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WHY MENTORING?

For better or for worse, mentors encountered early in the career occupy a potent position in one's development as a practitioner. By influencing the next generation of practitioners, mentors can also shape the future of their professions. In his book *Academic Duty* (1997), the president emeritus of Stanford University, Donald Kennedy, asserted the critical importance of mentoring for the survival of the academy:

> It is through [mentor-student] relationships that the academic profession reproduces itself. . . . What the new faculty member knows about the university, he or she learned by absorption—in a library or laboratory, under the guidance (or, perhaps, the indifferent sponsorship) of a graduate or postdoctoral mentor. The faculty member's understanding of his or her academic responsibilities is not prescribed by contract or institutional rule; in this respect it is unlike the understanding of duty one would have as a soldier or as a mid-level executive in a large corporation. It is, rather, part of an inherited culture, and the route of transmission is thus of vital importance. (p. 97)

This is a book about the route of transmission that Kennedy found to be of vital importance, a route in which mentors and graduate advisors play a significant role. We report on a systematic investigation into how graduate mentors can amplify specific values and practices that become part of an inherited culture. We interviewed at length not only mentors but also multiple generations of students to discover the extent to which values and practices are inherited and how such a process occurs.

Historically, the ideal mentor has been conceived as someone who serves as advisor, sponsor, host, exemplar, and guide for a relative novice who is moving from dependence and inexperience toward independence and proficiency. An effective mentor may also facilitate the realization of a young person's aspirations by bestowing responsibility, trust, and opportunities to achieve (Levinson, 1978). However, the experience of mentoring during graduate or professional training appears to be more mixed than one might expect. In one large-scale study on perceptions of mentoring, only 56 percent of nearly one thousand students in a variety of programs were "satisfied" or "very satisfied" with their mentoring relationships (Ortolani, 1998). Smaller studies vary by profession but paint a similar picture. For example, in a qualitative study of doctoral students in counseling psychology, 38 percent reported being unsatisfied (Schlosser, Knox, Moskovitz, & Hill, 2003). Dissatisfied students describe their mentors as unavailable, unsupportive of their academic endeavors, and lacking in competence, interpersonal skills, or both.

More worrisome are known cases of abuse of power, including incompatibility of attitudes, sexual harassment, and exploitation, sometimes culminating in disastrous outcomes. From a mentor's point of view, problems arise if a student's expectations of the mentor are unrealistic. From the student's perspective, a bad relationship may significantly taint the entire educational experience, resulting in feelings of alienation (Tenenbaum, Crosby, & Gliner, 2001). When a Nobel laureate's star graduate student in the Harvard chemistry department committed suicide in the late 1990s, leaving a note declaring "this event could have been avoided . . . professors here have too much power over their students," commentaries that followed made clear that the perceived pressures were familiar to academics in the sciences and beyond (Hall, 1998, p. 120). At one extreme, the intense focus of many graduate advisors on their own work leads them to neglect their students. At the other, advisors may be accessible but place crushing demands on their students.

In one leading lab, a sign dictated: "Don't try. Do" (Hall, 1998, p. 120). More darkly, one commentator in the *Chronicle of Higher Education* observed: "The prof is dependent on your work; he/she must often use guilt trips, harsh yelling, insults, or subtle jabs to get you to work. He/she has to" (Schneider, 1998, p. A12).

Advisors thus have the capacity to do real harm. When they mentor well, however, there can be a multitude of benefits. Effective mentoring at the graduate level has been related to completion (Lovitts, 2001), as well as academic success, scholarly productivity, and subsequent career achievement. Graduate students who indicate that they have a mentor produce significantly more predoctoral publications, including first-authored publications, conference papers, and grant applications, compared with students who are not mentored (Cronan-Hillix, Gensheime, Cronan-Hillix, & Davidson, 1986; Reskin, 1979; Smith & Davidson, 1992). After graduation, they are more likely to obtain a tenure-track position at a university, collaborate more on professional research projects, publish more, and garner more advancements over the course of their careers (Cameron & Blackburn, 1981; Reskin, 1979).

