



Cell and Molecular Biologists Drive Advances in Human Health

Scott Emr “shares the dream” for excellence at the new Joan and Sanford I. Weill Institute for Cell and Molecular Biology in Ithaca.

BY LINDA MCCANDLESS

Scott Emr is watching a knobby green, blue, and red structure that is bigger than his head slowly tumble end over end on his computer monitor. It looks like an alien that has been accidentally launched into space. But this frontier is not about traveling through space. It is about traveling on a molecular level, in and out of cells, on biological pathways that serve as highways for proteins, in transport carrier vesicles that are smaller than 1/100th the width of a human hair.

Research on understanding these transportation systems—and how cells work on a molecular level—has laid the groundwork for recent breakthroughs across the biological sciences, including new ways to understand cancers and viruses like HIV.

Emr is using these three-dimensional crystal structures of protein complexes—called endosomal sorting complex required for transport, or ESCRTs—to explain fundamental processes common to all cells and to answer key questions about cell signaling and molecular dynamics. He believes that interdisciplinary approaches to decoding the mysteries of the cell herald an explosive period of discovery for life sciences.

“Completing the sequence for the human genome represented an enormous step forward in biomedical research,” says Emr, the enthusiastic director of the new Weill Institute for Cell and Molecular Biology at Cornell. “But it was only the beginning.”

Emr is one of 12 new faculty at the Weill Institute who will transform the future.

“The overarching theme for research at the institute will be cell signaling and molecular dynamics,” says Emr. “Scientists will develop and apply approaches and instrumentation needed to characterize the structure, function, and dynamics of the

molecular machines required to keep all cells alive. They will address a wide array of key questions: cell-cycle control, signal transduction, regulation of the cytoskeleton, organelle biogenesis and function, regulation of membrane architecture, and protein quality control.”

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—Steve Kresovich

Scientists at the institute will conduct structural, biochemical, and genetic studies on the tiny molecular machines that direct essential processes in the regulation of cell shape, cell signaling, and cell growth, according to Emr. They will work to analyze the protein products of the approximately 25,000 human genes to determine their function, how they interact with each other, and how these networks of interactions determine the specific functions of cells that make up the tissues and organs of the human body.

“Even though many components have been identified in cells, how they are assembled and regulated is still largely unknown,” says Emr.

Discoveries resulting from this work will lead to understanding the molecular basis for much broader questions in neurobiology, development, immunology, and human disease.

