Peter Satir

"It came to me as I was walking down Second Avenue," Peter Satir recalls. It was 1959. Satir was on his way back to work as a graduate student in Keith Porter's electron microscopy laboratory in what was then called the Rockefeller Institute in New York. The problem on Satir's mind was cilia and whether they moved by contracting or by sliding the structures we now call microtubules. Satir's experimental epiphany was the idea of stopping a metachronal wave in its tracks. The cilia that line the gills of freshwater mussels beat in metachronal waves, each cilium just out of phase with its neighbor. If Satir could "fix" a wave instantaneously, he would capture cilia in every stage of the beat cycle from the effective to the recovery position. A blast of OsO4 fixative would do it, Satir calculated. It would chemically freeze the wave and preserve each cilium for serial cross-sectioning and close study under the electron microscope. "Or at least that was my idea," Satir says.

His Eureka moment on Second Avenue took five years to unfold. The fixative flash-freezing worked like a charm, Satir recalls, yielding a bountiful supply of samples. "I was able to describe some ultrastructural changes but when you look carefully at ultrastructure, it's actually much more difficult to know what is going on. I didn't really figure it out until 1964 when I realized that by studying the tips of cilia, I could actually see whether the microtubules contract or slide when they bend."

We know today that microtubules do slide along and so much more about the ultrastructure underpinning cell motility because of Peter Satir's pioneering work, according to Win Sale. An early Satir graduate student, Sale is now at Emory University Medical School. Satir's proof of sliding was especially elegant, says Sale. Satir hypothesized that, "If microtubules were inextensible, then based simply on the geometry, microtubules on the inside edge of a bent axoneme (one of the nine doublet microtubules bundled around the cilium perimeter) must extend beyond those on the outside. Peter reasoned that microtubule

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displacement could be identified in the pattern of microtubules at the tips of cilia." Satir used a geometric model of a circular bending arc to predict the angle between inside and outside axonemes, that is, if microtubules did slide. Satir's model, the EM images and the measurements matched precisely, says Sale. That work and Satir's subsequent discovery of the minus-end polarity of the dynein protein were critical to the cell motility revolution that continues to this day, says Sale.

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Satir has also had a tremendous impact on cell biology through the generations of scientists he has trained, Sale adds. "I took his cell biology class at Berkeley so I was still an undergraduate when I went to ask if I might be able to do some research work in his lab. And Peter said, 'By all means! Come in and we'll find you something to do.' That's how I started in electron microscopy but it was later as his graduate student that I really began to understand Peter's vision of what research could be about."

Soren Christensen was a Satir post-doc at Einstein from 1998 to 2000. "It was my best place ever," says Christensen who is now at the University of Copenhagen. "Peter is such a warm, gregarious person but he also knows how to grow scientists. He allows new students to think for themselves. He gives you a certain freedom and then he supports you in every way he can. So now I send my students to Peter's lab. He is not only a colleague but still a very important mentor for me."

Christensen says that Satir's scientific influence has been particularly strong in Denmark through Satir's fellowships in Copenhagen labs, his mentoring of Danish students in the Bronx, and his marriage to Birgit Hegner, who among many other things is a Fellow of the Royal Academy of Science in her native land. Peter Satir's influence was recognized last November by an honorary doctorate from the University of Copenhagen and a reception by Queen Margrethe II. According to Christensen, "It was quite an event." A ceremony at the University was followed by a formal reception with the Queen and later by a performance at the new Opera House. "Peter speaks almost fluent Danish so he was able to converse with the Queen about his work," Christensen adds.

Driving everything was Satir's hunger for new data and new insights.

Though Satir didn't mention this honor, he can be forgiven as his CV has a lot to cover. Among other things, Satir was at the first meeting of the ASCB in 1961 where he remembers giving a cilia paper at Edgewater Beach Hotel in Chicago. In the 1970s, Satir was involved in the formation of ASCB's Minorities Affairs Committee (MAC). Two years ago, Satir agreed to rejoin MAC. "There's a lot more activity on MAC and a much wider perspective on the issues today," says Satir."I originally got involved because of Winston Anderson," says Satir. "It was Winston who really got MAC going when he brought in the first grant to organize the Woods Hole minority program."

