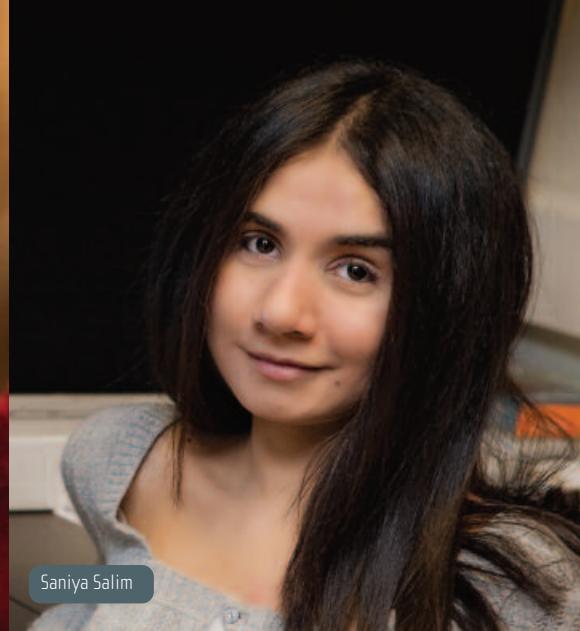




Nimil Sood



Chris Liu



Saniya Salim

Contributing to Cancer Research Undergraduates Pursue Cutting-Edge Projects

With diseases ever present in family life, many children dream of growing up to help cure cancer or some other disease or to make significant breakthroughs in scientific research. Undergraduates Chris Liu '10, Saniya Salim '08, and Nimil Sood '08 are already helping to advance the field of biomedical research through their undergraduate research.

Chris Liu Studies Brain Cancer Cells

Undergraduate Chris Liu, a chemical and biomolecular engineering major, is working on projects that take him to labs on the Cornell-Ithaca and WCMC campuses. Since March 2007 Liu has been working on a collaborative project in the labs of Claudia Fischbach-Teschl, Biomedical Engineering, and John A. Boockvar, Neurological Surgery, WCMC. His research involves the study of angiogenesis in brain cancers, the process by which new blood vessels are created out of pre-existing vessels. Liu studies the recruitment of blood vessels by the tumor cells to promote tumor development. By addressing these factors that allow brain tumors to thrive, Liu's research has implications for the treatment of cancer.



As brain cancer grows, protein factors bind to the tumor cells and signal the release of angiogenic growth factors such as vascular endothelial growth factor (VEGF) and interleukin-8 (IL-8). One of these protein factors, epidermal growth factor (EGF), is particularly important in the recruitment of blood vessels and the promotion of brain tumor development. In Liu's research, it is hypothesized that in addition to EGF, there is another signaling pathway involved in brain tumor angiogenesis—one that is regulated by the

demonstrate that the cell-ECM pathway is indeed viable. Currently in tumor cell treatment, anti-angiogenic factors can block the signaling of angiogenic factors and stop the tumor growth. If Liu's hypothesis is correct, the cell-ECM pathway can also be targeted to stop brain tumor angiogenesis, thereby providing another direction to cancer therapy. Liu looks forward to continuing his work on cutting-edge cancer research as he progresses in his undergraduate life at Cornell. He explains that one value of undergraduate

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binding of cells to their extracellular matrix (ECM). Liu studies the interconnection between both pathways using three different cell lines provided by the Boockvar lab: one control, one that has been modified to express abnormal EGF receptors typical of brain cancers, and one that has been modified to express normal EGF receptors found in normal brain tissue.

To test the hypothesis of the role of cell-ECM in brain tumor angiogenesis, Liu created an artificial three-dimensional environment for growing cells based on a protocol that Fischbach-Teschl developed using organic polymers. The three-dimensional environment better mimics the environment of the human body than cultures within two-dimensional Petri dishes, an approach that is typically utilized to study brain cancer *in vitro*. Comparing cell signaling in the regulation of protein factors under both culture conditions, Liu demonstrated enhanced cell-ECM interactions in the three-dimensional environments concluding that using three-dimensional environments are a more accurate means to grow the cells.

