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RESEARCH

Radical rethink

Student-initiated projects have the potential to change a lab's focus. But with freedom comes responsibility.

BY ROBERT FREDERICK

For the past three years, Jon Beckwith's lab has focused on studying *Mycobacterium smegmatis* as a model for tuberculosis. It has been a major shift in direction for Beckwith, a microbiologist at Harvard Medical School in Boston, Massachusetts, who spent the previous four decades using *Escherichia coli* to study fundamental problems of biology, including cell division, protein folding and membrane-protein structure. He is still surprised that he has ended up working on problems with direct medical significance. "It's a bit of a shock," says

Beckwith. And he owes it all to a student.

Rachel Dutton was a PhD candidate in Beckwith's lab in 2006, when she first decided to study other bacteria. It wasn't so much that she was bored with *E. coli* as that she was interested in microbes about which little was known. "It took a while to convince Jon that it was an interesting project," recalls Dutton, who is now setting up her own microbial-diversity lab at Harvard. "We had many meetings where he would give me these looks." Dutton gained the support of Dana Boyd, a senior scientist in the lab, but she knew that Beckwith was questioning the value of her ideas. Eventually, however,

he gave Dutton the freedom she was seeking. "If someone insists on doing something," says Beckwith, "I let them, unless I have really strong fundamental disagreements with what they're doing." Eventually, Dutton and Boyd's results convinced Beckwith to find funding for the project, which now occupies his entire lab.

Fledgling researchers can reap plentiful rewards from the freedom to pursue their own interests. They can learn important lessons about the responsibilities and pitfalls of independence. And successful projects might also lead to funding and publication opportunities for others in the home lab. But independence for students requires an open-minded principal investigator and a flexible funding source, and brings the risk of failure. Young scientists who are given research freedom need to know what they are getting into.

FLEXIBLE FOCUS

It is rare for a postgraduate project to completely change the focus of a lab as Dutton's did; but both students and mentors should embrace students' pursuit of tangential or parallel projects. Indeed, some researchers argue that it is crucial for those who want to run labs to carve their own niches. "You don't want to compete with your principal investigator for grants," says Maryrose Franko, senior programme officer for graduate science education at the Howard Hughes Medical Institute in Chevy Chase, Maryland. Instead, she says, "you want to set yourself apart" by branching out into new areas. Franko advises young scientists not to abandon their original projects. Instead, she says, they should volunteer to split their time between the mentor's project and their own. "They'll understand that you need those preliminary results," says Franko. "You need some research to take with you."

In some places, including the United States, students don't start their own projects as soon as they join the lab. "You first typically have to prove yourself in what the principal investigator needs to get done," says Zoe Fonseca-Kelly, an ophthalmology researcher at the Massachusetts Eye and Ear Infirmary in Boston. "After a certain amount of time you can develop your own projects, provided you can juggle your time." This usually happens between several months and a year into the PhD.

Students shouldn't get too discouraged if their mentor resists a proposed project, says Cynthia Fuhrmann, programme director for academic career development at the University of California, San Francisco. In 2008, Fuhrmann ►

► surveyed the university's graduate students and found that a significant proportion of them get disillusioned with academia around the time that they need to find their own projects, with almost half of those who reported being interested in academic research careers in their first year changing their minds by their third (C. N. Fuhrmann *et al. CBE Life Sci. Educ.* 10, 239–249; 2011). The students who can be proactive and pursue a project that excites them — even if it deviates from the lab's focus and requires outside collaborators — are most likely to keep dreams of a professorship alive, says Fuhrmann.

PROCEED WITH CAUTION

Ideally, postdocs and graduate students should find out how much freedom to expect before they apply to work with a principal investigator (see *Nature* 470, 129–131; 2011). They need to do their homework, says Cathie Johnson Phillips, executive director of the US National Postdoc Association in Washington DC. She advises that applicants consider the type of publications that come from the lab, and whether most of them were based on the principal investigator's research, or were prompted by lab members, graduate students or postdocs. But applicants should tread carefully — asking a potential employer about the flexibility of their research agenda can be taken as a criticism of their status or current work. "It's not an easy conversation to have," admits Phillips. Students and postdocs might also talk to lab members, or even to scientists working with other investigators in the same department.