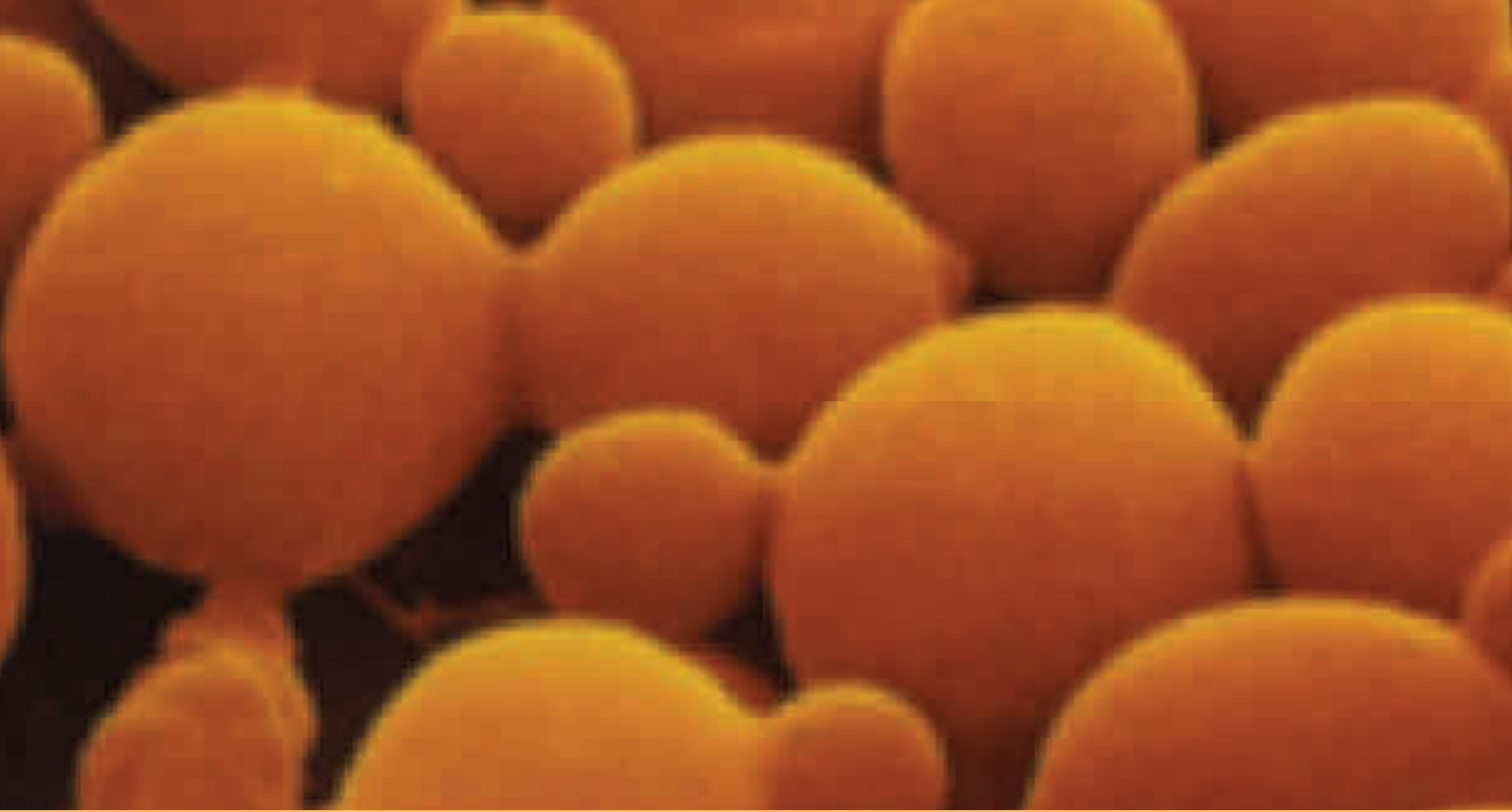
To help the layperson understand what he is doing, Emr likens the job of a cellular mechanic to that of a car mechanic—except “we are looking at ‘automobiles’ without ever having seen one go before,” he says. “We open the hood and decide something important must be going on. At first, we don’t even know that what we are looking at is an engine. When we start tearing it apart systematically, we gradually discover the systems that are making it work and how they interconnect. We isolate the systems, determine their function, and then learn how to manipulate them.”

An Institute for Life Sciences

Emr is passionate about his field and passionate about the opportunity to shape the Weill Institute for future generations of molecular biologists. He characterizes his years studying microbiology and molecular genetics at Harvard, UC Berkeley, and Cal Tech from 1976 to 1991 as “learning to dream.” From 1991 to 2006, when he was professor of cellular and molecular medi-



The \$160 million, 250,000-square-foot Weill Hall, on Tower Road, is slated to open this spring. It will be the centerpiece of Cornell’s New Life Sciences Initiative.



When Yeast is a Model for a Human

Scott Emr works small and thinks big. The Frank H.T. Rhodes Class of '56 Director of the new Joan and Sanford I. Weill Institute of Cell and Molecular Biology uses the genetics of a single-celled model organism to identify the specific molecular pathways that drive basic cell processes.

