on which the resources will be provided.

The library resources at New Mexico Tech are more than sufficient for the needs of the program. The most important need for graduate research programs is access to scientific literature. The library subscribes to a number of search engines relevant to the program, the most important of these being Web of Science. Current subscriptions allow instant online access to thousands of journals, including most of the journals that are relevant to biotechnology. Journal articles that are not instantly available can be obtained relatively quickly through Interlibrary Loan. The library also has adequate permanent collections of books and each of the relevant departments has a budget for acquiring new books and other resources. The formula for allocating these funds is based in part on degree offerings; the addition of the Biotechnology Ph.D. program will increase the shares of book-buying funds to the participating departments. Please see attached statement on behalf of the NMT library from Dr. William Stone, Dean of Arts and Sciences, who is chairing a search committee to fill the currently vacant position of Librarian.

(c) Additional facilities, equipment and technological resources needed for the program.

- Start-up funds for two replacement faculty in Biology starting in August 2016. This is, strictly speaking, not additional resources, since start-up funds are generally provided. However, because the new faculty members will have expertise in biotechnology, their new equipment will directly benefit the new Biotechnology Ph.D. Program.
- Start-up funds for a new tenure-track faculty member to begin in August 2017. Again, this new faculty member will have expertise in Biotechnology and so equipment purchased from start-up funds will directly benefit the Biotechnology Ph.D. Program.
- Increased consideration for yearly equipment funding, provided in most years by the NMT President's office, during the first 5 years of the program

(d) New graduate assistantships needed to support the program, including the dollar value of the assistantships during each of the first five years of the program.

New graduate assistantships will be required to support this new program. These will be a combination of research and teaching assistantships. Research assistantships will be generated by extracurricular funds. All faculty members participating in the program will be expected to write grant proposals to major funding agencies and/or private foundations in support of their research and these will include funds for graduate research assistants. Most faculty members are already doing this. New teaching assistantships will be supported by increases in enrollment in relevant departments, including the Biology Department. The new Biomedical Sciences (BMS) degree is attracting increasing numbers of students in undergraduate biology courses, including lab classes, thereby generating new formula funding and requiring new undergraduate laboratory sections. New graduate formula funding generated by the Biotechnology Ph.D. program will also help to support new teaching assistantships.

New Mexico Tech's 2015-2016 Graduate Stipend Guidelines

(http://www.nmt.edu/images/stories/graduate_studies/Stipends/Grad_Stipends_2015-16.pdf) specify minimum 9-month stipends for Ph.D. program research assistants and teaching assistants of \$20,635, \$21,179, \$21,724, and \$22,267 for years one through four, which reflect 2.5% yearly increases. From this, students pay tuition of \$5,810.58. Minimum current summer research assistantships range from \$6,546 to \$7,090, from which students pay \$1,936.86 in tuition. The Guidelines are revised each year to reflect changes in the cost of living and also tuition increases. Budgets for research grants generally include 5% yearly increases for graduate research assistantships. Student fringe benefits are budgeted at 2% of salary. These graduate stipends are competitive with those of other graduate programs, especially considering the relatively low cost of living in Socorro.

(2) State support. An analysis must be presented showing the approximate amount of state operational formula funding that will flow to the program for each of the first five years, based upon the projected student credit hours and current formula funding factors, and recognizing the delay and averaging characteristic of the formula.

We project the following in increased formula funding to New Mexico Tech as a result of the Biotechnology Ph.D. program.

Table 2. Projected formula funding to be generated by the Biotechnology Ph.D. Program.

| | year 1 | year 2 | year 3 | year 4 | year 5 | year 6 |
|---|----------|----------|-----------|-----------|-----------|-----------|
| Number of students | 2 | 4 | 6 | 8 | 8 | 8 |
| Number of graduate credits/student/year | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of undergraduate credits/student/year | 6 | 6 | 6 | 6 | 6 | 6 |
| Credit funding | \$48,672 | \$97,334 | \$146,016 | \$194,688 | \$194,688 | \$194,688 |
| Number of graduates | 0 | 0 | 0 | 0 | 2 | 2 |
| Degree funding | 0 | 0 | 0 | 0 | 4,640 | 4,640 |
| STEM funding | 0 | 0 | 0 | 0 | 6,960 | 6,960 |
| Total formula funding | \$48,672 | \$97,334 | \$146,016 | \$194,688 | \$206,288 | \$206,288 |