These benefits concern only the impact of mentoring on the academic and career success of the individual student. More broadly, as novices move into a profession, they start to construct an understanding of the profession they are entering—what ends it serves, what it asks of them, what it rewards—and begin to define the kind of professional they want to become. They start internalizing standards, forming a distinctive approach to work, shaping their goals and a sense of purpose, and setting a moral compass for their professional conduct. With respect to these aspects of development, an advisor may demonstrate that success can coexist with responsible, ethical practice—or, instead, model conduct that undermines the highest standards of the profession. We were particularly interested in the transmission of orienting values and principles uniting excellence with responsible practice. This book reports on research that systematically examined whether and how exemplary practitioners might influence their students in these areas.

There is reason to believe that mentors may matter a great deal in these areas of development, as well as in career success. For example, mentoring received during graduate or professional training may provide crucial support for a commitment to the common good. Law students may be lured to the profession by the lucrative prospects of working for a corporate law firm rather than by the prospect of practicing law to serve the public good. However, even the students most strongly committed to pursuing public interest law find their dedication waning during law school unless they are encouraged to pursue it by a subculture that includes mentoring relationships with experienced lawyers and teachers (Stover, 1989).

Few disagree that mentoring can be beneficial, and in a variety of ways. The main difficulty appears to be that there is not enough good mentoring to go around. In some instances, this shortage might be the consequence of inattentiveness or laziness on the part of institutions or would-be mentors. We suspect, however, that more often the shortage results from a collective lack of awareness about what it means to mentor well—lack of an adequate understanding of the pathways that successfully foster excellence and perpetuate responsible professional practice. Mentoring is a lot like parenting: something one is expected to pick up naturally, with little or no formal training. However much organizations from university departments to law firms to large corporations may depend on the process for their survival, professionals are still expected to learn the process almost through osmosis, with little effort or energy. While a plethora of how-to books on mentoring have been published, too many are not based on rigorous social-scientific research. In this book, we ask: What exactly is it that early career professionals learn from good mentors? And how does the transformational process occur?

Spanning the Generations: Mentoring in Elite Scientific Lineages

This book relates what we learned by studying the impact of mentors on new practitioners who are forming their approaches to work and their professional identities, and it explains how we view mentoring as a result of our research. The mentoring processes that we examined occurred in a single field—that of genetic research—and yet the lessons learned relate to principles of effective mentoring in any profession where the role of apprenticeship is (or could be) strong. First, however, what indications did we have that experienced professionals can play a positive role in the development of a practitioner in the respects of central interest to us and that this impact can extend down generations of students?

The first promising sign was the case of the great twentieth-century Danish physicist Niels Bohr. We became familiar with Bohr and his profound impact on younger scientists through interviews with several physicists in their seventies and eighties who had worked with him early in their careers. (Unless otherwise indicated, comments by Bohr's students come from unpublished interviews conducted for a study of creativity in later life described in Csikszentmihalyi, 1996.) In their younger years, these scientists were eager to make a contribution to physics, and they were drawn to Bohr because they wanted to learn how to do groundbreaking work from a master in the field. Each of them went on to achieve excellence, winning prestigious awards, and all named Bohr as a crucial figure in their development as successful scientists. He taught them "how to think" as one put it, and "a new way of looking at the world, of raising questions" according to another (see Riordan, 1998, p. 24). His protégés did more than become skilled scientists, however. Their time with Bohr also left them better members of the scientific community. In contrast to scientists determined to get ahead at all costs, Bohr deeply impressed them as "too great for haste, too high for rivalry" (Taylor, 1972, p. 475). He was concerned with exploring what he still did not understand rather than dwelling on his past accomplishments. He struggled mightily with scientific problems yet was always willing to admit if his conclusions were wrong. In short, he was a model of scientific integrity (Pais, 1991).

In addition, Bohr was attentive to his younger colleagues, encouraged them, and made them more sensitive to the scientist's responsibility to society. They recounted influential conversations with Bohr about both the domain of physics and important matters beyond the scope of science. They recalled times when they had shared meals, taken walks, and engaged in other social activities together. They reflected on his concern for them as persons as much as scientists. Bohr had a "special way of teaching," distinguished by a holistic perspective and a sense of caring that modeled collegiality, integrity, responsibility, and scientific excellence.

