

DEPARTMENT OF CHEMICAL + BIOLOGICAL ENGINEERING



Associate Professor Manolis Tzanakakis is engineering ways to improve stem cell therapies. (Credit: Alonso Nichols/Tufts University)

STEM CELL THERAPEUTICS

Ramping up Discovery in Pluripotent Cells for Future Therapies

Two major challenges in realizing effective stem cell therapies include cell functionality and quantity. Engineers must be able to generate stem cell-derived cells with functional attributes akin to those of native cells—for example, contractility in heart muscle cells—and do so in a reproducible fashion and in quantities to meet clinical demands. Associate Professor Emmanuel (Manolis) Tzanakakis is developing efficient differentiation strategies and scalable systems for generating stem cell therapeutics.

Mathematical modeling and experimentation is part of Tzanakakis’ multi-scale approach to better understanding two particular cell types: heart muscle and pancreatic endocrine insulin-producing cells.

“The heterogeneity observed in stem-cell populations is considered key to their differentiation,” said Tzanakakis, “and we investigate this through mathematical modeling coupled to experiments.”

Continued on page 3

“If successful, the cells will serve as an inexhaustible source of material for high-throughput screening of candidate drugs.”

IN THIS ISSUE

- From the Chair 2
- Research Highlights 3
- Off Campus 3
- Faculty Highlights 4
- Graduates 5
- Alumni News 6
- In Memoriam 7

FROM THE CHAIR



Dear Alumni and Friends,

I hope that this letter finds you well. Taking stock of this past year, I am very pleased to tell you that it has been another highly successful year for the department. We have graduated a stellar class of students, welcomed new faces, and celebrated many wonderful accomplishments of our students, faculty, and staff.

This past summer, Manolis Tzanakakis joined the department as Associate Professor with tenure. He was previously a faculty member in the Department of Chemical and Biological Engineering at the University of Buffalo, where he was the director of the WNYSTEM Stem Cell Culture, Banking and Training Facility. His research interests include stem cell bioprocessing and tissue engineering with applications in cell-based therapies for heart disease and diabetes. We are delighted to have Manolis become a member of our faculty, and I encourage you to learn more about his research by reading the cover story in this newsletter.

I am delighted to share the news that Maria Flytzani-Stephanopoulos, the Robert and Marcy Haber Endowed Professor in Energy Sustainability, has been elected to the National Academy of Engineering (NAE) this past spring. This is one of the highest honors in the engineering profession and recognizes

Professor Flytzani-Stephanopoulos' truly distinguished career. Congratulations, Miretta!

I am also very pleased to tell you that the department's research productivity continues to rise. Just this past spring and summer, faculty members have secured seven (7) new research grants and contracts totaling more than \$1.8 million, obtaining funding from the National Science Foundation, National Institutes of Health, Department of Energy, Department of Defense, and Biogen-IDEC. Faculty and students also continue to publish their research results in high-impact journals such as *ACS Nano*, *JACS*, *Science*, and *Nature Communications*, to name a few.

Before I close, I would like to give special thanks to Research Associate Professor Howard Saltsburg, who led the department as Acting Chair from 2001–2002 and has been a long-time contributor to the department as a teacher, researcher, and mentor to students and faculty. Professor Saltsburg retired from the department this past summer to finally devote more time to his health and pursue his other numerous interests. At Tufts, professor Saltsburg was a valuable collaborator to Professor Flytzani-Stephanopoulos in her research on atomic-scale catalysts for fuel processing, and a co-advisor or thesis committee member of more than 10 doctoral students. This collaboration has resulted in several seminal publications that have been cited more than 2,500 times to date.

As you can see, the department has many wonderful accomplishments to reflect on and celebrate. Thanks to the efforts of talented and dedicated faculty members, students, and staff as well as generous support from our alumni and friends, the department continues to elevate its visibility and

grow its reputation as a vibrant place of learning and scholarship.

With warm regards,

Kyongbum Lee
Professor and Chair

Notables...