(3) Other support. If the proposed program will benefit from other sources of operational support, the proposal should describe those. For example, if particular cost categories such as new equipment or additional graduate assistantships are expected to be supported by research grants, contracts or other sources, the proposal should clearly describe those sources and levels of support and should indicate the advantage to the state of receiving such support.

Faculty members conducting biotechnology research are currently funded by extramural grants, e.g., from the National Science Foundation (NSF), New Mexico EPSCoR (through an NSF grant), New Mexico INBRE (through an NIH grant), and other agencies. It is expected that all of the NMT faculty participating in the Biotechnology Ph.D. Program will submit research proposals to these and other agencies and that the proposals will include funding for graduate research assistantships. Even if only a fraction of those proposals are funded, then research assistantships should be available for approximately half of the Biotechnology Ph.D. students, i.e., one new student per year.

F. Quality of the program

(1) All programs supported by state funds are expected to comply with principles of academic quality delineated as part of the NMHED's regulation on instructional funding: 5.3.12 NMAC.

(2) Among the questions that will be considered in evaluating proposals for new graduate programs are the following:

(a) Is the curriculum adequately structured to meet the stated purposes of the program?

The curriculum is structured so as to insure that students gain a breadth of knowledge in Biotechnology via the Core Biotechnology courses and also a depth of knowledge in specialized topics via upper level elective courses and dissertation research.

(b) Is the faculty adequate in number, experience and availability to offer a high quality program?

We have a large and diverse faculty with expertise related to biotechnology; this group spans eleven academic departments and disciplines (see Section D.(1)). With the hiring of 3 new faculty members in Biology in a two-year period and addition of engineering faculty members (see section E.(1)(a)), the Biotechnology Ph.D. Program will be well staffed for the first six

years or more.

(c) How do the proposed academic admission standards for students entering the program compare with standards for other programs at the institution and with admission standards for comparable programs at other institutions in New Mexico or other states?

The standards for admission are at least as high as those for related Ph.D. programs at the other New Mexico research universities. Students will be required to have a B.S. in a relevant field at the time of entering the program and are expected to have competencies in math, chemistry, and physics equivalent to those required for completion of a B.S. degree at New Mexico Tech. See Draft Catalog Section above.

(d) How will the proposed program utilize current technologies to support program quality and delivery?

New Mexico Tech is up to date in pedagogical technologies, including those supporting graduate studies. These include use of Banweb and Starfish for online tracking of student progress. DegreeWorks is in development for graduate student tracking. New Mexico Tech also maintains state-of-the-art research equipment and computational capabilities.

(e) What opportunities will be available for assisting students to gain experiences relevant to work settings for which the program will prepare them?

In addition to the hands-on research performed at New Mexico Tech, students will have opportunities to gain extra training and to perform research at other research universities in New Mexico, LANL or SNL, other collaborating institutions, e.g., NCGR, or entrepreneurial organization and businesses (<http://www.thebiosciencecenter.com/nm-bio-companies/> and <https://nmbio.org>).

(f) What academic support services are available to students, to assist them in succeeding in the program?

NMT prides itself not only for the rigor of its academic programs but also for the support provided to students to meet the high expectations. Academic support services available to graduate students include the annual Graduate Student Orientation, Teaching Training for all new graduate teaching assistants, the Writing and Oral Presentation Center (<http://infohost.nmt.edu/~huma/centersAndservices/wopc.html>), communications assistance from STEMCommunication Fellows, tutoring in the Office of Student Learning, annual Thesis and Dissertation Boot Camp, and Counseling and Disability Services.

(g) What final integrating experiences or other features will be used to assure that graduates have acquired the knowledge and skills expected for the degree or certificate awarded?