Peter Satir was born in Manhattan but grew up a proud product of the Bronx, educated in the public schools and a graduate of the famed Bronx High School of Science. As an undergraduate at Columbia, Satir fell under the influence of cell physiologist Teru Hayashi. "Of course, my parents wanted me to become a doctor but I had no interest in becoming a physician," Satir recalls. "Fortunately, Columbia had all incoming students take aptitude tests. My advisor called me in and said, 'Whatever you do, don't apply to medical school. You have absolutely no aptitude for medicine.' This was a great relief to me as I could call up my mother and tell her that my advisor strongly recommended against it."

Free to pursue his research interests, Satir followed his mentor, Hayashi, to Woods Hole in the summer after his senior year to audit the MBL Physiology Course and hear Keith Porter's Harvey Lecture on the wonders of electron microscopy. He joined Porter's lab at Rockefeller as a graduate student in 1956. In those early years, Rockefeller graduate program strongly urged (and underwrote) a year's fellowship in an overseas lab. Satir spent 1958 in Copenhagen as a fellow in Erik Zeuthen's lab, one of only a few in the world then studying the cell cycle, mainly by synchronizing cell division in Tetrahymena. Satir returned to the Rockefeller and his Second Avenue epiphany about the ultra structure of cilia the following year but his Danish connections flourished, especially after he convinced Birgit to see what American science had to offer. They married in 1962, soon after Peter took his first position at the University of Chicago.

In truth, American academic science had very little to offer married couples in the early 1960s. Fierce departmental "anti-nepotism" rules doomed one scientific spouse, usually the woman, to a non-salaried bench or an appointment elsewhere. Birgit and Peter Satir became career trailblazers in 1967, when the Physiology Department at Berkeley made them its first-ever double job offer. Birgit was not fully salaried, Peter remembers, but she had her own appointment, and eventually her own lab.

When the Satirs left Berkeley for the Bronx in 1977, Peter says that a major enticement was the full double appointment, salary and lab space offer from Albert Einstein. The move was also poetic revenge for Satir's mother. Her son with no aptitude for medical school was now Chair of Anatomy at the Albert Einstein College of Medicine. The move also brought Satir full circle in the Bronx. His family's old apartment was only blocks from his new office.

The Satir labs have drawn a steady stream of talent to Einstein, including Jeff Salisbury who was finishing his doctorate at Ohio State in 1978 when he accepted an invitation from Satir to come see him in the Bronx. A long train, subway and bus ride later, Salisbury wondered if he'd ever find his way home. The journey was worth the effort, says Salisbury who is now at the Mayo Clinic Medical School. "I stayed there in the Bronx for six years and gained 30 pounds which I haven't lost since. Part of that was Peter. He loves life. Not only did he teach me a lot of great science, he taught me how to eat."

Driving everything was Satir's hunger for new data and new insights, Salisbury recalls. "Peter's office door was always open. No matter what he was doing, there was nothing he liked better than for you to come in there with a stack of new EMs. He'd drop everything, clear a space and go through them with you, one by one. He just couldn't resist."

Salisbury continues, "I can't emphasize this too much but a major part of Peter's strength as a scientist is that he has Birgit as a partner. The two of them have an interesting balance to life. They banter back and forth constantly but always in a very positive way. They are unique."

Today the Satirs live in Greenwich, Connecticut. The elder son, Jakob, is a computer programmer in Florida and the father of Anthony, their only grandchild, so far. Their other son, Adam, is a personal banker in Spain. The Satirs have no plans to retire anytime soon, says Peter Satir. He is especially energized these days by the "renaissance" in ciliary biology following recent discoveries linking mutations in primary cilia to polycystic kidney disease (PKD). "It's really taken off because of the disease relevance," says Satir, "but it's not just PKD and the kidneys. It seems to be involved as a growth control mechanism almost everywhere that there are primary cilia. There isn't any reason to retire. I'm having a great time." ■

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