Assistant Professor **Matthew Panzer** won the Recognition of Undergraduate Teaching Excellence (ROUTE) Award at Tufts. The award recognizes faculty who demonstrate excellence in teaching and advising, show concern for their students' academic and personal growth, and who convey a passion and enthusiasm for their field.

Doctoral student **Ming Yang** received an International Precious Metals Institute (IPMI) student award at the 38th IPMI Conference in June 2014. Ming is a fourth year Ph.D. candidate working in the Nano Catalysis and Energy Laboratory with Haber Professor Maria Flytzani-Stephanopoulos.

Senior **Andrew Rosen** received one of two scholarships awarded to Tufts students from the Barry Goldwater Scholarship and Excellence in Education Foundation. After graduation, Andrew would like to pursue his doctorate and conduct research in transport phenomena and thermodynamics while teaching at the university level. Rosen published a paper in the *Journal of Physics B: Atomic, Molecular and Optical Physics* based on research he performed at the Plasma Science and Fusion Center at MIT.

Seniors **Bassel Ghaddar**, **Jerren Grimes**, and **Andrew Rosen** as well as junior **Yangming Kou** were awarded 2014 Summer Scholar research awards. Ghaddar worked with Professor Kyongbum Lee on arachidonic acid and its metabolites. Grimes is researching chemical interactions within solid ionogel electrolytes with Assistant Professor Matt Panzer. Kou is working on novel membrane technologies with Professor Asatekin. Rosen is studying the conductive and optical properties of 2D-assembled silver nanoparticles with Associate Professor Hyunmin Yi.

Stem Cell Therapeutics *Continued from page 1*

Using human pluripotent stem cells (hPSCs), researchers in Tzanakakis' lab have been successful in generating heart muscle cells under pathogen-free conditions. The cells express markers of native cardiomyocytes and exhibit contractile activity that can be altered—sped up and slowed down—with drugs in the same way as native cardiac cells respond to drug treatment.

Parallel efforts are underway for fine-tuning the commitment of hPSCs toward pancreatic insulin-secreting cells resembling native endocrine beta-cells. “If successful, the cells will serve as an inexhaustible source of material for high-throughput screening of candidate drugs,” Tzanakakis said.

To produce this “inexhaustible source”, researchers in Tzanakakis' lab are also designing bioreactor systems for the economical production of large quantities of functional stem cell progeny free of animal-derived components typically found in mammalian cell cultures.

“Combined with our work on stem cell culture scaled-up to a bioreactor, the differentiated cells may be a solution to the severely limited availability of donor tissue for heart and diabetes therapies,” he said. — *Jane Carter, Communications Assistant*

RESEARCH HIGHLIGHTS

Predicting Gut Metabolites to Better Understand GI Diseases

Professor and Chair Kyongbum Lee and collaborators, including ChBE alumnus Arul Jayaraman, EG95, from Texas A&M University, have produced the first report to predict and identify the metabolic products of gastrointestinal (GI) tract microorganisms utilizing computational modeling. Understanding these metabolic products could influence how clinicians diagnose and treat GI diseases, as well as many other metabolic and neurological diseases increasingly associated with compromised GI function.

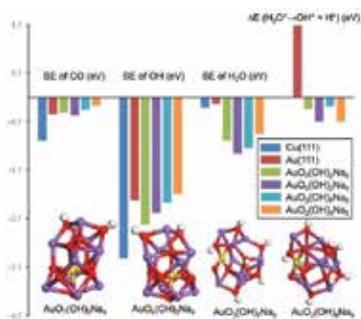
In their approach, published in *Nature Communications* (doi: 10.1038/ncomms6492), the microbiota is understood as a single, complex network of reactions. By using computational algorithms for network analysis, virtual pathways can be constructed to determine possible metabolic products. Then, these products can be parsed into host-derived or microbiota-derived categories.