One of Bohr's students explained, "I lived as a member of his family . . . he had a great feel for people, their careers, and their problems." Another said, "He was always living with or among us. . . . Although he was much better than us, he was accessible. . . . He was interested to talk to us not only about physics, but also about philosophy, politics, and art. We went together to the movies." A third added, "As he walked around the table in his office talking about some of the great questions, you would have the feeling that you could understand how people such as Buddha or Confucius really existed. . . . He took his role as citizen and scientist very seriously. . . . He had a great feeling of responsibility and citizenship."

Some of Bohr's protégés also recalled encounters with Albert Einstein, and the contrast with Bohr is instructive. They learned a great deal about science from the celebrated physicist, but they were not influenced in nearly the same way. Einstein worked more independently than Bohr did, and although he thought and wrote on a broad range of topics as a humanist and pacifist, these younger colleagues did not describe being profoundly influenced by his example. One scientist noted that Einstein was a quintessential independent thinker whose deepest need was "to think separately, to be by himself. Bohr, on the other hand, craved togetherness, in life and in thought" (Pais, 1991, p. 227).

Bohr left an indelible imprint on the generation of younger scientists he mentored. Moreover, the impact of his mentoring extended beyond his protégés' lives. His influence was also felt by the scientists whom his protégés in turn influenced. For example, a junior colleague saw in one of Bohr's protégés, John Wheeler, a set of inherited traits "so charming and insidious that I find myself adopting them." He reported, "I never met Niels Bohr, and yet feel I have watched him through John." He concluded, "In a multiplicity of ways: in print, [but also] in characteristic gesture, in mode of thought, in politeness and openness of mind . . . do the lives of great men reverberate in our own" (Taylor, 1972, p. 476). In this sense, Bohr created a *lineage*, or line of descent. Through his protégés' subsequent conduct as leading scientists, he affected the ethos of the nuclear physics community and the role that it played in the wider society during and after World War II (for a discussion of Bohr's influence on the physics community and beyond, see Pais, 1991).

Bohr's example fueled our interest in whether and how mentors can have a positive influence on their protégés' guiding values and attitudes, in addition to affecting the quality of their work and their subsequent professional success. His example makes clear that the stakes are high: through their impact on the next generation, good mentors can also affect the future character of their profession. How unique was Bohr? In the research on which this book draws, we traced the impact of senior professionals on several subsequent generations of practitioners.

Studying Scientific Lineages

The field of genetics experienced a golden age during the final decades of the twentieth century. We chose to study how mentoring takes place in this important field with the expectation that what was learned would apply to mentoring in the sciences at large, in many respects to graduate education generally, and in some respects to mentoring in any profession. The lessons learned are relevant to advisor-guided graduate training normally occurring within universities and to experience-based professional training, as in medical residencies or law clerkships.

Graduate science education's reliance on learning by apprenticeship makes it an ideal setting for examining mentoring in early career development. Not every graduate student has a mentor, but unlike some other forms of professional preparation, the advisor-student relationship at the heart of graduate training ensures that every student has the possibility of having one. In addition, the state of genetics at the turn of the century is well suited for the study of how mentoring relates to "good work," a topic to which we turn shortly. Briefly, toward the end of the twentieth century, the critical influence of genetics on society became very evident; in addition, with the growth of cloning, biotechnology, and gene therapy and growing competitive pressures within the field, genetics began to be the subject of the kinds of concern that inspired the launch of the larger GoodWork Project. For this reason, a study providing us with a base of knowledge of good work in genetics had been conducted earlier (Gardner, Csikszentmihalyi, & Damon, 2001).

Within genetics, we focused on multigenerational "lineages" among the scientific elite (Zuckerman, 1978). It is not uncommon in academia for individuals to refer in conversation to their intellectual fathers or mothers or to compare notes about their intellectual offspring. At elite levels, lineages have been shown to extend across generations of teachers and students for decades, displaying clear lines of descent from mentor to protégé (see Zuckerman, 1977; Kanigel, 1986). We adapt the concept of generations to refer to the reproduction of practitioners within a profession, such that the first generation of offspring comprises a practitioner's students, the second generation comprises the students' students (the original practitioner's "grandchildren"), and so on. Because the most eminent scientists of one generation train a disproportionate number of the succeeding generation's leaders, we wanted to learn what kinds of values, beliefs, and practices might be communicated from teacher to student across three generations of these elite ranks and how this process occurs.

