

PROMOTION RECOMMENDATION  
The University of Michigan  
College of Engineering  
Department of Chemical Engineering

Sunitha Nagrath, assistant professor of chemical engineering, Department of Chemical Engineering, College of Engineering, is recommended for promotion to associate professor of chemical engineering, with tenure, Department of Chemical Engineering, College of Engineering.

Academic Degrees:

Ph.D. 2004 Rensselaer Polytechnic Institute, Mechanical Engineering, Troy, New York  
M.S. 2000 Rensselaer Polytechnic Institute, Nuclear Engineering, Troy, New York  
B.Tech. 1992 Sri Venkateswara University, Chemical Engineering, India

Professional Record:

2013 – 2015 Assistant Professor, Department of Biomedical Engineering, University of Michigan  
2010 – present Assistant Professor, Department of Chemical Engineering, University of Michigan

Summary of Evaluation:

Teaching: Professor Nagrath has taught a range of courses from fluid mechanics for undergraduates to BioMEMS (Biomedical Micro Electro-Mechanical Systems) and Applied Mathematics for graduate students in Chemical Engineering. Her performance in the interdisciplinary BioMEMS course is outstanding with Q1/Q2 scores ranging from 4.5 to 5.0. She has introduced examples from her own research as well as combining theoretical and experimental approaches to designing and analyzing the performance of the MEMS devices used in biomedical applications. Professor Nagrath has taught large lecture classes with enrollments of 150 students or more. Her Q1/Q2 scores for the large undergraduate fluid mechanics class range from 3.12 to 3.77. In an effort to improve her scores, Professor Nagrath has sought help from CRLT with a midterm evaluation. She was also invited to join a large course teaching circle conducted by CRLT. Other efforts included the introduction of numerical analysis methods into the course in order for students to understand the fluid mechanics part of the problem without being bogged down by the difficult mathematics. It is clear from student comments that Professor Nagrath is genuinely working to improve her teaching style. She spends significant amounts of time outside the class both to prepare and help students learn the material discussed. Her approachability and care for the students' learning is greatly appreciated by both the graduate and undergraduate students.

Professor Nagrath has mentored approximately 20 undergraduate students and helped with multiple STEM activities during summers. She has graduated one Ph.D. student and is currently advising another nine at various stages of progress. Student comments offer glowing praise of her mentoring skills and the impact she has had on her advisees' lives.

Research: Professor Nagrath's research is creative, impactful, and innovative. Professor Nagrath was recruited to Michigan because she was widely recognized by her contributions to the microfluidic isolation of Circulating Cancer Cells (CTCs) in blood. CTCs are so rare that on the average only one is found for every billion blood cells. She was the first author on a *Nature* paper

which demonstrated the capture of Circulating Cancer Cells (CTCs) and on a related paper in the *New England Journal of Medicine*. These two papers have been cited more than 1800 and 1100 times, respectively. The importance of this research area cannot be overstated. It offers a totally new approach (liquid biopsy) to identify the presence of cancer as well as progression of treatment with only small blood samples (~5-10ml), and without requiring invasive biopsies, which are very difficult or impossible in cases such as lung cancer and pancreatic cancer. After arriving at Michigan, Professor Negrath set out to accomplish another quantum jump in the field of circulating cancer cells; capturing CTCs from patient blood and expanding them for detailed molecular and genomic analyses. This was indeed a difficult challenge, which she was able to overcome by using graphene oxide based chips. The seminal nature of this work is verified by the fact that in less than two years it has received almost 100 citations. Since 2010, Professor Negrath has published 14 papers with a number of new manuscripts submitted. Overall, her papers have been cited over 4000 times. She has been very successful in obtaining financial support for her research program. Counting only her share in collaborative projects, Professor Negrath has raised over \$3,700,000 from a variety of sources, including NSF, DOD, NIH and several foundations. She has three patents and four provisional patent applications and is also actively pursuing transfer of the technology she has developed in isolating CTCs. Evidence of her contributions to the efforts of the U of M Cancer Center can be seen through her publications co-authored with internationally distinguished Cancer investigators. She has become an integral part of the Cancer Center as well as the BioInterfaces Institute.