Single-Atom Gold Catalysts May Offer Path to Low-Cost Production of Fuels and Chemicals

New catalysts designed by Professor Flytzani-Stephanopoulos and collaborators from other university and national laboratories have the potential to greatly reduce processing costs in future fuels, such as hydrogen. The catalysts, composed of single gold atoms supported by a wholly unique structure comprised of non-reactive silica materials, demonstrate comparable activity and stability with current catalysts used in producing highly purified hydrogen. The work, which appears in the November 27, 2014 edition of *Science Express*, points to new avenues for producing single-site supported gold catalysts that could produce high-grade hydrogen for cleaner energy use in fuel-cell powered devices, including vehicles.

This new research describes how single gold atoms dispersed on non-reactive supports created with silica materials can serve as the exclusive sites for catalysis when stabilized with alkali ions. As long as the gold atoms, or cations, are stabilized in a single-site form configuration, irrespective of the type of support, the precious metal will be stable and operate for many hours at a range of practical temperatures.

“This novel atomic-scale catalyst configuration achieves the maximum efficiency and utilization of the gold,” says Flytzani-Stephanopoulos. “For many hours, these single-site gold cations were active for low-temperature water-gas shift reaction and stable in operation at temperatures as high as 200°C.”



Comparison of CO binding, OH binding, H2O binding and water activation thermochemistry between candidate active sites, Cu(111) and Au(111). Entry for water activation thermochemistry on Cu(111) is -0.01eV, very small to be discernible in the graph. Au, Na, O and H atoms are shown in yellow, purple, red and white spheres, respectively.

OFF CAMPUS



This fall, Assistant Professor **Matthew Panzer** gave a talk at Carnegie Mellon University and at the Natick Army

Labs to the Natick, Mass. chapter of Sigma Xi.



Over winter break, Assistant Professor **Ayse Asatekin** will co-teach a course at Yonsei University in Seoul. In

February, she will give a paper at the ECI Conference on Advanced Membrane Technology, in Sicily, Italy. Later in the spring, she will give a talk at 5th Physical Chemistry Congress in Konya, Turkey.



This fall, Professor and Chair **Kyongbum Lee** gave a talk at Tufts HNRCA. In December, he is

scheduled to speak at Princeton University. Lee will also be part of the Distinguished Lecture series at Northeastern University this spring and give a seminar at Purdue in April.

Faculty Highlights

Maria Flytzani-Stephanopoulos, the Robert and Marcy Haber Endowed Professor in Energy Sustainability, has been elected to the National Academy of Engineering for contributions to atomically dispersed heterogeneous metal catalysts for efficient production of fuels and chemicals.

Election to the NAE is among the highest professional distinctions accorded to an engineer. Professor Flytzani-Stephanopoulos' election to the NAE recognizes her as a leader in the field of clean energy technologies and underscores her importance to our community as one of our most valued faculty members in engineering for sustainability research—one of Tufts School of Engineering's three strategic cross-disciplinary focus areas.

She is the recipient of many honors and awards. These include a Space Act Award from NASA, a Career Advancement Award from the National Science Foundation, the Distinguished Scholar Award of Tufts University in 2007 and the Henry J. Albert Award from the International Precious Metals Institute in 2008. Last year, she received the Giuseppe Parravano Memorial Award for Excellence in Catalysis Research. An elected fellow of the American Association for the Advancement of Science and the American Institute of Chemical Engineers, Flytzani-Stephanopoulos chairs the American Institute of Chemical Engineers Catalysis and Reaction Engineering Division.



Invited Talks

- **Keynote Speaker**
TOCAT 7 international meeting in Kyoto, Japan, June 2014
- **Keynote Speaker**
8th International Conference in Environmental Catalysis (ICEC 2014) in Asheville, NC, Aug. 24–27, 2014
- **Plenary Speaker**
ISCRE 23 meeting in Bangkok, Sept. 7–10, 2014
- **Invited Professor Lecturer**
CNRS/Paris, University Pierre and Marie Curie in Paris, Oct. 13, Oct. 20, and Nov. 3, 2014
- **Invited Seminar**
Ghent University, Department of Chemical Technology, in Ghent, Belgium, Oct. 17, 2014
- **Invited Seminar**
University of Lille, CNRS, in Lille, France, Oct. 24, 2014
- **Presentations with doctoral students, AIChE Annual Meeting in Atlanta, Nov. 16–21, 2014**
- **Invited Seminar**
University of South Carolina in Columbia, SC, Dec. 4, 2014

