Fred Chang grew up in Palo Alto, California. It was the early days of Silicon Valley, and he has memories of his father, an engineer, starting a company in the garage and building new video tape recorders. However, rather than following in his father’s engineering footsteps, the young Chang had instead found himself fascinated by the wonderfully diverse shapes and sizes of the different cell types of the human body. His mother, a research technician studying diabetes in Gerald Reaven’s lab at Stanford University, first introduced Chang to the lab environment and taught him the fundamentals of working at the bench.

Now in San Francisco at the UCSF Department of Cell and Tissue Biology, Chang has turned his fascination with cell shape and size into the central focus of his lab’s work. Touching on topics from cytokinesis to cell polarity to cell size control, his research focuses on the cellular processes and gene functions that control cellular dimensions and shapes. We contacted him to learn more.

**Where did you study before starting your own lab?**
I was an undergraduate at Princeton University and worked during the summers at Stanford University. I was taken with microbes and genetics, first in the lab of Dale Kaiser at Stanford, where I worked with *Myxococcus xanthus*, and then with Austin Newton at Princeton, studying *Caulobacter crescentus*. The asymmetric divisions of *Caulobacter* inspired my initial interests in microbial cell shapes and division. I went on to an MD-PhD program at the University of California, San Francisco, where I worked with the late, great Ira Herskowitz for my PhD. My project was to “study cancer” in budding yeast and try to understand the basic mechanisms of growth control, as these were thought to be missing in cancer cells. I worked toward identifying how a mating pheromone causes cells to arrest in the G1 phase of the cell cycle and identified a gene called FAR1 that is needed for cell cycle arrest but not other pheromone responses. This protein was one of the first examples of a CDK inhibitor, which are now shown to be involved in the vast majority of cancers. I also finished medical school, and although I enjoyed seeing patients, I decided that my talents lay in research.

I went on to do a postdoc with Paul Nurse at the University of Oxford and David Drubin at the University of California, Berkeley. In the Nurse lab, I decided to study cytokinesis, using genetics in fission yeast *Schizosaccharomyces pombe*. At the time, little was known about cytokinesis at a molecular level in any cell type. It was appreciated that fission yeast formed an actin ring that seemed similar to the contractile ring in animal cells. I thus started by performing a screen for cytokinesis mutants, which defined a set of genes involved in actin ring assembly. This was one of the first forward genetic screens performed specifically for cytokinesis mutants in any cell type, and identified many core cytokinesis genes that are well conserved. The yeast mutants exhibited a wide range of cytokinesis defects, from cells that formed no actin at the division site to those that formed rings in the wrong places. I was hoping to find a “nucleator” for the actin ring and chose to focus on Cdc12 on the basis of the cdc12 mutant phenotype. I was a bit disheartened to find, after almost a year of cloning and sequencing, that the *cdc12* gene sequence had no obvious similarities or motifs to anything in the databases at that time, except for curious tracks of polyprolines.

As it turned out, Cdc12 was one of the founding members of the formin family of proteins (1, 2), which are now well known to be key nucleators for the actin cytoskeleton.

**What is your lab actively working on?**
The lab is studying various aspects of cellular morphogenesis, asking questions such as how cells grow into certain shapes and how they might sense their shape and size. Our primary lab organism is the fission yeast *Schizosaccharomyces pombe*, which has turned out to be a simple and powerful eukaryotic model. Fission yeast cells have a very well-defined rod-like shape and size, and so it is easy to identify mutants and measure their morphogenic parameters. These cells are ideal for molecular genetics and rigorous quantitative cell biology.

We are studying cellular processes important for morphogenesis and cytokinesis, including the actin and microtubule cytoskeletons, membranes, and cell wall machinery. A recent development is investigating mechanical regulation of cell shapes; for instance, we are seeing how forces such as turgor pressure contribute to shaping the elastic cell wall and influence cell growth and division mechanisms (3, 4, 5). Another recent area of interest is the investigation of how cells sense their own size for size control.
Fission yeast cells grow to a certain size before entering mitosis. For this process, they may sense their size by measuring their surface area using a system of membrane-bound proteins (6). Our studies in different areas have provided us with perspective into how different systems interact within each cell; for instance, the studies on cell size control have emanated from our previous studies of cytokinesis and cell polarity proteins (6, 7). My lab has a mix of biologists and biophysicists, and I also foster collaborations with physicists, engineers, etc., outside of the lab. I have really been enjoying the interdisciplinary synergies that happen when scientists with different backgrounds and expertise work together.

Can you tell us more about your lab’s recent move?

Yes, we moved at the beginning of the year from Columbia University in New York to the University of California, San Francisco. It has been a big adventure, and we are getting settled and recruiting postdocs and students. I am delighted to be back at UCSF for many reasons—both scientific and personal—and am excited about forging scientific friendships in the Bay Area and exploring new directions for our research.

What do you regard as the biggest accomplishments of your lab?

One of the general impacts of the lab has been the development of fission yeast as a model for cell biology. With the advent of live cell imaging, we and others tagged many of our favorite proteins and cellular structures with GFP and discovered how dynamic cellular components actually are. I regard my biggest accomplishment as having trained the many talented people from the lab, who have gone on to run productive, innovative labs of their own.

Who were the key influences early in your career?

Key influences include Ira Herskowitz, my thesis mentor, who really helped to form me as a scientist. Ira was a pioneer in yeast genetics. His clarity of thought and lessons as a teacher continue to influence how I think and manage the lab. Another important influence is Ray Rappaport, whose creative work on cytokinesis instilled in me an appreciation for cellular geometry and imaginative experimentation. I also have many other good friends and collaborators who help to shape and influence the work at many levels. In particular, I have been spending summers at the Marine Biological Laboratory in Woods Hole as a Whitman Summer Investigator. These summers have been a great opportunity to recharge, try new microscopes, and get inspired by the convergence of a fantastic community of cell biologists who gather there. I work there with David Burgess on cytokinesis in sea urchins, where we are having fun squishing cells into different geometries.

What hobbies do you have?

Music has shaped my life. I studied violin intensely in my youth. My violin teacher, Jenny Rudin, was like a second mother to me and gave me the confidence and technique to play from the heart. I continue to be active in chamber and orchestral music and have just joined an orchestra in San Francisco. Many of the instincts in artistic expression from my musical training have found parallels in my science, and vice versa. I actually perceive music in shapes. What if I had chosen music over science? Perhaps I would be a member of a string quartet, which would be an equally intellectual and artistic pursuit. My favorite composer is probably J.S. Bach, whose music has a beautiful, logical structure that readily translates to science.

Any tips for a successful research career?

Keep on learning new things, ask big questions that seem mysterious—and remember to have fun!

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