Prior research suggests that eminent scientists transmit to their apprentices both the standards and practices that support creative accomplishment, and the signature ideas and research style that may distinguish one leading scientist from another. In the pages that follow, we simultaneously explore the direct influence of exemplary senior scientists on their individual students and their indirect influence on future generations, with implications for the health of their profession. Specifically, our study centered on (1) the practices, values, and beliefs embodied by three exemplary senior practitioners; (2) the extent to which these mentors were able to successfully pass on an orientation toward "good work" (as explained next) to subsequent generations; (3) the mentoring practices they employed; and (4) characteristics of the relationships they formed with students.

Professional Pressures and Good Work

Mentors have the capacity to be either harmful or beneficial by virtue of what they may model or pass down to subsequent generations. We were particularly interested in the capacity of mentors to model and pass down practices exemplifying professional excellence and ethical responsibility. This combination has been dubbed "good work" by the GoodWork Project, a research program out of which our study grew. The GoodWork Project was begun in 1996 by Howard Gardner, Mihaly Csikszentmihalyi, and William Damon to investigate a perennial challenge that professionals face, and its intensification under contemporary societal conditions. They argued that the challenge for professionals is to do work that is "good" in two respects: of high quality *and* true to the profession's traditional mission and code of ethics. The growing public distrust harbored today toward virtually every profession—business, health care, law, journalism, and others—reflects the compromised ability to meet this challenge because pressures and incentive systems create temptations to sacrifice responsible practice. Since the turn of the twenty-first century, such temptations have increasingly resulted in publicized instances of public fraud, breaches of good faith, and corporate crimes. The book *Good Work* (Gardner et al., 2001) discussed the nature of work that is both excellent by the profession's standards of quality and ethical, responsibly serving the common good. It focused on the professions of genetic research and journalism to explore the current conditions—such as growing self-interest, cutthroat competition, and ubiquitous profit pressures—that can impede excellence and compromise professional ethics. In recent years, we have seen the consequences in almost every profession.

Genetic research is no exception, particularly in biotechnology, which ties research to lucrative industry. A recently publicized example was the case of Hwang Woo Suk, the South Korean scientist who rose to international prominence after reporting a series of remarkable breakthroughs in stem cell research. He was considered one of the pioneers in the field and became a national hero after publishing two articles in the prestigious journal *Science* in 2004 and 2005, reporting that he had cloned embryonic stem cells, a technique that might lead to cures for a range of diseases. But the reports turned out to be fraudulent, containing a large amount of falsified data, and the journal retracted both papers. After initial denials, Hwang admitted to various fabrications and frauds.

The current situation in the field of genetics has deep roots; indeed, it has been argued that cutthroat competition characterizes the origin story of modern genetics. On a February afternoon in 1953, Francis Crick burst into the Eagle Pub in Cambridge, England, and exuberantly announced to "everyone in hearing distance" that he and his younger colleague, James Watson, "had found the secret of life" (Watson, 1968, p. 197). In some respects, he was right. Earlier that day, Crick and Watson had identified the double-helix structure of deoxyribose nucleic acid, edging out other researchers in England and the United States racing to do the same. Their discovery was monumental, nothing short of unearthing the holy grail of science at the time, and it made possible the rise of modern genetics. Together they had competed vigorously against their transatlantic rival, Linus Pauling. Within weeks, Watson and Crick published their results in the journal *Nature*, revolutionizing biochemistry and establishing themselves as two of the most celebrated scientists of the twentieth century (Watson & Crick, 1953). Finally, they had won.

