Johns Hopkins researchers have discovered a new mechanism that explains how cancer cells spread through extremely narrow three-dimensional spaces in the body by using a propulsion system based on water and charged particles.

The finding, reported in the April 24 issue of the journal *Cell*, uncovers a novel way that the deadly cells use to migrate through a cancer patient’s body. The discovery may lead to new treatments that help keep the disease in check. The work also points to the growing importance of studying how cells behave in three dimensions, not just atop flat two-dimensional lab dishes.

Based on such lab dish studies, cancer researchers had concluded that tumor cells require actin and other proteins to form arm-like extensions to “crawl” across the flat surfaces. This type of travel was believed to be the primary means of how cancer spreads within a patient, a process called metastasis. Based on this conclusion, researchers have been working on ways to disable actin and its molecular helpers, hoping this can keep cancer from spreading.

But in a study published in 2012, a Johns Hopkins team led by Konstantinos Konstantopoulos, PhD, chair of the Department of Chemical and Biomolecular Engineering, found that tumor cells could move through narrow spaces without using actin and its biochemical partners. “That was a stunning discovery, not in line with the prevailing beliefs about how cells migrate,” Konstantopoulos said. “So we wanted to figure out exactly how the tumor cells were able to move through these spaces without relying on actin.”

He collaborated with Sean X. Sun, a Johns Hopkins associate professor of mechanical engineering with experience in math modeling and physics at microscopic levels. “The mystery we needed to solve,” Sun said, “was how the cells in these confined spaces could still move when you took away their usual ‘engine,’ the actin.”

Kostantopoulos said Sun and Hongyuan Jiang, a postdoctoral fellow working in Sun’s lab, “came up with an excellent mathematical model that provided insights into how the cells might use a different system to travel.” Then Konstantopoulos and other team members, including Kimberly Stroka, a postdoctoral fellow in his own lab, used a microfluidic lab-on-a-chip and imaging techniques to conduct experiments establishing the new mechanism of migration. The tests utilized human and animal cancer cells.

CONTINUED ON PAGE 5
MESSAGE FROM THE CHAIR
Dear JHU ChemBE Alumni and Friends,

It is my pleasure to share with you some of the recent successes of our faculty, students and alumni. Over the past year, our faculty published more than 115 papers in premier journals, including Nano Letters, PNAS, Nature Communications, Nature Chemistry and Nature Reviews Cancer—an average of more than eight papers per faculty member per year. Our ChemBE faculty were also awarded numerous research grants from diverse funding agencies such as NIH, NSF and DoD. Among the year’s highlights were Zachary Gagnon’s CAREER award, Chao Wang’s AFOSR Young Investigator Research Program award, and Joelle Frechette’s promotion to tenured Associate Professor. I also congratulate Dennis Wirtz on being named Vice Provost of Research.

The successes of our faculty are linked to the remarkable accomplishments of our students and postdoctoral fellows. Our postdocs, Kimberly Stroka and Elizabeth Nance, received the prestigious Burroughs Wellcome Fund Career Award at the Scientific Interface (see p. 5). ChemBE postdoctoral fellow, Daniele Gilkes, was awarded the K99/R00 Pathway to Independence Award. Two of our postdocs, Stephanie Fraley and Kimberly Stroka, are launching their academic careers in the Department of Bioengineering at University of California, San Diego and University of Maryland at College Park, respectively. Our graduate students have been recognized for their innovative and creative work, and received prestigious awards (see p. 3). Our undergraduates, too, are award-winning engineers, including a group of seniors (see p. 3). Our undergraduates, too, are award-winning engineers, including a group of seniors.

Since 2008, our departmental ranking according to US News & World Report has steadily improved from 27th to 20th. Given the continued remarkable achievements of our faculty, students and alumni, I have no doubt that the future of our ChemBE department looks brighter than ever before.

Best wishes,

Konstantinos Konstantopoulos
Chair of Chemical & Biomolecular Engineering

FACULTY NEWS

Frechette earns tenure
Joelle Frechette was promoted to Associate Professor in January 2014. She received NSF funding for a collaborative project on the deposition and transport of particles in porous media. She also received seed funding from HEMI to study hydrofracturing of hydrogels. In 2014, she was selected to be on the editorial advisory board of Langmuir, and she is on the executive committee of the Adhesion Society. Her current effort in understanding capillary alignment was published in Langmuir and Applied Physics Letters. Her lab efforts are in the area of colloids and interfaces, with specific projects aimed at understanding the mechanisms for tree frog adhesion and for the adsorption of particles at fluid interfaces.