The curriculum and the specific degree requirements have several built-in milestones, each with Completion of each of these milestones involves evaluation by faculty members. These

milestones include:

- qualifying exam
- research proposal
- submission of manuscript(s) for publication (one first-author, peer-reviewed manuscript must be accepted to meet degree requirements)
- dissertation defense

Standards for completion of each of these milestones will be in keeping with those of other doctoral programs at NMT and with related programs at other New Mexico research universities.

(h) Has the proposed program been evaluated by any external reviewers or is there other external evidence or opinion regarding the quality of the program?

(i) When will the new program be proposed for accreditation by the Higher Learning Commission of the North Central Association?

We will seek accreditation as soon as the program has been approved by the State of New Mexico.

(j) Will specialized accreditation be sought for the program? If so, when?

There is not a specialized accreditation program available for Biotechnology.

G. Assessment of operations and impact. The proposal must include a plan by which the proposed program will be assessed for its operation and impact over at least a five-year period.

(1) At a minimum, the plan must indicate methods that will be used to monitor program operations, progress of students and program completion rates.

- The NMT Biotechnology Ph.D. Program will participate in all NMT assessment procedures to evaluate the degree to which students meet outcome expectations and to improve that performance (<http://www.nmt.edu/assessment>).
- Student progress will be monitored by the student's Advisory Committee, by the Biotechnology Advisory Panel (see below, essentially this is the equivalent to the departmental level), and by the Center for Graduate Studies.
- We will appoint an External Advisory Board, consisting of five representatives from industry, national laboratories (Sandia National Laboratory, Sandia National Laboratory), and academia (UNM, NMSU). We will schedule on-site reviews of the program at 2- or 3-year intervals.
- We will monitor the number and quality of publications, number of citations, patents, patents licensed, etc. generated by the program.

(2) The plan also must include methods for obtaining evaluations from students, graduates or other appropriate sources and feeding that information into future operation of the program.

We will conduct annual and exit interviews with each of our Biotechnology graduates to solicit

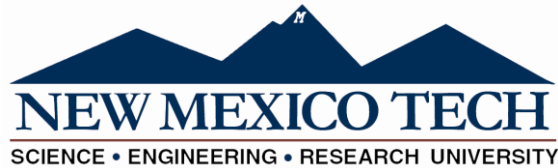
their opinions on the strengths and weaknesses of the program, the quality of mentoring, etc. We will also track the career paths of all of our graduates and when possible obtain their views several years after graduating from the program. New Mexico employers of our Biotechnology alumni will also be queried for their views on the strengths and weaknesses of the program.

H. Administrative responsibility for the program and institutional commitment.

(1) The proposal should indicate where in the structure of the institution the program will be administered. For example, which department will have primary administrative responsibility and which additional departments, if any, will contribute to operation of the program?

A Biotechnology Advisory Panel consisting of one representative of each of the above-named departments will provide leadership for the program. A rotating Chair (3-year tenure) will be selected from this panel. We will establish a Biotechnology Graduate Faculty that will consist of faculty members who are eligible to advise Biotechnology Ph.D. students. The Biotechnology Graduate Faculty will also regularly meet as a group to make decisions regarding acceptance of new students, changes in degree requirements, appeals of decisions, identify upcoming research opportunities, etc.

(2) The proposal should include a clear statement of administrative support for the program, sufficient to assure that resources will be provided during the first five years of the program. The proposal should also verify that all within-institution approvals needed for the program have been granted, including approval by the institution's governing board.



October 5, 2015

Subject – Academic Affairs Letter of Support for PhD Program in Biotechnology

To: Thomas L. Kieft, PhD – Professor, Department of Biology
Snežna Rogelj, PhD - Professor and Chair, Department of Biology

Dear Drs. Kieft and Rogelj:

This letter is written to indicate Academic Affairs support for the New Mexico Institute of Mining and Technology's (New Mexico Tech's) proposed multidisciplinary Ph.D. program in Biotechnology, which is to begin in August 2016. New Mexico Tech has placed this Biotechnology doctoral degree among its highest priorities. The transdisciplinary nature of the program, includes the collective talents of ten different departments; Biology, Chemistry, Psychology, Computer Science, Mathematics, Earth and Environmental Sciences, Chemical Engineering, Mechanical Engineering, Materials Engineering, and Environmental Engineering. These departments saw increased resources due to six new tenure track positions created in 2014 and the additional benefits of emeriti professors who have retired and been replaced, but are still continuing to conduct very active research programs. In the 2015-2016 school year, it is anticipated that up to three additional tenure track positions will be created in these disciplines. An additional biology position is committed for the 2016-2017 school year.