Studying these microenvironments, Liu's work suggests that cell-ECM interactions have a significant role in brain tumor angiogenesis. The next steps are to culture brain tumor cells within polymeric matrices in the absence and presence of cell-ECM interactions and then see if angiogenic factor secretion increases as a function of EGF receptor signaling. If the regulation does increase, Liu hopes to

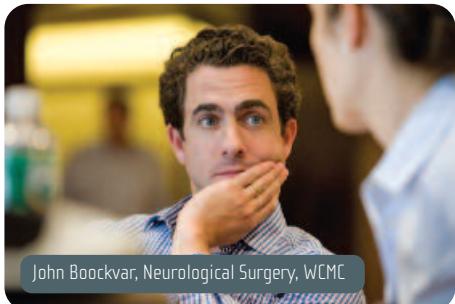
research, as he experiences it in the Fischbach-Teschl lab, is that the lab interaction bridges the distance between professors and students. While most students receive talks and lessons from professors, the research experience allows both the student and the professor to better understand each other. Liu says that the research experience has "opened my eyes to see what research is like. It truly means 're-search'—testing hypotheses over and over and continuously modifying and repeating the experiments."

As part of his work, Liu was invited to New York City in January 2008 to work in Boockvar's lab at WCMC and study how they isolate cells from patient specimens. He is excited to understand how his work at Cornell-Ithaca can be applied to clinical settings. In addition to engaging in research early in his undergraduate career, Liu has received an invaluable opportunity as an undergraduate to work directly with the medical school team in his biomedical research.

Saniya Salim Works on Cancer Computational Models

Saniya Salim, a biological and environmental engineering major, first began undergraduate research in the summer of 2006 when she approached Jeffery D. Varner, Chemical and Biomolecular Engineering, about working in his lab. Growing up in a medically oriented family, Salim knew from an early age that she wanted to pursue a future in medicine and the treatment of cancer. With her intense

Jeffery Varner



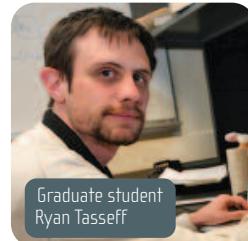
John Boockvar, Neurological Surgery, WCMC

Claudia Fischbach-Teschl,
Biomedical Engineering

Liu's research involves the study of angiogenesis in brain cancers, the process by which new blood vessels are created out of pre-existing vessels.



Part of the Team



Salim describes the graduate students as mentors, helping her to learn how to do a certain task, and if it goes wrong, how to try it again.

In a discussion on undergraduate research at Cornell, Jeffrey D. Varner, Chemical and Biomolecular Engineering, remembers the impact his research experience in college had on his future. He explains, "Undergraduate research really changed my perspective. Had I not had that experience, I would not have become an academic." Varner continues that tradition through the support and encouragement of undergraduates in his Cornell lab.

In addition to allowing students "to see the research side of things, to do something

practical in the research world, and to apply coursework to real world issues," Varner says that the undergraduate research experience also teaches students team responsibility and management of time while immersing them in important problems in the field. In his lab, that includes research on the cell cycles and mechanisms that lead to cancer growth.

There are three undergraduates in Varner's lab: Saniya Salim '08, Jalal Siddiqui '08, and Damien Kudela '08. These students become well versed first in the biology of the research projects and then work on the

computational models that are the focus of the lab. Varner wants the students to be excited about the research. He encourages them not to become disillusioned when faced with a problem. As part of their experience, the undergraduates work with the graduate students as equal members of a problem-solving research team. The academic excellence and the tight teamwork of the group members keep the team focused and often leads to success.

Another invaluable experience of the undergraduate researchers in Varner's lab is

that all three of the students have been able to publish and present on their research. Varner describes his undergraduates as "hard core" and an "outstanding resource" in the lab, actively contributing and always engaged in the problems that they are trying to address. While common for graduate students, the outstanding work of the undergraduates has provided the unique opportunity for them as undergraduates to demonstrate their excellence in academic journals and at national conferences.



interest in mathematics and biomedicine, she was excited about working in Varner's lab on models for cancer research.