NEW FACES EMMANUEL (MANOLIS) S. TZANAKAKIS



Associate Professor Manolis Tzanakakis joins Tufts ChBE from his position as Associate Professor of Chemical and Biological Engineering at SUNY-Buffalo where he was also the director of the Stem Cell Culture, Banking and Training Facility at the Western New York Stem Cell Culture and Analysis Center. He also held joint appointments in SUNY-Buffalo's Department of Biomedical Engineering, the Genetics, Genomics and Bioinformatics Program and the New York State Center of Excellence in Bioinformatics and Life Sciences. Tzanakakis obtained his Ph.D. in chemical engineering from the University of Minnesota and then worked as a post-doctoral associate at the Stem Cell Institute on the conversion of adult stem cells to cardiomyocytes. He continued his post-doctoral training at the Diabetes Center at the University of California-San Francisco (UCSF) studying signaling during pancreas development.

Congratulations to our 2013–2014 Graduates

Congratulations to our newest alumni! The Class of 2014 was honored during commencement weekend with a brunch hosted by the department to recognize students' hard work during the past four years. During the festivities, students showed their families around SciTech and introduced them to members of the faculty. Professor of the Practice Derek Mess was the emcee, describing senior lab projects, as well as pointing out individual accomplishments. Seven students graduated with *summa cum laude* honors: Laura Crowell, Nikolai Klebanov, Jeremy Ho, Jared Nash, Zachary Ladwig, Robert Dimatteo, and Adam Helitzer. Two students successfully pursued and defended senior honors thesis: Sergei Hanukovich and Jared Nash.



Doctoral Recipients

Branko Zugic (Aug 2013)

Thesis: Carbon-Supported Platinum- and Palladium-Based Catalysts for Low-Temperature Water-Gas Shift and Butyrate Decarboxylation Reactions
Advisor: Professor Flytzani-Stephanopoulos

Master of Science Recipients

George Cladaras (Aug 2013)

Thesis: Selective Hydrogenation of Phenylacetylene on Bimetallic Pd-Cu and Pt-Cu Catalysts
Advisor: Professor Flytzani-Stephanopoulos

Matthew Rutter (Aug 2013)

Thesis: Cobalt-Promoted Iron Oxide Nanoparticles for the Selective Oxidative Dehydrogenation of Cyclohexane
Advisor: Professor Flytzani-Stephanopoulos

Peng Wu (Aug 2013)

Thesis: Syntheses and Evaluations of Nanostructured Gold-Iron Oxide Catalysts for the Oxidative Dehydrogenation of Cyclohexane
Advisor: Professor Flytzani-Stephanopoulos

MS Bioengineering: Cell and Bioprocess Track

Charmian Wu (May 2014)

Thesis: Construction of a Genome-Scale Gut Microbiota Model and its Application to Discovering the Fates of Aromatic Amino Acids
Advisor: Professor Lee

ME Bioengineering: Cell and Bioprocess Track

Nathan Lee (Aug 2013)

Master of Engineering Recipients

Adam Brooks (Feb 2014)

Darshan Sokhey (May 2014)