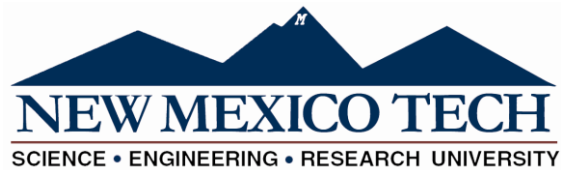
Academic Affairs commits increased support and funding for Biotechnology equipment maintenance, repair, and replacement. This support will focus on working with the Faculty Senate to identify key equipment requirements in the various departments and how existing equipment can be leveraged across the institute and more efficiently repaired, when necessary. Where equipment voids exist, efforts will be made to provide funding to purchase new equipment. Academic Affairs funding will be utilized in conjunction with funding identified by the Advancement Office.

It is anticipated that there will be an increase in the number of teaching assistantships as the Biomedical Science degree program and the Biotechnology Ph.D. program grow and warrant the increase.

In summary, Academic Affairs is committed to supporting the new PhD Program in Biotechnology. This program is critical to meeting the institute's strategic plan. If I can provide any additional information, please do not hesitate to contact me.

Focused education in science and engineering

Academic Affairs · 801 Leroy Place · Socorro · New Mexico · 87801
Telephone: 575.835.5227 · FAX: 575.835.5649 · e-mail: vpaa@admin.nmt.edu
New Mexico Institute of Mining and Technology is an EEO-AA Institution



Respectfully,

Warren J. Ostergren

Warren J. Ostergren, PhD
Vice President for Academic Affairs
201A Brown Hall
New Mexico Institute of Mining and Technology
Socorro, NM 87801-4796
Phone: 575-835-5363
Fax: 575-835-5649
E-mail: warreno@nmt.edu

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New Mexico Institute of Mining and Technology is an EEO-AA Institution



25 September 2015

To whom it may concern:

New Mexico Tech is proposing a new PhD in Biotechnology. In discussion with the committee preparing the proposal, we concluded that the current resources of the NMT Joseph R. Skeen Library should be more than sufficient. We have electronic access to 170,000 journals, including many in the area of Biotechnology. These will meet the needs of the new program.

The library also maintains access to several databases in Biology, Health & Medicine, and other areas. These include Medline, Web of Science, the database of the National Center for Biotechnology Information, and others. Articles or books not available at the Skeen Library can be obtained through Inter Library Loan.

The book collection, both paper and electronic, is extensive, with almost 120,000 paper and more than 310,000 electronic books. Since the library allocates the book-buying budget based on degrees awarded, the new program will allow for at least a modest increase in the funds available for books in the area.

The Skeen Library remains committed to meeting the information needs of students, faculty, and researchers in all areas at Tech. When this new PhD is approved, we are confident we will be able to provide the necessary services.

Wm. D. Stone
Dean of Arts & Sciences
New Mexico Tech



10/1/2015

Snežna Rogelj, Ph.D.
Professor and Chair
Department of Biology
New Mexico Institute of Mining and Technology
Socorro, NM 87801

Dear Dr. Rogelj,

I am writing to express my enthusiastic support for your proposed Ph.D. program in Biotechnology.

Our mission at NCGR is to solve the preeminent challenges of 21st Century biology through collaborative research using sequencing technologies and the application of bioinformatics, and we rely heavily on highly-qualified scientists who want to make New Mexico their home. Currently, eleven of our staff of 25 are Ph.D. level scientists, of whom only a small minority were recruited from in-state. I anticipate significant ongoing demand for scientists having a cross-disciplinary education that addresses our needs in bioinformatics, biostatistics, computational biology, and related disciplines.