James Watson's ascendance in science has rarely been paralleled. He was twenty-five years old when he codiscovered the double helix. In his thirties, he joined the Harvard faculty and shared the 1962 Nobel Prize in chemistry for his role in the landmark discovery. When he was forty, he published *The Double Helix*, his wildly popular chronicle of the events surrounding the 1953 discovery, which now ranks seventh among Modern Library's most important nonfiction books of the twentieth century. Twelve years after joining the Harvard faculty, he took the helm of the prestigious Cold Spring Harbor Laboratory, running it with the same brashness, determination, and competitiveness that carried him to eminence as a young man. The lab gained a reputation as a powerhouse in the field, and Watson's prominence grew steadily as well. He was at Cold Spring Harbor for over twenty years, leaving only when the National Institutes of Health launched the Human Genome Project in the late 1980s and named him as its first head. He resigned from the project in 1992 in protest over the U.S. government's plans to patent gene sequences, and he returned to Cold Spring Harbor for another fifteen years.

A former associate was asked about Watson's impact on the field of genetics (comments come from an unpublished research interview that was conducted for the GoodWork Project in 1998). The researcher offered a surprising appraisal: rather than celebrating Watson's important breakthroughs and lauding his contributions to science, this former colleague instead criticized Watson's approach. He described it in terms of an increasingly pervasive set of practices that he believes scientists and educators should regard with skepticism rather than praise. He advised reading *The Double Helix*, but *not* as an inspirational work: "I say read it, because to me it's a very clear picture of how not to do science. I think that book has probably done more damage than any other book in the field. You know, the lesson of the book is, [however you get it], if you get the right answer it's fine. Life is rosy for you. I don't think that's a good message."

This scientist likened the public's eager embrace of Watson's book, and the scientific community's commendation of Watson, to the unreflective manner in which popular movies and television shows are devoured by the public: "It's a good story . . . it's sort of like reading *The Godfather. The Godfather* is an excellent story, and the film is wonderful, but that's perhaps not what I would want to be, not how I would like to run my life."

Watson's approach has been described as pitting the junior scientists against one another "to get as many people as possible working on the same problem so that it would get solved quickly," garnering prestige for the lab. There can be no doubt that this approach produced results, as well as high acclaim for Watson, but at what cost? Competing to "do the same experiment faster," rather than tackling some other problem well, actively discourages the open exchange of information and sharing of knowledge that is a cornerstone of science (on the norms of science, see Merton, 1973).

This behavior certainly does not rise to the level of public fraud or corporate crime, nor did anyone ever imply that Watson's science was dishonest. The danger is that aspiring scientists may embrace *The Double Helix* as their guide, concluding that the path to professional success must be paved with single-minded competitiveness even at the cost of ethical considerations.

Talented young scientists dream of great accomplishments; they want to leave their mark on the field. Many young professionals aspire to behave ethically and responsibly—so long as it does not harm their chances for professional success. According to one recent study, promising students said that they fully intend to behave ethically—once they have "made it" in their careers (Fischman, Solomon, Greenspan, & Gardner, 2004). Until then, however, some regard integrity as a luxury that they may be unable to afford. During the pressure-filled scramble to get ahead, they may cut corners or even lie about their work. This principle was demonstrated in the case of an ambitious high school student competing in the Intel Science Talent Search, who espoused a strong moral code and intended to live by it—just as soon as she was established in the field. To get ahead, however, she deliberately concealed disqualifying information about her experiment from the competition's judges. Justifying her actions, she stated, "Maybe it was lying, in a way. But I didn't think that it was wrong, because I deserved to be rewarded" (Fischman et al., 2004, pp. 88–89). She had, after all, worked very hard. Was it only a coincidence that this student admired *The Double Helix*?

The most widely publicized examples of succumbing to career pressure may represent extreme cases. However, the pressures and temptations that they highlight are felt by ambitious young people, and even not-so-ambitious individuals, in many professions today. Other challenges include time pressures in the seemingly impossible task of balancing work with home and personal life, which are intense for many young career professionals, both female and male (see Hochschild, 1997). In the absence of senior guidance, such pressures can produce temptations to publish work hastily or before a substantial contribution is made, avoid the sharing of scientific information, or in extreme cases like that of Hwang Woo Suk, misrepresent scientific data or results.