#### Recent and Significant Publications:

- Yoon HJ, Kim TH, Zhang JZ, Azizi E, Pham, TM, Paoletti C, Lin J, Ramnath N, Wicha M, Hayes DF, Simeone MD and Negrath S, "Sensitive capture of circulating tumour cells by functionalized graphene oxide nanosheets," *Nature Nanotechnology*, 8 (10), 735-741 (2013).
- Zhang Z, Shiratsuchi H, Lin J, Chen G, Reddy RM, Azizi E, Simeone D, Beer D, Ramnath N and Negrath S, "Expansion of CTCs from Early Stage Lung Cancer Patients Using a Microfluidic Co-culture Model," *Oncotarget*. 2014; 5(23): p. 12383-97.
- Muralidhar V, Zenali M, Grabauskienė S, Ghannad-Rezaie M, Wicha MS, Simeone MD and Negrath S, "A Radial Flow Microfluidic Device for Ultra-high-throughput Affinity-based Isolation of Circulating Tumor Cells," *Small*, 29 Jul, 2014.
- Kanwar S, Dunlay CJ, Simeone D and Negrath S, "Microfluidic device (ExoChip) for On-Chip isolation, quantification and characterization of circulating exosomes," *Lab on a chip*, 2014 Jun 7; 14(11): 1891-900.
- Maheswaran S, Sequist L, Negrath S, Ulkus L, Brannigan B, Collura C, Inserra B, Diederichs S, Iafrate J, Digumarthy S, Muzikansky A, Irimia D, Settleman J, Tompkins R, Lynch T, Toner M and Haber DA, "Detecting Epidermal Growth Factor Receptor gene mutations in circulating tumor cells from patients with Non-Small Cell Lung Cancer," *New England Journal of Medicine* 359(4), 366-77 (2008).
- Sequist L, Negrath S, Maheswaran S, Haber DA, Toner M and Lynch TJ, "The CTC-chip: An exciting new tool to detect circulating tumor cells in lung cancer patients," *The Journal of Thoracic Oncology* 3(4), 281-283 (2009).

Service: Professor Negrath has served on numerous departmental committees (seminar, faculty search), College committees (Microfluidics in Biomedical Sciences Training Program Executive committee, Graduate Student Symposium judge). She has also been a vigorous supporter of STEM programs for women and minorities by hosting students in her research labs. Externally, she has also served on a large number of NIH review panels as well as being a regular reviewer for nine large

circulation journals. She has also organized and chaired two technical sessions at professional meetings. We expect her to be more active in professional societies as her career progresses.

External Reviewers:

Reviewer A: "Dr. Nagrath represents one of the brightest 'rising stars' in the field of liquid biopsies for cancer diagnosis and therapy . . . Dr. Nagrath is an institutional treasure who has brought much renown in the CTC field to the University of Michigan..."

Reviewer B: "Her work is distinguished by her deep collaborations and sophisticated assays with clinical samples, which is unusual within the microfluidic CTC community."

Reviewer C: "I admire her determination to accomplish a new effective method to isolate CTCs from blood samples of pancreatic, breast and lung cancer patients."

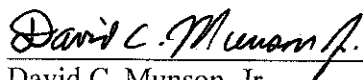
Reviewer D: "Given the relatively short time to develop an independent career in this complex field of clinical/research, she is off to a very solid start."

Reviewer E: "... I believe she would meet the requirements for tenure here at [my institution] and at other major research universities."

Reviewer F: "Dr. Nagrath has taken her earlier post doc work to a new innovative level and to a new focus during her work at the UofM. This significant advance and uniqueness of directions indicates her ability to carve a research niche and perform original high impact science distinguishing herself completely from her earlier work and that of her mentors."

Reviewer G: "...I am most impressed with Sunitha's approach to complex scientific problems, her drive to enter new fields, her ability to work within large multidisciplinary teams, and her relentless drive to bring together engineering and cancer biology to solve complex problems. She has accomplished a great deal in short time. This promotion is not only timely and well deserving but also will poise her to broaden her impact in research and education."

Summary of Recommendation: Professor Nagrath is a very recognized and productive chemical engineer who has made seminal contributions to cancer diagnosis and monitoring without biopsy; she is an excellent interdisciplinary course teacher and she has made significant service contributions internally and externally. It is with the support of the College of Engineering Executive Committee that I recommend Sunitha Nagrath for promotion to associate professor of chemical engineering, with tenure, Department of Chemical Engineering, College of Engineering.



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David C. Munson, Jr.  
Robert J. Vlasic Dean of Engineering  
College of Engineering

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