The research we do at NCGR is inherently cross-disciplinary, involving aspects of bioinformatics, molecular biology, genetics, mathematics, statistics, and computer science. We frequently assemble inter-disciplinary teams, but the ideal job candidates embody broad training covering several of these areas. Accordingly, NCGR stands to benefit from a training program like the one you propose, which should produce individuals that are trained in multiple areas relevant to our needs.

NCGR is only one such center experiencing a shortage of New Mexico-grown suitably-trained personnel; the national laboratories, the New Mexico Consortium, UNM, and other employers such as the Lovelace Respiratory Research Center all are conducting research and development using technologies that fall within the scope of biotechnology.

I would be delighted to see a new program that graduates highly-qualified individuals that contribute to New Mexico's talent pool.

Sincerely yours,

Callum J. Bell, Ph.D.
President
cjb@ncgr.org
(505) 995-4428



September 25, 2015

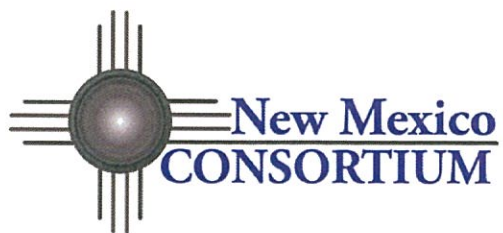
Dr. Thomas L. Kieft
Biology Department
New Mexico Institute of Mining and Technology
Socorro, NM 87801

Dear Dr. Kieft,

I am delighted to write this letter in enthusiastic support of New Mexico Tech's proposed Biotechnology Ph.D. Program. I'm already familiar with New Mexico Tech, primarily through the excellent former students from your B.S. and M.S. programs whom we've hired here at Lovelace Respiratory Research Institute (LRRI). I have no doubt that we'll eventually employ graduates from your new Ph.D. program, as well. Extending your level of training to offer a doctorate in Biotechnology is a next logical step. Your new Ph.D. program will help to serve our staffing needs and will also help to stimulate the biotechnology industry here in New Mexico. LRRI is engaged in a number of health-related research areas. Drug discovery is chief among these and is well aligned with the ongoing research being carried out by Dr. Snezna Roglej and her colleagues at New Mexico Tech. Several of LRRI's research capabilities, such as our BSL-3 facility, testing of drugs in animal models, and access to patients for clinical trials ("bench-to-bedside" capabilities) can complement New Mexico Tech's biotechnology research. LRRI's Gene Therapy Research Program may also provide opportunities for innovation and collaboration. I look forward to working with you and the other New Mexico Tech biotechnology researchers as you develop this exciting new program.

Sincerely,

Robert W. Rubin, Ph.D.
President and Chief Executive Officer



October 25, 2015

Dr. Snezna Rogelj
Biology Department
New Mexico Institute of Mining and Technology
Socorro, NM 87801

Dear Dr. Rogelj,

As Director of the New Mexico Consortium (NMC), I enthusiastically support New Mexico Tech's proposed Biotechnology Ph.D. Program. As a former researcher and manager at Los Alamos National Laboratory (LANL), I worked with many of New Mexico Tech's excellent graduates. I definitely expect significant employment opportunities for your Biotechnology graduates with both the NMC and LANL.

The New Mexico Consortium, as a growing non-profit organization focused on research and education, is in need of well-trained staff. Biotechnology is an integral part of the NMC's strategic plan. The NMC has active and expanding programs in biofuels; food security; and the development of new diagnostics and treatments for plant, animal, and human pathogens. Your program represents an ideal opportunity for collaboration. NMC partnerships with your program could include research collaborations (with some potentially carried out in NMC laboratories), teaching and mentoring of your students, as well as sabbatical opportunities for your Program-affiliated faculty. Also possible are internships at LANL that are available through the NMC. Such internships would provide your students with unique, relevant, and meaningful engagements while building skills and paving paths towards further inter-disciplinary and inter-institutional collaborations, acquisition of research support, and entrepreneurial growth.