Wang receives new funding
Chao Wang, Assistant Professor, is a recipient of the Ralph E. Powe Jr. Faculty Enhancement Award (ORAU, 2013) and AFOSR YIP Award (2014). In the past year, his group has carried out a variety of research, including development of organic solution synthesis for nanomaterials, such as alloy nanoparticles and 2D transition metal chalcogenides, and electrocatalytic studies of energy conversion reactions, such as CO2 reduction and water splitting. He has recently received three NSF grants (one as PI, two as co-PI) to support his research, including one NSF/DMREF grant of more than $1 million (as co-PI).

Cui lands grants and publications
Honggang Cui, Assistant Professor, was awarded a pilot grant from Older Americans Independence Center to develop new targeting strategies for improved treatments of aging-associated diseases, and also received an NSF grant to study polyelectrolyte nanocages. He received the 2014 Tsinghua Global Scholars Fellowship, which supported his two-week visit to Tsinghua University (China) this past summer, and he organized the first ACS/PMSE symposium on Functional Supramolecular Polymers. Cui delivered 10 invited university and conference lectures, including the Faraday Discussions on Self-Assembly of Biopolymers, the Gordon Research Conference on Cancer Nanotechnology, and the 2013 Nano Drug Delivery Symposium (NanoDDS’13). Cui lab has published more than 20 peer-reviewed articles since 2013, and his lab work on the design of supramolecular nanobeacon was highlighted in the magazine Chemical & Engineering News.

Wirtz named Vice Provost for Research
Denis Wirtz, Theophilus H. Smoot Professor, was named Vice Provost for Research for Johns Hopkins University in February 2014. In the past year, Wirtz gave over 15 departmental seminars and invited conference talks and was elected to the editorial board of Technology. He also was an advisor for Aphelion NIH-NSF Physical Sciences and Advancement. He published 22 peer-reviewed articles in the past year, including papers in Cancer Research, PNAS, and Nature Reviews Cancer.

FACULTY AWARDS AND HONORS
Michael Betenbaugh, Professor, received an EFRI collaboration grant together with 3 other co-investigators to study the application of microalgae for enhanced conversion of carbon dioxide and sunlight to higher value biochemicals. The grant will combine genome scale models with metabolic engineering and process control to optimize algal operations for biotechnology.

He also was part of the research team that sequenced and published the Chinese hamster genome and led an effort on the proteome. His ‘omics-based research has expanded to included genomics, proteomics, glycomics, and more recently metabolomics and lipidomics. A recent project funding by NSF will focus on engineering glycosylation pathways to produce higher value biopharmaceuticals in the widely used Chinese hamster ovary cell line.

Michael Bevan, Associate Professor and Director of the Graduate Program, received invitations to present his research at a number of universities and conferences, including keynote talks at the ACS Colloids Summer meeting, the ACS national meeting, and a plenary lecture at the AIChE national meeting, Bevan
has been invited to write feature articles for Soft Matter, Langmuir, and the Journal of Colloid and Interface Science, and he has published several papers on novel control science algorithms and reconfigurable antenna applications involving colloidal assembly schemes.

His former PhD student Daniel Beltran, a 2012 graduate, received the prestigious LaMer award from the ACS Colloids and Surfaces division for the best doctoral thesis, which includes a $3,000 award and a plenary lecture at the summer meeting.

Zachary Gagnon, Assistant Professor, has been selected by the National Science Foundation to receive its prestigious CAREER Award, which recognizes promise and excellence in early stage scholars. The five-year grant of nearly $500,000 will support Zachary’s work to develop inexpensive and portable biosensors for rapid, sensitive, and label-free multiplexed biomolecular detection.

Sharon Gerecht, Associate Professor, led her lab in the publication of 14 referred papers in the past year, among them a publication in Nature Communication that established a new class of oxygen-controlling biomaterial hydrogels. She was a member of the organizing committees of SBE Stem Cell Engineering, TERMIS-AM and the Aegean Conference on Tissue Engineering. She has received the W.W. Smith Charitable Trust Heart Award (2014-2017) and has been elected to the Homewood Academic Council.