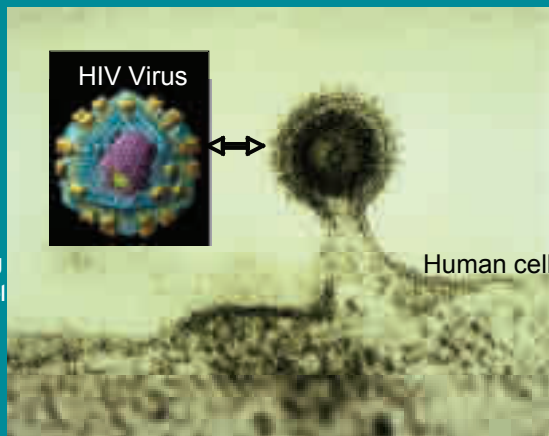
"Model organisms continue to provide the most powerful systems for approaching complex questions," says Emr, whose model of choice happens to be yeast. "Yeast have 6,000 genes, compared to the 25,000 in humans. Most of the 6,000 are also represented in the human genome. This overlap in the genomes—together with the ease

with which yeast can be manipulated in the laboratory, both genetically and biochemically—make yeast an excellent model system to understand complex biological pathways."

Proteins drive many fundamental processes in cells. Emr's explanation of how proteins get in and out of cells, a process called membrane trafficking, has given other scientists an understanding of the specific pathways that drive these basic processes. One set of essential transport factors that the Emr lab has discovered—ESCRT, or endosomal sorting complex required for transport—plays a critical role in a broad range of biological pathways, including antigen presentation during an immune response, viral budding, and receptor down-regulation following growth-factor stimulation and cell division.

For Emr, who was recently elected to the National Academy of Sciences, yeast has been a good model. With it, he has improved the scientific community's understanding of virology, HIV-AIDS, cancer, immunology, development, and neurobiology. His cell-signaling research in yeast could help arrest cancers and HIV infection and has enormous potential to drive advances in human health. Emr's studies may lead to the development of new drug therapies for the treatment of AIDS and other diseases. "When we started out, no one would have anticipated that yeast would provide such fundamental insights into the complex cellular processes of HIV-AIDS and human cancers," he says. "And similar mechanisms may also have applications in animal and plant science."

Linda McCandless



(above) Yeast cells, the model system that Scott Emr uses to study complex biological pathways and cell signaling.

cine at University of California, San Diego and an investigator with the Howard Hughes Medical Institute, he says that he was "living the dream." Since March 2007, when he was given the opportunity to shape the new institute of cell and molecular biology at Cornell, Emr says that he has been "sharing the dream."

The Weill Institute is one of the cornerstones of the \$650 million New Life Sciences Initiative at Cornell, and a core component of the \$160 million research building on Tower Road slated for occupancy in the spring of 2008. The goal of the institute is to build a vibrant center of scientific excellence in basic biology integrated with existing programs in chemistry and chemical biology, physics, computational biology, and engineering.

One of Emr's first moves was to appoint Anthony Bretscher, professor of molecular biology and genetics, as the Weill Institute's associate director. Bretscher helped Emr design the institute's space

and is helping with recruitment. Emr and Bretscher bring to an even dozen the total number of faculty at the institute.