Since research experience is fundamental to the success of this program, we fully support the proposed Biotechnology Ph.D. Program and commit to providing research opportunities for students in the program. We also commit to hire, promote, and/or retain qualified program participants as job openings become available.

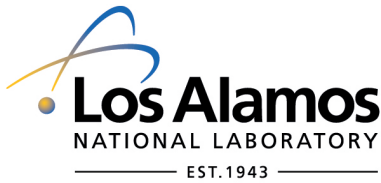
I look forward to working with you and the other New Mexico Tech biotechnology researchers as you develop this exciting new program.

With my best wishes and full support of your exciting new program.

Sincerely,

A handwritten signature in black ink that reads "Steven J. Buelow". The signature is fluid and cursive, with a long, sweeping underline.

Steven J. Buelow, Ph.D.
Director
New Mexico Consortium



National Security Education Center

Los Alamos National Laboratory

MS T001

Los Alamos, New Mexico 87545

505-667-9531

Date: October 18, 2015

Symbol: NSEC 15-103

Prof. Snežna Rogelj
Chair, Department of Biology
Jones Annex 315
New Mexico Tech
Socorro, New Mexico 87801

Dear Prof Rogelj:

I was delighted to learn of your plans to create a new Ph.D. program in biotechnology. The National Security Education Center (NSEC) at Los Alamos National Laboratory (LANL) supports your effort as an important vehicle for increasing collaborations.

There are several apparent ways in which collaborations between our institutions would be enhanced by the new program. First, as a member of the New Mexico Consortium (NMC), New Mexico Tech has an active interface for access to the laboratory. Biotechnology is part of the joint strategic plan developed by LANL and NMC. Second, biotechnology—and specifically biofuels—is a major area of activity at the Entrada Biolab run by NMC with LANL staff; this facility offers a place for your faculty and students to interact with our staff. Third, through our nascent Joint Appointment Program, I anticipate that staff from the lab will desire to be directly involved in your program by teaching and mentoring students. In addition, as our Joint Appointment Program matures, we plan to host NMTEch faculty at the lab as full-fledged staff.

The prospectus you have prepared for the new program impresses me. Judging from the growth of related programs at engineering schools elsewhere, your Ph.D. program can be expected to be successful in serving the biotechnology industry and academia in the State of New Mexico.

Sincerely,

A handwritten signature in blue ink, reading "Alan Hurd".

Alan J. Hurd
Director (Acting), National Security Education Center

AJH:mm



Bioscience Division

P.O. Box 1663, MS M888
Los Alamos, New Mexico 87545
505-667-2690/Fax 505-667-8339

Date: October 15, 2015
Symbol: BDO-15-076

Dr. Thomas L. Kieft
Professor of Biology
New Mexico Tech
801 Leroy Place
Socorro, NM 87801

Dear Dr. Kieft,

I am writing this letter in support of the new Ph.D. program in Biotechnology at New Mexico Tech. There is great need for programs like this in New Mexico. Biotechnology Ph.D. graduates from New Mexico Tech will have excellent job prospects in industry and government-funded national laboratories, including possible employment as postdoctoral research and staff members at LANL having attending a program like this one. The quality and rigor of the existing programs at New Mexico Tech and the high number of LANL staff members with one or more degrees from your institution are a testament to the extraordinary educational resources available to students there.

LANL has a long history of collaborations with New Mexico Tech. My understanding is you had collaborated with Dr. Larry Hersman who was in Bioscience Division working on the geomicrobiology of the proposed high-level nuclear waste repository at the Nevada Test Site. Currently, one of our staff scientists, Dr. Momchilo Vuyisich, is mentoring one of New Mexico Tech's Biology 5-year B.S./M.S. students. A Biotechnology Ph.D. program will further facilitate such collaborations between LANL and New Mexico Tech to address problems in medical science, national security, environmental science, etc. Like LANL, the New Mexico Tech Biotechnology Ph.D. program is highly interdisciplinary and focuses on very applied problems. This is different from your counterparts at the University of New Mexico or New Mexico State University.