Jeffrey Gray, Associate Professor, continues work on engineering antibodies. In a recent blind prediction assessment, Gray’s lab achieved the best antibody binding-loop structures on four challenge targets. His lab published a study on designing antibodies for use as sensors using non-canonical amino acids. The Rosetta consortium renewed an NIH grant for biomolecular software engineering, and the lab was awarded supplemental NIH funding for an outstanding undergraduate. Gray’s lab was awarded one million CPU hours on an NSF national supercomputer, and his grant proposal was shared on the NSF website as a model proposal. Gray joined the JHU Diversity Leadership Council last fall, where he serves on the Faculty Recruitment and Child Care committees.

Konstantinos Konstantopoulos, Professor and Chair, was awarded a new $2.2 million, five-year NIH/NCI R01 grant on pancreatic cancer mechanics and imaging. He published 10 peer-reviewed articles in premier journals such as CELL and Journal of Cell Biology, and delivered more than 10 invited talks at universities and national and international conferences. He received the Bioengineering Distinguished Alumnus Award from Rice University in 2013.

Konstantopoulos will present the 2014 AIChE Division 15d/e Plenary Lecture. He joined the Editorial Board of Annual Review of Biomedical Engineering and Technology (2014-present), and he also serves as section editor for Biological Engineering in Current Opinion of Chemical Engineering (2014-present). He serves on the advisory board of the Chemical and Biological Engineering Department at Tufts University (2013-present). Konstantopoulos’ postdoctoral fellow, Kimberly Stroka, will join the faculty of Bioengineering at the University of Maryland at College Park on January 1, 2015.

Marc Ostermeier, Professor, received a grant from TEDCO’s Maryland Innovation Initiative to further develop his new PFunkel mutagenesis technology for commercialization. The technology has been licensed to Revolve Biotechnologies, a startup company formed by former and current graduate students in his lab and located in JHU’s FastForward technology accelerator.

His group published papers in Nucleic Acids Research and Molecular Biology and Evolution that exploit this mutagenesis technology to address fundamental questions in evolutionary biology, a relatively new area of research for him. This area of research will be funded by two new NSF grants that he received this year. He became a fellow of the American Institute for Medical and Biological Engineering and was elected to the Homewood Academic Council.

Rebecca Schulman, Assistant Professor, focuses on adaptive biomaterials built using synthetic DNA. Recent work has appeared in Nano Letters and Technology. In August, Schulman organized the first mid-Atlantic DNA Nanotechnology symposium, attended by more than 75 researchers.

**AWARDS & HONORS**

- Dr. Jason Labonte, a postdoctoral fellow in the Gray lab, received an NIH F32 Fellowship for modeling glycoproteins.
- Daniele Gilkes, a postdoctoral fellow in the Wirtz lab, won the K99/R00 Pathway to Independence Award.
- Angela Jimenez, a PhD candidate in the Wirtz lab, was selected to attend the 2014 Lindau-Nobel Laureates Meeting and won an ARCS Fellowship.
- Brian Weitner, a PhD candidate in the Gray lab, won the 2013 Service to Rosetta Award for co-founding the coding boot camp and establishing a shared-code github platform for the 40-lab biomolecular modeling and design consortium.
- Jenna Graham, a School of Medicine PhD candidate in the Wirtz lab, won the Whitaker International Fellows Grant to support one year of research abroad at the Swiss Federal Institute of Technology in Zurich (ETHZ).
- Tiana Warren, a PhD candidate in the Ostermeier lab, was awarded a 2014 NSF Graduate Research Fellowship.
- Alison Chamblish, Elad Firnberg, Lye Lin Lock, Julian Rosenberg, Vasudah Srivastava and Ying Wang received the 2013-14 Chemical and Biomolecular Engineering Graduate Student Awards.
- Tara Edwards and Kimberly Stroka received the 2013-14 Chemical and Biomolecular Engineering Postdoctoral Fellow Awards.
- Christian Pick and Dominic Scalise received the 2013-14 Chemical and Biomolecular Engineering Teaching Assistant Awards.
- Colin Paul, a PhD candidate in the Konstantopoulos lab, received the Biomedical Engineering Society (BMES) Graduate Student Design and Research Award.