Good Mentoring from an Evolutionary, Systems Perspective

In the face of these conditions, what supports ethical and responsible professional conduct? Surely one of the likeliest bulwarks, as Gardner and his colleagues suggested, is education. But what educative forces exist that can best support the conjunction of responsible practice and high-quality work? It is our thesis that books, the Internet, and classroom lessons about professional ethics cannot—or at least do not—fully convey the values and practices promoting responsible practice. Rather, the best chance for their cultivation is likely to lie with teachers who embody these values and practices and the learning environments that the teachers create. Through them, orienting values can be acquired—to use John Dewey's felicitous phrase—in "intimate organic connection" with the associated knowledge and technical skills (Dewey, 1916, p. 360). In this book, we focus on mentoring that encourages good work, which we call *good mentoring*.

A word about terminology is in order. Researchers use the term *mentoring* to refer to a relationship in which "a more experienced . . . individual acts as a guide, role model, teacher, or sponsor for a less experienced . . . protégé" (Clark, Harden, & Johnson, 2000, p. 263). This needs to be distinguished from use of the term in some popular discourse to refer to a more circumscribed, often brief relationship focused only on aiding professional entry, advancement, and access to resources. We consider the latter to be *sponsorship*. Particularly in the sciences, the graduate student's association with an advisor is an organically developing, long-term relationship integral to becoming a professional. It is relationships of this kind that have sparked interest in creating formal mentoring programs, but the same quality of relationships has often proven difficult to reproduce there. Our book addresses mentoring more than *sponsorship*.

At times, we use the term *apprenticeship* as well as *mentorship*, although they are not synonymous. *Mentoring* commonly refers to a dyadic relationship that involves a one-on-one interplay between two individuals—a more experienced practitioner and a student or novice. The term normally specifies very little about the structure of the interactions through which learning takes place. In contrast, *apprenticeship* refers to the experiential learning that takes place in a community of practice where experts conduct the authentic work of a profession. Much of graduate education is structured loosely on the model of a craft apprenticeship, in which the novice is trained and supervised by a more seasoned practitioner. For a period of months or years, the senior practitioner exposes students, close up, to one possible approach to professional life. Analogous training models characterize other professions as well, though specific practices vary. Because this book takes graduate education in the sciences as the lens through which to study the perpetuation of good work, the mentoring relationships we describe take place within the context of apprenticeships.

In this book, then, we address the potentially profound effects of good mentoring on individual professionals, and in doing so, we broaden the context within which the mentor-student relationship is placed by adopting an evolutionary, systems approach. We consider the long-term transgenerational implications of a mentor's actions, and we recognize repercussions of these actions for the broad set of interacting systems to which the individual mentor and individual student belong. The study of lineages makes this broader view possible.

From a systems perspective (see Csikszentmihalyi, 1996), the relationship of novice to experienced practitioner interweaves three trajectories: one individual, one cultural, and one social. The relationship has the potential to play a role not only in the development and future success of the individual student, but also the perpetuation and transformation of the domain of professional knowledge and practice, and the evolution of the social field, or professional community, to which mentor and student belong. In short, it affects both professionals and the profession. The fate of the professions has consequences for us all. Every profession is also part of the larger sociocultural system, with which it interacts in multiple ways, particularly through its impact on those whom it is meant to serve.

Complementing this systems approach, we employ the perspective of cultural evolution, which provides a vocabulary for describing the transmission of lessons from mentor to student. In his book *The Selfish Gene* (1976), Richard Dawkins introduced the term *meme* to denote the building blocks of culture. Analogous to the role of genes in biological evolution, memes carry instructions for action that are transferred from one generation to the next. Dawkins's notion of memes is controversial, but we found it a valuable heuristic in this study, where we were interested in the role of mentors as potential carriers and transmitters of memes such as skills and knowledge, standards of quality, ethics and integrity, and overarching aims. We were especially interested in memes supporting good work.

Each seasoned practitioner has a characteristic approach to professional work. If we compare lineages headed by different practitioners, members of successive generations in one lineage may share a meme—a value, a practice, a belief—while those in the other lineages do not. If so, it would suggest that the distinctive characteristic of the lineage head had been transmitted over generations in that lineage. The genetic analogy would be blue eyes running through one family tree compared to brown eyes running through another. However, whereas the consequences for a community's welfare may be small if blue eyes selectively persist rather than brown eyes, the same is not true of professional conduct. If a spirit of cooperation is selectively perpetuated in a lineage rather than competitiveness, for example, the lineage will contribute to the profession's evolution toward a culture of collaboration.