Welcomed into the Varner lab, Salim began working on computational models that identify points in the mechanism of cancer development that can be targeted for treatment. She created a mechanistic mathematical model for the progression of cancer in human cells. The models help Salim track all the intermediate steps of the system in order to conduct a sensitivity analysis of the cancer cells.

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Sensitivity analysis is one of the many techniques used to determine "fragile mechanisms," for example, mechanisms that can be disrupted to change the behavior of a cancer cell. These fragile mechanisms typically have an important role in cell division and the development of cancer. Once identified, pharmaceutical companies can use this vital information to develop new drugs that inhibit cancer cell growth. Salim is an integral part of the Varner lab of graduate and undergraduate students. Varner explains that Salim's outstanding work on the development of the computational model could be important to larger cancer treatment initiatives.

Salim says that her experience in the Varner lab has been positive. She describes the graduate students as mentors, helping her to learn how to do a certain task, and if it goes wrong, how to try it again. She says, "Everyone in the lab is very welcoming. They are so open to being approached. This is very encouraging in my learning experience." She goes on to explain how her research experience has helped her to understand the concepts taught in her classes. She is excited when she already has the experimental background to understand a new concept in class. The research experience in the Varner lab has helped Salim define her interest in studying biomedical engineering in graduate school. The opportunity to present at conferences such as the American Institute of Chemical

Engineers (AIChE) and American Chemical Society (ACS) will serve as an invaluable source of research experience and recognition when applying to graduate schools and positions in the future. Salim says that Varner has been a big influence and source of support encouraging her to pursue future research in graduate school. Through her love for mathematics and biology, Salim believes that her undergraduate research is one more confirmation that she made the right decision in pursuing biological engineering.

microfluidic cytotoxicity chip to count the number of live and dead cells.

After this initial training, Sood began to work in the Putnam lab where he has been able to work on projects with large implications for drug therapy and gene introduction. He worked on a larger project of Sharon Wong, a graduate student in biomedical engineering. As part of this project, Sood characterized polymers created in the lab to learn more about how they can be used to introduce genes into a target cell. Current practices of inserting external genes into target cells use plasmids or viruses. The use of such vectors can often hurt the cells; however, the use of polymers has the potential to increase the safety of the process. He calculated the percentage of conjugation of side chains using ultraviolet/visible (UV-Vis) spectroscopy techniques, which is essential to determining polymer toxicity.

Sood's project continues with research that entails binding plasmid DNA to polymers to form a DNA-polymer polyplex. Using these samples, he runs experiments to measure the surface charge and size of the polyplex. These are called zetasizing experiments. Knowing the size and charge of the polyplex may grant the lab greater understanding of the mechanisms that determine how negatively charged DNA and positively charged polymers can enter the cell. When Wong recently presented her research on polymers at the Biomedical Engineering Society conference, Sood says he was excited to see how the data he had collected was put directly into her presentation. He feels an accomplishment that his work, in part, contributes to her thesis.