**GRADUATE/POSTDOC AWARDS**

- Zachary’s work to develop inexpensive and portable biosensors for rapid, sensitive, and label-free multiplexed biomolecular detection.

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- Colin Paul, a PhD candidate in the Konstantopoulos lab, received the Biomedical Engineering Society (BMES) Graduate Student Design and Research Award.
STUDENT INVOLVEMENT

UNDERGRADUATE AWARDS

- Ryan Alvarez ’14, Jordan Baker ’14, Galit Benoni ’15, Daniel Keith ’16, Beril Polat ’15, Arya Reddy ’16, Joshua Temple ’15, Andrew Thierman ’14 and Chanon Tuntivate ’15 received the Sarah K. Doshna Undergraduate Research Award.
- Tyler Cloutier ’14, Mark Hall ’13, Alexis Ham ’13 and Katherine Tschudi ’13 received the Joseph L. Katz Award.
- James Moxley ’14 and Rachel LeCover ’14 received the Loy Wilkinson Award.
- Abraham Anonuevo ’15 and Christopher Argento ’16 received the Paul A.C. Cook Award.
- Rachel McFarland ’13, James Moxley ’14 and Paul Roberts ’16 received the Elnora Streb Muly Award.
- Alex Abramson ’15, Xin Fang ’14, Megan Schwarz ’15, Eric Scott ’15 and Lien-Chun Weng ’15 received the AIChE Award.
- Pavlos Pachidis ’15 and Ryan Alvarez ’14 received the Francis J. Fisher Award.
- Xin Fang ’14 received the Genentech Outstanding Student Award.
- Jordan Baker ’14, Weitong (Jeron) Chen ’15, Pavlos Pachidis ’15 and Siqi Tan ’15 received the Summer 2014 Provost’s Undergraduate Research Awards. Ryan Alvarez ’14, Nathaniel Kato ’15 and Victoria Laney ’16 received the Fall 2014 Provost’s Undergraduate Research Awards.

2014 AIChE ANNUAL MEETING

November 16-21, 2014
Atlanta Marriott Marquis,
Hilton Atlanta, Georgia

The AIChE Annual Meeting is the premier educational forum for chemical engineers interested in innovation and professional growth. Academic and industry experts will cover a wide range of topics relevant to cutting-edge research, new technologies, and emerging growth areas in chemical engineering.

The Johns Hopkins University Reception will be held on Tuesday, November 18th from 8PM – 10PM in the Marriott Hotel in Room A601.

Undergraduates Clean Up in Innovation Competition

With the knowledge that two out of three Americans fail to use soap when washing their hands, three engineering undergraduates set out to invent a device that automatically infuses soap into the water coming out of faucets in public restrooms.

Ryan Alvarez, Alex Abramson and Parth Patel, all seniors, collaborated on the project, known as Easy Suds, for a senior design project. They later entered their concept in a competition for young entrepreneurs sponsored by the National Collegiate Inventors and Innovators Alliance. Their project was funded earlier this year with a Stage 1 grant of $5,000.

“Our product is meant to force people to wash their hands with soap and make it an easy and enjoyable experience for the user,” says Alvarez.

The soap enters the water stream for three to five seconds, so the subject can was his or her hands, then switches to pure water for rinsing. The total experience lasts about 20 seconds, which the U.S. Centers for Disease Control recommends as the hand-washing time needed to kill germs.

“By far the biggest engineering challenge was to control how much soap was released during the hand-washing process without utilizing electricity,” says Abramson. “To overcome this problem, we had to harness the energy from the water flowing in the pipes.”

The students are applying for Stage 2 NCIIA funding, in the amount of $20,000, as well as other grants so they can complete beta testing and take their product to market – focusing on elementary school restrooms. Alvarez says. The design team is considering a three-tier pricing system, says Patel, with hospitals at the top tier, privately owned businesses receiving the medium pricing, and nonprofits and governmental entities, such as UNICEF, receiving discounted pricing.
ALUMNI AWARDS