How We Conducted the Study

In this study, a unique sampling design was critical. Assembling a sample of leading scientists would have been adequate if the goal had been limited to identifying effective practices in the cultivation of success. Because we also sought to understand processes that span successive generations, and the cultivation of ethical as well as successful practice, we needed a more complex sampling strategy. We studied mentors known as both moral exemplars and highly accomplished scientists, and used a multigenerational sampling design in order to examine the dynamics of the immediate teacher-student relationship, as well as the evolution of values and practices across linked generations of professionals.

We compared three lineages, each comprising three generations of scientists. The study's linchpins were three senior scientists. For these three lineage heads, who constituted Generation 1 of our sample, we sought elite scientists who best met three criteria. They needed to have made major scientific contributions, formed a strong reputation for responsible practice, and mentored a younger generation of practitioners.

Through a combination of background research and expert nomination, we created a list of Generation 1 prospects in the field of genetics. We examined biographical profiles, curriculum vitae, published interviews, newspaper articles, laboratory Web pages, disciplinary and institutional histories, scientific reports, and other materials. In addition, we interviewed several highly qualified consultants (for example, historians of genetics) to provide informed opinions about the candidates. Together, the consultations and research yielded a list of more than two dozen Generation 1 candidates, representing various areas within genetics. We selected three senior scientists, who unambiguously met all three criteria and represented three different subdomains within genetics: cytogenetics (cell biology), medical genetics, and population genetics.

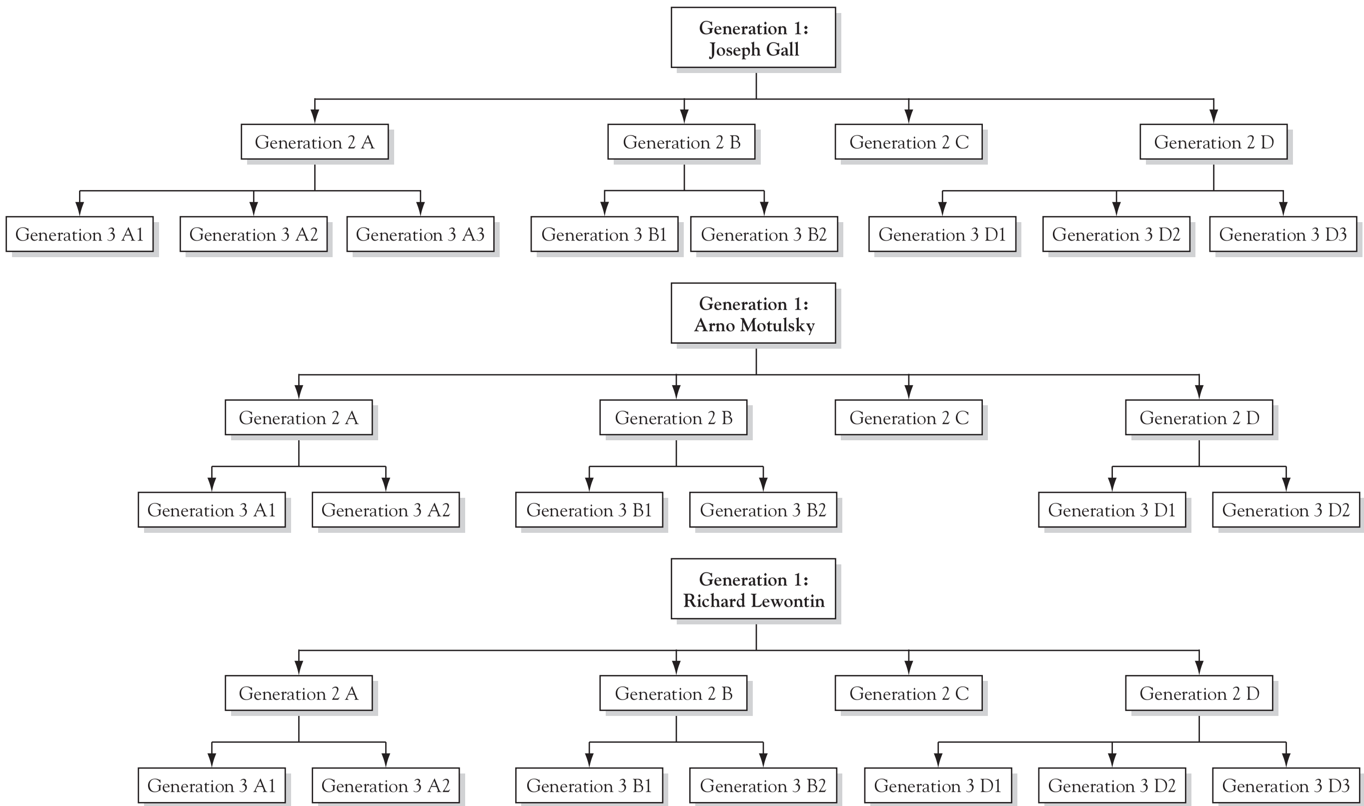
To identify Generation 2 and 3 representatives, we again employed a combination of background research and nomination. Each lineage head graciously prepared a list of former trainees who had pursued scientific careers. Their lists included many more successful midcareer scientists than we could interview. For each lineage head, we interviewed four former students, representatives of Generation 2 who were established researchers and had trained students of their own who were active in the field. To represent Generation 3, we solicited lists of laboratory alumni from the Generation 2 scientists and identified former students who were actively working in the domain and had already begun training students themselves. In each lineage, we interviewed six to eight G3s. In selecting Generation 2 and 3 candidates, we favored the clearest instances of authentic apprenticeships. That is, most of those interviewed had pursued their graduate training or a multiyear research fellowship with a lineage member. Who, if anyone, a given representative of Generation 2 or 3 actually saw as a primary influence, and how he or she related to the "expected mentor," could not be known prior to the interview, however. The resulting variability in students' actual experiences allowed us to compare strong mentoring relationships to weaker ones and to assess how well the same mentor met the needs of different students.