It is for these reasons that I give full support of your program. Please let me know if I can help in any other way.

With Kind Regards,

José Olivares
Bioscience Division Leader

NV



Bioscience Division
Bioenergy & Biome Science

P.O. Box 1663, MS M888
Los Alamos, New Mexico 87545
505-667-2699/Fax 505-665-3024

Date: October 20, 2015

Dr. Snežna Rogelj
Professor and Chair, Department of Biology
New Mexico Institute of Mining and Technology

Dr. Rogelj:

I am contacting you concerning your proposal to develop a new Ph.D. program in Biotechnology at New Mexico Institute of Mining and Technology (NMT). I am in strong support of your efforts, as it will provide my group with a new regional source of local graduate students and local postdoctoral fellows trained in our area of interest. In particular, we are in need of bioinformatics graduate students and postdoctoral fellows that are US citizens.

I represent the Genomics Program in the Biosciences Division at Los Alamos National Laboratory. The Genomics Program has a long history in genomics science with roots in the 1950's AEC whole animal radiation studies, 1970's radiation cell biology and development of fluorescent flow cell sorters, 1980's National Gene Library Project: Single chromosome flow sorting and creation of chromosome specific DNA libraries, 1990's DOE Human Genome Program peaking with publication of the Human Genome in 2001, 2000's environmental and pathogenic microbe genomic sequencing and finishing, and 2010's plant and algae genomic sequencing/analysis, and transcriptomics. Over the years, our program has hired many graduate students and postdoctoral fellows. It is important to note that most of our junior scientist hires come from the LANL postdoctoral fellow program.

The Genome Program is aggressively interested in developing local graduate students in genomics and hiring local postdoctoral fellows. I am impressed with the proposed NMT Biotechnology PhD program due to participation of the many departments, particularly the engineering, mathematics, computer science, environmental science, and biology departments. A typical candidate we interview has strength in perhaps one of these disciplines, when we need knowledge spanning several disciplines to make progress in our genomics/bioinformatics research in bioenergy, environmental microbiology, and clinical microbiology. The cross-disciplinary training of a NMT student or graduate would be very desirable for our program.

In closing, a New Mexico based biotechnology doctoral program at New Mexico Institute of Mining and Technology will be a valuable personnel resource for the LANL Genome Program.

Please do not hesitate to contact me for further information.

Regards,

A handwritten signature in black ink, appearing to be 'DB', with a long horizontal line extending to the right.

David Bruce
B-11 Deputy Group Leader
Los Alamos National Laboratory

October 15, 2015

Dr. Snezna Rogelj
Biology Department
New Mexico Institute of Mining and Technology
Socorro, NM 87801

Dear Dr. Rogelj,

I am very pleased to offer my enthusiastic support for your proposed Biotechnology Ph.D. Program at New Mexico Tech. My familiarity with NMT has unexpectedly grown out of having one of your impressive undergraduate students work with me during the summer of 2014 and 2015. I visited NMT in the Spring of 2015 to give a talk about our extensive state-of-the art genomics technology at LANL and met with faculty members from numerous departments as well your vice presidents and deans; we uncovered our mutual desire that our institutions develop close collaborations both in the realm of research and in education. Expertise in biotechnology is prerequisite for our research in the fields of Bioscience, Bioenergy, Biosecurity and Public Health, so your Ph.D. program, unique for New Mexico, will directly benefit our Laboratories by teaching the needed cutting-edge biotechnology skills at the doctoral level. Conversely, LANL's existing interest and investment in educating New Mexicans can be strengthened thru a deeper relationship with your academic programs at the undergraduate and graduate levels. For example, LANL participates in the nation-wide, DOE-sponsored SULI Summer Internship Program (<http://science.energy.gov/wdts/suli/>) which provides undergraduate students with research experiences at the Department of Energy (DOE) laboratories with the ultimate goal of encouraging them to pursue careers in STEM. LANL additionally offers internship opportunities to students at the graduate and postdoctoral level, and LANL scientists already serve as research advisors to NMT graduate students and vice-versa. A Ph.D. Program in Biotechnology would definitely expand the flow of knowledge and scientific expertise via this undergraduate-to-graduate pipeline and, in turn, benefit all of New Mexico.

