

Acknowledgements

“I’ve spent more time than many will believe [making microscopic observations], but I’ve done them with joy, and I’ve taken no notice of those who have said ‘why take so much trouble and what good is it?’” — Antonie van Leeuwenhoek

It has been a privilege and honor to spend so much time in the past five years watching bacteria form beautiful biofilms. I am grateful for the resources and encouragement that have surrounded me and made research such fun at Caltech. Truly, Caltech must be the best place on earth at which to study as a graduate student.

When I visited Caltech, I hoped to find an advisor who would allow an electrical engineer to study biological circuits. How lucky I am that Frances Arnold spoke at the bioengineering visit weekend! I am extraordinarily grateful to Frances for indulging my crazy project ideas. She has given me freedom to explore research that is quite apart from her lab’s primary trajectory, and has generously learned enough about biofilms to ask tough questions. Frances is a perceptive, creative, wise, and gifted scientist. She is also a vibrant teacher and compelling writer. Her helpful, detailed criticism has sharpened my scientific and communication abilities, and her professional discipline and diligence inspire me to the same. I am also very grateful for her model as a successful

female professor who is a mother. Her encouragement, particularly as my daughter was born, has been invaluable.

My committee members, Dianne Newman, Michael Elowitz, and Jared Leadbetter have been a boon to my research for the past five years. Dianne has cheered me on since I brought my first biofilm results to her desk. I am grateful for her kindness, enthusiasm, and thoughtful, articulate advice. Michael consistently and patiently replies to my emails—whether I am requesting an obscure plasmid or need advice about an assay. Jared is a repository of microbiological wisdom, and brainstorming with him at the beginning of this project was a lot of fun. Additionally, Ron Weiss and David Karig provided instrumental collaboration upon the work detailed in Chapter 2, and conversations with Lingchong You were fundamental to the formation of the ideas in Chapters 1 and 4. I am grateful to all of these astute scientists, and it is a privilege to have had my work refined by their hands and minds.

I am grateful to the Caltech Biological Imaging Center (BIC), and particularly to Scott Fraiser who funds it and Chris Waters who runs it, for the opportunity to conduct my biofilm experiments there over the past four years. The smiling faces, flexible colleagues, and well-maintained Zeiss 510upr with a 40x-water objective that I have found in the BIC have made my research not just possible but fun.

My time at Caltech would have been lonely without the cell-circuits subgroup, particularly including Cara Tracewell, Michael Dougherty, Eric Haseltine, and Roe

Amit. I am also grateful to Dionysios Barmoutis, who made running biofilms much more fun in the summer of 2008. I will miss Michael's microbiology advice, subgroup cheese-time, and the home-baked goodies in Braun 378 that have made even the most discouraging weeks livable. I am also indebted to many Caltech staff including Linda Scott, Margot Hoyt, Blanca Mariona, Luz Maria Castillo, and Cheryl Nakashima; without their cheerful and compassionate support this work would have been much harder and taken much longer. It is also important to remember your roots; I gratefully acknowledge Manish Raizada, who took me under his wing and spent countless hours teaching me everything I needed to know to survive as a molecular biologist.

I am deeply grateful to my parents, John and Linda Braden, for their patient encouragement throughout my every adventure, including graduate school. Their unconditional love reminds me that my value as a person does not hinge upon my completion of this degree or upon professional accolades. My parents-in-law, Mike and Molly Brenner, have also been a constant source of enthusiasm. Additionally, this would not have been possible without the love, laughter, and prayers of many friends including Melissa Pope, Maren Schneider, Joyce Cannon, Allison Crumly, Megan Resor, Betsy and Jon Wood, the Wednesday night group, the ladies of Thursday lunches, and CCF-grad.

I feel that I am the luckiest mommy alive to have Ruthie, and the luckiest daughter alive to have my mom, Linda Braden. She made it possible for me to finish experiments by living with us and caring for Ruthie for much of her first six months of life. Claire Kelly, Lori Richardson, Molly Brenner, Margie Coffin, and Maren Schneider also helped to care

for Ruthie while I finished this thesis. I am so grateful for and indebted to all of these kind caregivers.

Finally, my husband, Ted Brenner, deserves as much credit for the completion of this thesis as I do. I am finishing it in large part thanks to his generous patience and encouragement amid my late nights at the lab, mercurial biofilm experiments, and the general trials of graduate school. He has helped me to find balance, to have faith, and to get on with life (including helping me to bring Ruth Elizabeth into the world, and being primary caregiver for several months while I finished this degree). I love him with all my heart.