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On Becoming a Scientist

ONE NORMALLY BECOMES A SCIENTIST THROUGH A SERIES OF APPRENTICESHIPS, PURSUING research in laboratories directed by established scientists. My own scientific mentors were Jacques Fresco and Paul Doty at Harvard, where I learned not only technical skills but also how to think and function as a scientist. Both from them, and by making my own mistakes,* I learned how to identify important problems, how to think critically, and how to design effective research strategies. Because so much of one's scientific future is shaped by early experiences, it is critical that beginning scientists select their mentors wisely. Unfortunately, what constitutes a "good" choice is not always obvious. Here I offer some personal advice to help young scientists make these tough decisions wisely.

The exact project pursued for a Ph.D. degree is not nearly as important as finding the best place for learning how to push forward the frontier of knowledge as an independent investigator. My first piece of advice for graduate students is to begin research training in a laboratory led by a person with high scientific and ethical standards. It is by talking to people in that lab or those who have previously trained there, and by consulting other scientists in the same field, that one can gain this important insight.

It is also important to find an adviser who will pay close attention to your development as a scientist. Brilliant scientists sometimes make poor mentors. Often, an established leader who has no more than about a dozen people to manage can best nurture a creative, exciting, and supportive place to work. But carrying out research with an outstanding new professor with a very small group can frequently provide even better training.

Students enter graduate school both to learn how to do science well and to discover where their talents and interests lie. Success at either task requires that they be empowered to create new approaches and to generate new ideas. In my experience, beginning scientists will only gain the confidence needed to confront the unknown successfully by making discoveries through experiments of their own design. The best research advisers will therefore provide their graduate students with enough guidance to prevent them from wasting time on nonproductive pursuits, while giving them the freedom to innovate and to learn from their own mistakes.

In my field of biology, two apprenticeships are standard for beginning scientists: first while earning a Ph.D. degree and then in a second laboratory in a postdoctoral position. The choice of a postdoctoral laboratory is best made with a long-term career plan in mind. Scientists at this stage should intentionally try to choose a laboratory where they can acquire skills that complement those they already have. For example, a student whose Ph.D. thesis gave her strong skills as a yeast geneticist might choose to do postdoctoral research with an expert protein biochemist, planning to later use a combination of powerful genetic and biochemical tools to attack a biological problem in an area where very few scientists have the same abilities.

But success as an independent scientist will require much more than technical skills. It is critical to be able to design research strategies that are ambitious enough to be important and exciting, innovative enough to make unique contributions likely, and nevertheless have a good chance of producing valuable results. An enormous number of different experiments are possible, but only a tiny proportion will be really worthwhile. Choosing well requires great thought and creativity, and it involves taking risks.

Senior scientists have the responsibility of maintaining a system that provides talented young scientists with the opportunity to succeed in whatever career they choose. My next editorial addresses the importance of ensuring that innovation and risk-taking are rewarded for those pursuing a life of independent research. Also, a new series in *Science Careers* highlights conversations with audacious scientists who give their own advice about selecting institutions, mentors, and projects.†

– Bruce Alberts

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