I am personally excited to explore common research interests in application of our advanced genomic and analytical technologies to medical and environmental questions with your Ph.D. students. Ultimately, I am certain that LANL will be employing the graduates from your new Ph.D. program and that our collaborations will lead to innovation as well as to enhanced funding opportunities for both of our institutions.

With my best wishes and in full support of your exciting new program,



Momchilo (Momo) Vuyisich, Ph.D.
Scientist
Genome Science Programs
Los Alamos National Lab

Theory, Simulation and Computation Directorate

Antonio Redondo, PhD

P.O. Box 1663, Mail Stop B210
Los Alamos, New Mexico 87545
505-667-9738/Fax 505-665-4055

Date: 15 October 2015

Symbol: AR-15-09

Professor Thomas Kieft
Biology Department
New Mexico Tech
Socorro, NM 87801

Dear Professor Kieft,

I write this letter in support of the proposed Ph.D. program in Biotechnology at New Mexico Tech. This program will fill a gap in an area of obvious need that has significant potential for growth. There are only a handful of academic institutions in the United States that offer such a program at the Ph.D. level.

Before I continue expressing my enthusiasm for your proposed program I should tell you a little bit about myself. After a thirty-three year tenure at Los Alamos National Laboratory, of which twenty years were as a scientific manager, I recently decided to go back to full-time research and I am now a Senior Scientist at the Laboratory. For the last nine years I was the Division Director of the Theoretical Division at Los Alamos National Laboratory. As such, I was responsible for managing a theoretical research organization consisting of approximately 350 people of which 270 have Ph.D. degrees. I am also in the adjunct faculties at the University of California, Santa Barbara, and San Diego State University. Prior to being the top manager of the Theoretical Division I was the Leader of the Theoretical Biology and Biophysics Group at Los Alamos. I have had the opportunity to hire many Ph.D. researchers over the last twenty years and strongly appreciate the advantages that a program such as the one you are proposing can bring to this important area of science and technology in New Mexico and the Nation.

In addition to my experience as a manager, I have a long research career working with industry and academia on a variety of problems in theoretical and applied physics, particularly computational modeling. I have been the recipient of Sandia and Los Alamos achievement awards several times; I am a Fellow of the American Association for the Advancement of Science and of the World Technology Network. I have also received an award and a medal from Vice President Al Gore at the White House for work on catalytic converters for green cars. My current research focuses on atomistic and particle simulations for complex fluids as well as biological systems.

Putting on my old hat as a hiring manager, I think that one of the most attractive features of the proposed Ph.D. program in Biotechnology is the versatility and variety of skills that your graduates are likely to have. As far as I know, the more pressing problems in biotechnology today require a multi-disciplinary approach. While it is unlikely that a single person will have all the skills that are required for a thorough solution of grand challenge biotechnology projects, the program you

are proposing at New Mexico Tech will produce graduates with two important characteristics: (i) a broad experience in relevant techniques, from coursework and research, and (ii) a versatile background in different areas that will make them quite adaptable to interact with colleagues coming from different disciplines. In my view, one of the most serious difficulties in establishing strong multi-disciplinary teams is the language barrier between different disciplines. From the Executive Summary for your proposed program I can see that your graduates will likely be familiar with much of the language of a variety of disciplines that intersect in the Biotechnology area. Given the track record and quality of work at New Mexico Tech, I have no doubt that your Ph.D. graduates in Biotechnology will be very attractive candidates for hires in many institutions, particularly academia, national laboratories and industrial research centers.

In conclusion, I strongly support your proposed program and hope that you will be successful in the approval process. If I can be of further assistance, please do not hesitate to contact me at redondo@lanl.gov or at the phone number at the top of this letter.

Sincerely,

A handwritten signature in blue ink, appearing to read "Antonio Redondo", with a horizontal line extending from the end of the signature.

Antonio Redondo, PhD
Senior Scientist
Los Alamos National Laboratory