Applicants could look for hints of flexibility in the investigator's own training, says Margaret Kiley, a social scientist at the Australian National University in Canberra, who studies how students learn to become researchers. "If you were socialized into the discipline and into the research, doing it in a particular way," says Kiley, "you are likely to replicate that yourself."

Candidates should investigate the career or publication trajectory of their potential mentors, says Franko, as well as the grant portfolio of the potential mentor's own principal investigator before, during and after the mentor's stint as a protégé. But the "big thing," Franko emphasizes, "is communication ahead of time".

Robert Dooling, a psychology researcher at the University of Maryland in College Park, makes sure that he talks to students and postdocs both before and shortly after they join his lab. "Before you came," he tells them in the second chat, "we had a conversation about why you came and what you want to work on. There's flexibility to try out things that are unusual, but it's not an unbridled freedom to do whatever moves you in the moment." After that, Dooling shows them his successful grant applications and explains that all lab members have an obligation to help to keep the lab funded.

There are downsides to having a mentor who is open to letting students explore completely new research: projects could be too ambitious, or might not provide results, and so might drag on indefinitely. "I don't believe in eight-year PhD theses," says Karolin Luger, a structural biologist at Colorado State University in Fort Collins. Principal investigators "have a bit more experience, and so we know what it takes to graduate a student," she adds. Students "may be super-optimistic and say, 'Oh, I can have this done in three months', and we know it's going to be like a two-year project. They need to graduate."

VARIABLE FUNDING

Even for students whose mentors encourage freedom, money can be a constraint. Before totally changing his research programme, Beckwith needed to be convinced not only of the project's scientific rationale, but also of the likelihood that it would receive funding. To that end, Dutton and Boyd did a series of small, inexpensive experiments. "Each idea

that she and Dana proposed, one after the other, turned out to be correct," says Beckwith. It took some time, but the results were so promising that Beckwith was able to secure the flexible funding that his lab needed to pursue the work further.

Strategic grant writing can help to give a lab's young scientists greater flexibility, suggests David Delpy, chief executive of the UK Engineering and Physical Sciences Research Council in Swindon. In grant applications, investigators could outline their grand research problems and several ways to seek solutions, from which young scientists can take their pick. Delpy cautions against extremely focused grant applications, which tend to quash creativity. "You can't define the outcome of your research at the outset," he says, "and you ought to follow up new ideas that come along that might be appropriate."

JUST ONE MORE EXPERIMENT

That extra, unplanned experiment often allows young researchers to find their own direction — and shows principal investigators that the researchers were right to take a radical departure. As a graduate student at Duke University in Durham, North Carolina, Jeremy Lenhardt did just one more experiment than was recommended by his supervisor, chemist Stephen Craig. It was a chance for Lenhardt to satisfy his scientific curiosity in his chosen field — mechanochemical coupling, the interplay between chemistry and materials. He had little in the way of a particular hypothesis, but he did have a hunch. "I want to try something," Lenhardt recalls thinking. The observations that he made led to several publications and, eventually, a postdoctoral position at Lawrence Livermore National Laboratory in Livermore, California, where he now works on super-lightweight materials with energy applications.

Choosing that extra experiment means taking risks; to minimize them, graduate students and postdocs can conduct multiple experiments at the same time, advises Franko. Many postdocs in successful labs have four projects going on at once: one that is essential for the lab; one that is safe and will lead to publications; one that runs in parallel with or tangential to the general direction of the lab, and that the postdoc can take with them; and one that is risky. The risky project is often the one that leads to an independent research career, says Franko.

Nancy Schwartz, a biochemist at the University of Chicago in Illinois, gets even her graduate students to work on multiple projects. "If you say, 'Here, go do it', then you're treating them like technicians and they're not going to learn to be investigators," she says. But there should still be constraints on, and monitoring of, their work. "Often they fail," says Schwartz. "That's the only way you really learn to do science." ■

Rachel Dutton quickly got senior scientist Dana Boyd (right) on board with her PhD project idea, which deviated from the lab's focus. But she had to convince her mentor, Jon Beckwith (left).

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