- **Courtney S. Young**, a former BS student currently pursuing graduate study at the University of California in Los Angeles, was awarded with an NSF Graduate Research Fellowship.
- **Daniel Beltran**, a former PhD student in the Bevan lab, was awarded with the Victor K. LaMer Award. This award is given to an outstanding doctoral thesis in colloid and surface chemistry accepted by a U.S. or Canadian university within the past three years.
- **Sumedh R. Risbud**, a former PhD student in the Drazar lab, won the Cossan-Kovasznay Outstanding Paper Award for a paper published in the Journal of Fluid Mechanics. The paper was titled, “Trajectory and distribution of suspended non-Brownian particles moving past a fixed spherical or cylindrical obstacle.”
- **Kimberly Stroka**, a postdoctoral fellow in the Konstantopoulos lab, won the 2014 Rita Schaffer Young Investigator Award from the Biomedical Engineering Society.
- **Van N. Truskett**, who received her PhD in 2002, will receive the 2014 Industrial Research & Development Award from the American Institute of Chemical Engineers at its annual meeting in November. Truskett, who is jetting manager at Canon Nanotechnologies Inc., is being recognized for her contributions to the development of core technology used in imprint lithography products for high-volume manufacturing.

**Nance, Stroka Win Career Awards**

Elizabeth Nance and Kimberly Stroka have received the Burroughs Wellcome Fund Career Award. The $500,000 prize, distributed over five years, helps transition newly minted PhDs from postdoctoral work into their new faculty positions.

Nance, a former PhD student of Justin Hanes, is a postdoctoral fellow in anesthesiology and critical care medicine and neuroscience at JHMI. She focuses her research on determining the mechanism of nanoparticle uptake in various fetal/perinatal brain injury large-animal models, utilizing an integrative engineering, developmental biology, and neuroscience approach. She is also working on developing dendrimer-based nanotherapeutics for optimally timed postnatal treatments of prenatal brain injuries, specifically cerebral palsy.

Stroka is a postdoctoral researcher in the laboratory of Konstantinos Konstantopoulos, chair of the Department of Chemical and Biomolecular Engineering. In January 2015, Stroka will be an assistant professor of bioengineering at the University of Maryland, College Park.

Stephanie Fraley, a former PhD student of Denis Wirtz and current postdoctoral fellow, won the same award in 2013.
Schulman Advances DNA Technology

Since winning a five-year Early CAREER award from the National Science Foundation in 2012 to help support her lab’s development of new methods to assemble connections between nanoscale device terminals, assistant professor Rebecca Schulman has been unstoppable. Her work holds promise for developing nanoscale circuits that could ultimately lead to faster computers, devices that can manipulate light at the nanoscale, and highly sensitive molecular detection systems.

“I’m interested in making it possible for us to build materials with the same capacities that living things have,” Schulman says. Some of these capacities, she says, include the ability to grow and change, to replicate, and to respond to environmental stimuli. Schulman’s work focuses on using DNA as a material for building nanostructures that will interact with cells and tissues. She and her colleagues are also working to try to create materials that may make it possible to build electrical circuits that can repair themselves.

Schulman joined the Whiting School faculty in 2011 and holds joint appointments in chemical and biomolecular engineering and computer science. She partnered with Paul Paukstelis, PhD, an assistant professor at the University of Maryland at College Park, to organize the August 8 Mid-Atlantic DNA Nanotechnology Symposium for colleagues working in the field of DNA research. “There are now a huge concentration of researchers in the area who use DNA for engineering, but in different ways,” says Schulman, who earned her B.S. from the Massachusetts Institute of Technology and her doctorate from the California Institute of Technology. “The goal of the one-day conference was to get all these people together to talk about their research and to foster local collaboration.” Seventeen speakers from institutions such as the Naval Research Laboratory and the National Institutes of Health offered presentations.

Cui Works On Drug Self-Assembly

One of the challenges in cancer treatment is achieving consistency in drug delivery. Honggang Cui, an assistant professor of chemical and biomolecular engineering, is working on ways to make cancer drugs capable of delivering themselves to target cells, a process called self-assembly. By organizing themselves into nanostructures, drug molecules could become more effective in treating disease and cause fewer adverse side effects.

To achieve this transformation, Cui and his team have to make the molecules amphiphilic, adjusting how the molecules react to water in different situations. Most drugs have poor water solubility, Cui explains. To help them react positively with water, the researchers are experimenting with using biodegradable chemical bonds to link water-loving peptides with the water-resistant drug molecules. Adjusting the peptide sequence will affect the drug’s shape, size and other characteristics, he says.