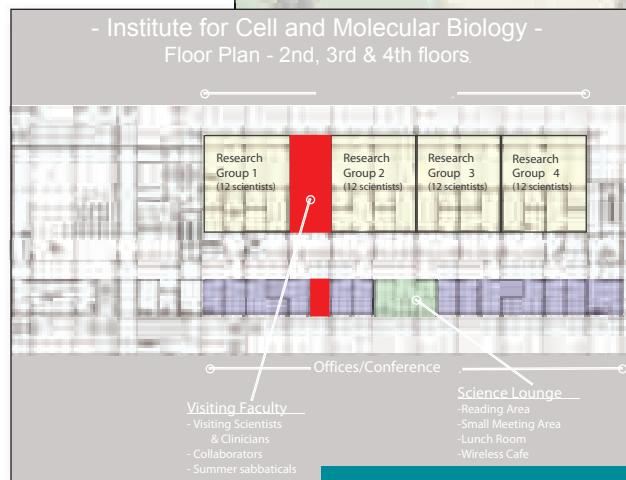
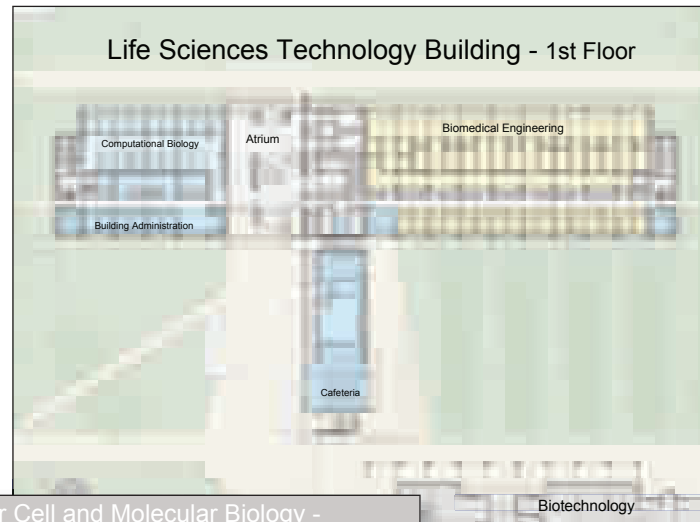
Emr has begun the search for the professors, associate professors, and assistant professors who will form the institute. Ten additional faculty, who will have full academic appointments in the basic science departments to which they will contribute teaching and science, will be hired at the rate of three per year over the next three to four years.

From last fall's first posting in *Science* and certain plant journals, Emr and the search committee received 490 applications—twice the number of applicants expected—for this year's search. "We believe we are getting inquiries from 80 percent of the people looking for these kinds of jobs," says Emr. The attractiveness of the new positions may be, in part, because of the ambitious goals of the new institute and its state-of-the-art facilities.

The College of Agriculture and Life Sciences is committed to hiring six of the 10 additional Weill Institute faculty. In fact, CALS has been responsible for hiring more than half of the 70 new faculty on campus who are working in the new life sciences, the \$650 million initiative launched by Cornell in 2002.

"The field is an extremely competitive one," says Steve Kresovich, vice provost for the new life sciences, and CALS professor of plant breeding. "Scott Emr understands what Cornell needs to do to compete and is committed to bringing top-notch people into the Weill Institute. Our goal is to attract the best scientists by providing endowed professorships wherever possible and offering generous start-up packages that allow new faculty to hit the ground running. At the same time, we want to attract the best graduate students and postdocs by offering graduate student and postdoctoral fellowships. We also want to enhance undergraduate education by offering summer research fellowships."

The institute will occupy three floors in the new research building, recently named the Joan and Sanford I. Weill Hall, with



A cornerstone of Cornell's New Life Sciences Initiative, Weill Institute will be a core component of Joan and Sanford I. Weill Hall (formerly known as the New Life Sciences Technology Building), now under construction on Tower Road.

web urls

Weill Institute for Cell and Molecular Biology—
www.icmb.cornell.edu

webcam at construction site (M-F, 8 am to 5 pm)—
www.pdc.cornell.edu/pdc/eng/stpm/pdc_webcam_lst-beast.cfm

four research groups per floor on the south end of the building. In addition to the Weill Institute, biomedical engineers will occupy the first floor, and computational biologists and statisticians will occupy part of the first floor on the north side. Nutritional sciences, mouse genetic labs, and a biotech incubator space will fill out the rest of the building. State-of-the-art imaging facilities and other technologies will be shared by scientists across the entire Cornell campus.

"The building will support life sciences

research, education, and outreach over the next 50 years and beyond," says Kresovich. "We wanted a building that will serve as an intellectual and operation magnet for students, faculty, visitors, and alumni. Scott was an incredible catch for us. His vision, focus, enthusiasm, and concern for quality will be great for the institute and great for fulfilling the interdisciplinary mission of the New Life Sciences Initiative."