

Executive Summary
Master of Science in Nanomedicine
College of Science

The recent proliferation of nanoparticle-based COVID-19 vaccines and diagnostics has placed nanomedicine at the forefront of medical research, but with only a handful of universities across the U.S. offering educational programs in nanomedicine, industry is currently experiencing a dire shortage of trained professionals. Having developed parallel on-ground, hybrid, and online sections for 5 nanomedicine courses (taught to 1000+ graduate students to-date), raised over \$9.8M for nanomedicine education and training initiatives, and created the world's first Certificate in Nanomedicine, Northeastern University is uniquely poised to address this rapidly growing need for professional nanomedicine education.

COS proposes to establish a new Master of Science degree in Nanomedicine. This professional degree program seeks to provide rigorous, real-world, hands-on training for scientists, engineers, and clinicians working in or seeking nanomedicine-related careers. This interdisciplinary degree program builds upon new and existing courses in COS, as well as electives across the university, to provide students with: (1) a broad understanding of the challenges and opportunities for improving health through nanomedicine; (2) in-depth hands-on training in the materials, methods, and translation strategies used in nanomedicine research, innovation, and commercialization; and (3) an integrated experiential learning opportunity through co-op. The program prepares students to enter the labor force with advanced knowledge, skills, and experience for high-demand research and entrepreneurship roles in biotechnology, pharmaceutical, biomedical, and healthcare industries.

Specifically, we recommend creating a new 2-year, full-time Master of Science degree program in Nanomedicine. In year 1, the master's program will provide six core nanomedicine courses along with a nanomedicine seminar series, co-op preparation course, and summer co-op experience. In year 2, students will have the flexibility to tailor their curriculum by selecting a concentration in: (1) nanoformulation research, (2) translation and commercialization, or (3) vaccine development. The program's concentrations are aligned to strategic areas of emphasis in COS and its interdisciplinary partnerships with industry and across the colleges and schools at Northeastern University. The program will uniquely position COS to engage with students, as well as employers, to offer a high-demand, skills-based professional master's program for today's labor force.

The total degree program will require 34 semester hours, with students completing an average of 8SH per semester in year 1 and 9SH per semester in year 2. This allows international participants to maintain full-time student status while also aligning with existing concentration and elective courses (which are typically 3SH each). The program will consist of: (1) 16 SH of common core courses; (2) 15 SH of concentration courses; (3) 3SH of elective courses, and (4) a four-month co-op. Students will complete one additional 0 SH course each semester, in the form of a co-op preparation course or a seminar/professional skills development course. Students completing a free-standing Certificate in Nanomedicine or Vaccine Development will be allowed to transfer their coursework into the master's degree with approval of the MS Program Director.

Program Description

The Master of Science in Nanomedicine is an innovative, interdisciplinary, flexible, industry-aligned professional degree that provides experiential learning in nanomedicine research, innovation, and commercialization. The program leverages 5 existing nanomedicine courses, whose content will be expanded and redefined to form 6 core courses, 2 concentration courses, and a year-round professional seminar course. In the first year, students will complete courses in nanotherapeutics, nanodiagnostics, preclinical and clinical study design, nanotoxicology, biomedical ethics, and experimental design. The program will offer concentrations in: (1) nanoformulation research, (2) translation and commercialization, and (3) vaccine development, which students will complete in their second year of study. This offers students interested in research the opportunity to iteratively design, synthesize, and characterize nanoparticles, while students interested in entrepreneurship take commercialization courses and develop a virtual start-up company centered around a business idea of their choice. Students interested in vaccine development can take coursework centered around vaccine development, currently offered as a COS certificate program. All concentrations provide the opportunity for content and skills mastery through mentored, semester-long interdisciplinary team projects. Students will complete a minimum of 1 co-op, for which they will be prepared by a professional development for co-op course. Knowledge and skills development will be integrated across courses and placed within industry contexts via the year-round professional seminar course. Collectively, these activities will provide a competitive advantage to students seeking high-demand nanomedicine-based research and entrepreneurship roles in biotechnology, pharmaceutical, biomedical, and healthcare industries.

Evidence of Nanomedicine Demand

Nanomedicine is a rapidly expanding, interdisciplinary field that seeks to develop new and improved nanotechnologies for the screening, diagnosis, treatment, and prevention of disease. Today, more than 50 different nanomedicines are used to treat patients

suffering from a range of disorders, including cancer, infectious disease, kidney dysfunction, iron deficiency, multiple sclerosis and chronic inflammation. Nanomedicine has been recognized as a national priority by the National Institutes of Health (NIH) since 2003 and continues to be considered one of the fastest-growing occupations by the U.S. Bureau of Labor Statistics. Despite this tremendous growth potential, there are few opportunities for students to receive formal training in nanomedicine, since nanomedicine research generally requires close proximity of research universities to hospitals in large metropolitan areas. Out of the 9 higher institutions worldwide that currently offer graduate degrees in nanomedicine, only one is based in the U.S. A 2022 independent market report by Hanover Research found clear demand for a U.S. master's degree in nanomedicine, with the highest nanomedicine labor projections based in Boston, Washington D.C., and London. This presents a clear opportunity for Northeastern University to develop an industry-aligned degree to educate the growing nanomedicine workforce.

Program Contribution to the University's Mission

The proposed master's degree addresses Northeastern University's mission to meet global and societal needs in the sciences through interdisciplinary and scientific methods. Furthermore, the program directly supports COS' mission to create confident, entrepreneurial, problem-solvers, with flexible skills for a vast set of careers. The proposed degree program will expand our strength as a world-leader in nanomedicine education and training by creating a new pathway to prepare students for careers that demand a skillset that is not currently taught by traditional educational systems.