Cui and his team published results of their work on self-delivering supramolecular nanostructures in the Journal of the American Chemical Society and ACS Nano. They are currently pushing for animal testing to further evaluate the potential of these self-assembling drugs. In 2013, this work earned Cui the National Science Foundation’s prestigious Faculty Early CAREER Development Award.

Faculty Research Highlights

Three-dimensional cell migration does not follow a random walk, P. Wu, A. Giri, S. Sun, D. Wirtz, Proceedings of the National Academy of Sciences 2014 111 (11) 3949-3954 (2014)

Biologists have long thought that cancer cells travel through the body in random patterns, based on their behavior in the lab, but Johns Hopkins researchers have shown that for cells moving through the body, more orderly travel patterns apply. This finding is important because it should lead to more accurate results for scientists studying how cancer spreads through the body. The discovery that cancer cells move in efficient, straight lines in a bid for metastasis will help clinicians better predict the rate at which the disease will spread.


The ability to capture and monitor single cells is important in biology, medicine and surgery. The Gracias lab, which has done pioneering work in self-folding, has recently reported the development of tiny self-actuating devices that were used to capture single fibroblast and red blood cells. The devices derive their energy for actuation from differential stresses in thin films and do not require any wires, tethers or batteries. Hence, they can be arrayed on substrates or used as free-floating devices. Since the processes used to create these devices are compatible with conventional optical and electronic microsensor platforms, the laboratory is now working to create an integrated platform that can capture, contain and analyze single cells for both in vitro and in vivo applications.

CONTINUED ON PAGE 7
Orcutt Pursues Imaging Biomarker

Ten years after completing her undergraduate engineering studies at the Whiting School of Engineering, Kelly Davis Orcutt is senior director of translational research at inviCRO, a contract research organization specializing in pre-clinical and translational medical imaging. “Our mission is to apply imaging technology and tools to address biological questions,” she says. “We work to understand the distribution of compounds in living animals by imaging them over time.”

One of Orcutt’s current projects is to support the development of an imaging biomarker to identify cancer patients whose disease expresses a specific target implicated in colorectal cancer. The goal is to identify patients who would be good candidates for a clinical trial of a therapeutic against the target.

She has integrated a mechanistic mathematical model of molecular transport in tumors with preclinical imaging data to guide the rational design of a first-in-human imaging study.

“I’ve always had a biomedical bent,” Orcutt says. “In fact, I almost switched to premed as an undergrad, but I was talked out of it by one of my engineering professors. And I now understand why he believed engineering was the right way to go for me. Engineering teaches a systematic way to approach problems, and then you can use that approach to solve whatever problems most interest you.”

Orcutt, 31, obtained her B.S. in chemical and biomedical engineering from Johns Hopkins in 2004. “It was a fantastic degree and an excellent foundation,” she says. She did materials research for a year at Medtronic before embarking on a doctoral program in chemical engineering at MIT. Working in the lab of MIT Professor K. Dane Wittrup, Orcutt used a combination of protein engineering and mathematical modeling approaches to engineer a novel radioimmunotherapy approach to treating cancer.

“Through all of my studies there was always an underlying application of mathematical modeling,” Orcutt says. She then spent a year at Harvard Medical School as a postdoctoral fellow in translational medicine, working to develop cancer therapeutic and imaging agents at the Center for Molecular Imaging at Beth Israel Deaconess Medical Center.

Orcutt joined Boston-based inviCRO, LLC in 2010 as director of translational research.

“At inviCRO, I have the incredible opportunity to work with scientists across many disciplines — physics, engineering, math, neuroscience, statistics, pharmacology — to apply a multidisciplinary approach to address questions in drug discovery and development,” she says. “We work to apply quantitation and mathematical modeling and simulation to better understand, and even predict, drug pharmacokinetics, distribution, targeting and efficacy.”

CONTINUED FROM PAGE 6

E. Firnberg, J. W. Labonte, J. J. Gray, M. Ostermeier

The fitness landscape model imagines evolution as a process by which a sequence moves by mutations across the fitness landscape, progressing through fitter and fitter sequences as it climbs towards fitness peaks.