Bachelor of Science Recipients

Oluseye Bankole

Christopher Barry

Priyanka Bhargava

Patrick Bressette

Maxim Bukhovko

Corey Christian

Jesse Cohen

James Collins

Jesse Cooper

Laura Crowell

Francesca D'Alfonso

Robert Dimatteo

Christopher
Ghadban

Alecia Hagman

Tesfamariam Hailu

Sergei Hanukovich

Adam Helitzer

Jeremy Ho

Blake Hotz

Nikolai Klebanov

Ketan Kumar

Zachary Ladwig

Brian Lai

Caitlin Meeks

Kathleen Miller

Harsha
Mirchandani

Jared Nash

Maximilian
Nopprapun

Christina Pan

Jeremy Rosenblatt

Jeffery Spencer

Jeffrey Thibodeau

Rachel Warren

Kenneth Westerman

Faith Wilson

Christina Wu

2014 Departmental Award Winners

Maxim Bukhovko

Class of 1911 Prize Scholarship

Laura E. Crowell

Audrey Butvay Gruss Science Award

Allyson Fournier, E15

Frederick Melvin Ellis Prize

Alecia I. Hagman

Air Force ROTC Prize Award
(nominated by her ROTC captain)

Jeremy Ho

Lt. Commander R.J. Manning Memorial Prize

Nikolai Klebanov

Class of 1947 Victor Prather Prize

Yangming Kou, E16

Karno Dean's Award for Academic
Excellence and Leadership

Zachary V. Ladwig

Alex Elias Memorial Prize Scholarship

**The senior class voted
Assistant Professor
Ayse Asatekin as “Best
Professor” and doctoral
student Jilei Liu “Best
Teaching Assistant.”**

PECASE and Tobias Young Investigator Award Winner

Alumnus **Adam Weber**, E99, EG99, was among the 2013 awardees of the Presidential Early Career Awards for Scientists and Engineers, the highest honor bestowed by the U.S. government on science and engineering professionals in the early stages of their independent research careers. Weber, currently a staff scientist at Lawrence Berkeley National Laboratory, is optimizing fuel-cell performance and lifetime; understanding flow batteries for grid-scale energy storage; and analyzing solar-fuel generators. Weber was among the 102 scientists and engineers honored at the White House on April 14, 2014.

This October, Weber also received the 2014 Charles W. Tobias Young Investigator Award at the Electrochemical Society (ECS) meeting in Cancun, Mexico. The ECS Tobias Young Investigator Award recognizes outstanding engineering work in fundamental or applied electrochemistry or solid-state science and technology.



President Barack Obama talks with the Presidential Early Career Award for Scientists and Engineers (PECASE) recipients in the East Room of the White House, April 14, 2014. (Official White House Photo by Pete Souza)

CheTA Boston

Sanya Ramjattan, E12, is one of the co-founders of CheTA, a networking and social group for Boston-area Tufts ChBE alumni. CheTA (Chemical engineering, Tufts Alumni)—pronounced “cheetah”—held its kickoff event at Sacco’s Bowl Haven in Somerville. To learn more about upcoming events, please visit: facebook.com/ChETAboston



Left to Right: Gautham Sridharan, EG13, Joe Lessard, E11, EG12, Ryan Nolan, EG05, EG11, Wesley Chen, E11, Billy Zile, EG13, Kristina Papa, E12, Sanya Ramjattan, E12, at the first CheTA event.

iGEM Conference

With advisor Assistant Professor **Nik Nair**, alumnus **Chris Ghadban**, E14, founded a team through the International Genetically Engineered Machine (iGEM) Foundation, which supports research in synthetic biology. This fall, the iGEM team hosted a conference on “The Future of Phage and Synthetic Biology.” Tufts President Anthony P. Monaco opened the conference which drew experts from the Boston-area community, including Professor Andrew Camilli from Tufts’ Sackler School of Graduate Biomedical Sciences. Other notable attendees were Anna Kuchment, an editor for *Scientific American* and author of *The Forgotten Cure*, as well as Dr. Robin Pierce, a senior law and ethics associate from Harvard Law School.



Assistant Professor Nik Nair, iGEM team advisor



Remembering Gregory D. Botsaris, Professor Emeritus of Chemical and Biological Engineering



Gregory D. Botsaris, Professor Emeritus of Chemical and Biological Engineering passed away on September 25, 2014 surrounded by his family and close friends.