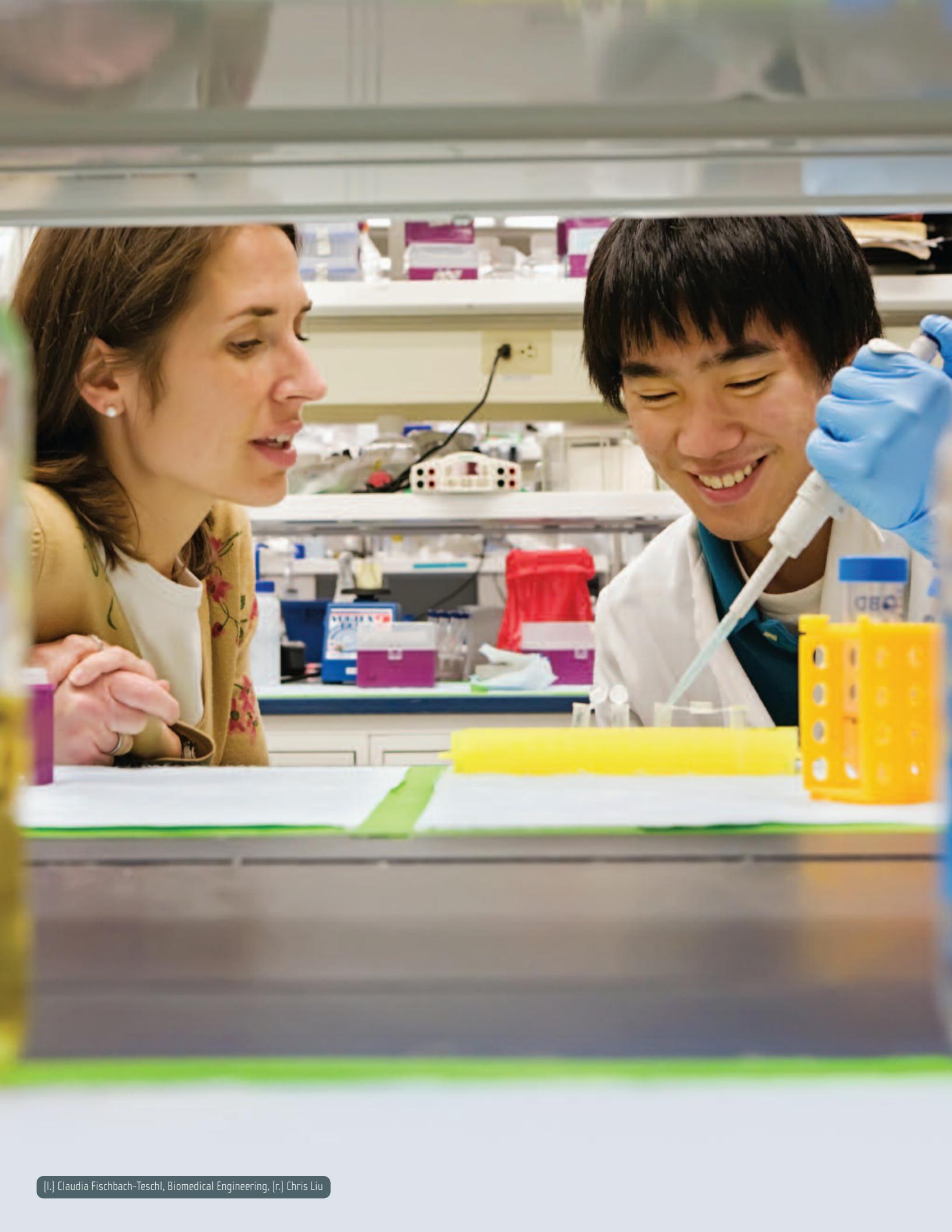
Before starting research in the Putnam Lab, Sood's training began in the lab of Shivaun D. Archer, Biomedical Engineering. There, he worked with a microfluidic cytotoxicity chip made of polydimethylsiloxane. The purpose of the cytotoxicity chip is to determine the appropriate concentration and flow rate of a cancer drug needed to kill the cancer cells. Cancer cells are subjected to varying concentrations of a cancer drug; the concentration gradient is established from the mixing and splitting of multiple streams in the chip. When studying a potential cancer therapy, it is important to know how strong a concentration needs to be in order to kill cancer cells but not run the risk of killing other cells. Sood used fluorescent microscopy to determine cell viability, which is the percentage of live cells after subjection to a drug. He stained live and dead cells and analyzed images of the

Sood's research experience in the Putnam lab has encouraged him to continue research in the biomedical engineering field, either through graduate school or beginning a career in research and development in industry. The research opportunity has offered him an enhanced awareness about the experimental nature of biomedical engineering.

Gillian Sarah Paul '08

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