The topology of the fitness landscape fundamentally shapes the dynamics and outcomes evolution. Although several studies have provided important insights using glimpses or samplings of landscapes, a comprehensive, experimentally determined map of even the first step in the fitness landscape for any native gene has not been described. The situation is akin to having a limited number of snapshots of a geographical region as opposed to having access to Google Earth. Our study is the first to provide a comprehensive map of the fitness landscape around a gene.


An emerging paradigm in the mimicry of three-dimensional (3D) microenvironments involves using a variety of bioinspired materials to reconstruct critical aspects of the native extracellular niche. Oxygen is vital for the existence of all multicellular organisms. Specifically, hypoxia, which occurs when the partial pressure of oxygen falls below 5%, plays a pivotal role during development, regeneration, and cancer. However, nobody has simulated controlled hypoxia in a 3D microenvironment.

In this study, we report a new class of oxygen-controlling biomaterials, hypoxia-inducible (HI) hydrogels that can serve as 3D hypoxic microenvironments. Oxygen levels and gradients within the hydrogels can be accurately controlled and precisely predicted. We show that HI hydrogels guide vascular morphogenesis in vitro and promote rapid neovascularization from the host tissue during subcutaneous wound healing. The HI hydrogel may prove useful in many applications, ranging from fundamental studies of developmental, regenerative and disease processes through the engineering of healthy and diseased tissue models towards the treatment of hypoxia-regulated disorders.


The biotic and abiotic worlds present significantly different capabilities. The biotic world is dynamic, chemically controlled and regenerative, while abiotic devices facilitate communication and programmability using optical and electronic signals. Merging capabilities from both worlds has been a longstanding goal in engineering, but it can be very challenging due to the mismatch between the physical properties of these materials.

In a groundbreaking collaborative paper between the Gracias lab and the McAlpine lab at Princeton, a new strategy to merge capabilities of both worlds was demonstrated using 3D printing. Specifically, a bionic ear was created by printing live cells, hydrogels and nanoparticles to form the cartilaginous structure of the ear within which a receiving antenna was embedded. The cells were viable during and after the printing process, and the antenna could receive signals both in the audible and radio frequency range. The approach outlines a new strategy that could be adapted to fabricate a range of bionic devices.
Dr. Kim Appointed President of SUNY Korea

ChoonHo Kim, who in 1986 received his doctorate in chemical engineering from the Whiting School of Engineering, embarked on an exciting new challenge when he became the inaugural president of the State University of New York, Korea in 2012. Established in Incheon, South Korea, SUNY Korea is the first American university in that nation.

Kim, 56, says his goal as president is to attract talented students and cultivate global business leaders. “My days and weeks are filled with meetings with government officials, research institutions, corporations and embassies to promote SUNY Korea, build networks, and attract researchers and funding for scholarships,” he says. “In my spare time, I try my best to spend time with our students. Occasionally, I invite students for dinner, (and I enjoy) having conversations and getting along with them.”

Marc Donohue, the professor who was Kim’s adviser at WSE, says he is proud of his former student’s many accomplishments. “Choon-Ho is a truly remarkable individual. He is a natural-born leader and has held several high-level positions in the Korean government and academic community. It has been a true pleasure to watch him evolve from being a graduate student here in the 1980s to being a world-renowned university president.”

Although Kim’s career after leaving Hopkins took him to executive positions at Korea’s Center of Excellence in Wireless and Information Technology and the Korea Electronic Technology Institute, Kim says his longtime dream has been to help produce dynamic leaders who would help create economic opportunities for the developing world.

“South Korea’s economic development has been regarded as one of the most successful in recent history,” says Kim. “In just five decades, Korea jumped from one of the poorest countries to a top 10 economic power in the world. Many developing countries are highly interested in learning and applying Korea’s development model.” Kim says he believes SUNY Korea has a unique opportunity to apply American ingenuity and Asian management philosophy to the challenges of the developing world.

“We plan to provide quality education in the American style and share the knowledge and know-how behind Korea’s successful economic development. Our ultimate goals are to engage countries and industries in cooperation toward shared prosperity, and to foster dedicated global leaders,” Kim says.

Despite the challenges of establishing and expanding the SUNY Korea campus, Kim says he is energized by the opportunities ahead.

“Sometimes, I get exhausted when I face difficult challenges; however, whenever I imagine our future in 20 years and think of our students making history in different parts of the world, I gather up my mind and brace my energies,” he says.