Professor Botsaris completed his undergraduate studies at the National University of Athens, Greece and received three graduate degrees from M.I.T., including a Ph.D. in chemical engineering. After completing his doctorate in 1965, he joined the Department of Chemical Engineering at Tufts University School of Engineering as an assistant professor. He was promoted to the title of Associate Professor in 1969 and to Professor in 1975. While on leave from Tufts in 1977, he served as the founding faculty member of the Department of Chemical Engineering at the University of Patras in Greece. From 1983 to 1993, he served as the department chair. Upon his retirement in 2004, he was named Professor Emeritus of Chemical and Biological Engineering.

Throughout his career at Tufts, Professor Botsaris worked tirelessly to enhance the Department of Chemical and Biological Engineering. During his chairmanship, the department moved to its current home in the Science and Technology Center, and its number of faculty and graduate students increased appreciably. He also created the Biotechnology Engineering Center, ushering in bioengineering activities at the School of Engineering.

For more than 40 years, Professor Botsaris consulted with many different companies including: Gillette, Textron, Polaroid, Fibergen, and CIBA-Corning. His research centered around two fields: crystallization and stability of colloidal dispersions.

“Professor Botsaris was truly an inspirational figure, a brilliant scientist, and a gifted teacher with outstanding human values. Professor Botsaris was kind, humble, and generous with his time. He was my mentor and advisor at Tufts, and instrumental in my pursuit of chemical engineering. He was convinced that chemical engineering would be a fantastic degree for my ultimate career in medicine, and I will forever be grateful for his guidance and wisdom.”

—Dr. Vasken Dilsizian, E77, EG99

His research in dispersions involved the stabilization of coal-water slurries and their use as alternative fuels in the power industry. In 1981, he was a member of a U.S. Department of Energy delegation that visited China at the invitation of the Chinese government for exchanging technical information on coal utilization in the form of slurries in water. In 1989, Professor Botsaris co-edited a book, *Interfacial Phenomena in Coal Technology*, which focused on clean-coal technologies.

The heart of his crystallization research involved the investigation of secondary nucleation and the effect of additives on crystal growth. His first doctoral student used chiral crystals in 1970 as a probe of the mechanism of secondary nucleation. This work was revisited and refined in the late 1990s and early 2000s and led to a novel model for secondary nucleation. This model has important implications for the separation of chiral drugs by crystallization in the pharmaceutical industry. In the 1990s, Professor Botsaris also studied environmental applications of crystallization—namely, the freeze concentration of the bleaching effluents of paper pulp plants and the production of a road deicer, calcium magnesium acetate, by a process involving crystallization. In 1997, he co-edited the book *Separation and Purification by Crystallization*.

He held membership in the American Institute for Chemical Engineers (AIChE) and served as chairman of the AIChE Crystallization Committee and sat on the Steering Committee of the Association for Crystallization Technology (ACT).

The Gregory Botsaris Lectureship was established in 2006 in recognition of Professor Botsaris' outstanding leadership and invaluable contributions to the Department of Chemical and Biological Engineering. Colleagues, friends, alumni, and current faculty members have contributed to the lectureship fund, which provides a biannual chemical engineering lectureship series for speakers including Professors Michael Doherty, Y.-A. Liu, Thomas Peterson, and Alan Hatton.

Greg is survived by his wife, Betty, his sister in Patras, his son Serge, and three grandchildren. Read more memories of Professor Botsaris: engineering.tufts.edu/chbe/rememberingbotsaris.htm

Tufts
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School of
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Department of Chemical
and Biological Engineering
Science and Technology Center
4 Colby Street
Medford, MA 02155

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This May, junior Allyson Fournier pitched a six-hit shutout as the Tufts University softball team won its second straight NCAA championship with a 6-0 victory against Salisbury at the University of Texas-Tyler. Fournier is also the recipient of the 2014 Frederick Melvin Ellis Prize, awarded to students who have “demonstrated marked athletic versatility, a modest manner, successful academic achievement, and the potential for effective leadership of youth.” This prize was established in 1968 by fellow alumni, students, and friends of Professor Frederick Ellis, Class of 1929.