In all, we interviewed the three lineage heads in Generation 1 (G1s), twelve members of Generation 2 (G2s), and twenty-one members of Generation 3 (G3s). We employ pseudonyms to protect the identities of the G2s and G3s. The representatives of Generation 2 worked at research institutions, including Princeton, University of Chicago, Yale, Stanford, and University of Washington, all of which house leading programs in the geneticists' respective areas. Their G3 students thus completed their training in elite programs. These students had established their own labs, and many had already made significant scientific contributions; however, at their comparatively early career stage, most were working at less prestigious institutions than their mentors. Figure 1.1 shows the sample, in schematic form, highlighting the lineage structure. There were thirty-six participants: thirteen from the cell biology lineage, eleven from the medical genetics lineage, and twelve from the population genetics lineage—twenty-four men and twelve women.

Concerning gender representation, the lineage heads are all male. This reflects the prevalence of men within the leading ranks of science in the historical cohort from which the lineage heads were drawn. In addition, all of the senior scientists who met the study's third sampling criterion for G1s, the training of a cadre of students who went on to become active scientists with students of their own, were male. This was true even though we solicited nominations from scholars in science and gender studies in an effort to identify both male and female candidates. However, one lineage head mentored many successful female scientists, and women comprise 50 percent of Generation 2.

Data were collected in a single, face-to-face, audiotaped interview, about two and a half hours in length, conducted by one or two researchers. The semistructured interview was designed to establish the participant's current guiding values, goals, and practices; key formative influences on his or her development as a scientist; the impact of the most influential person during the participant's formal training; and any obstacles or pressures encountered during the participant's career that may have caused his or her goals, commitments, and practices to evolve after the relationship with the mentor. We then investigated what the participant sought to convey to the next generation, and how he or she did so—in other words, the interviewee's own practices as a mentor. Finally, we probed for societal concerns and community involvements extending beyond the domain of genetics. Efforts were made to design an interview schedule that did not influence participants to describe their own approach to science in terms of the expected mentor's

Figure 1.1 Sample Structure for the Three Mentoring Lineages



values and practices. Interviewees first described their own approach to science and only afterward were asked about formative influences, including the relationship with the individual who was a member of the lineage.

This research design allowed expanding dramatically the scope of previous studies of mentor-student relationships, by permitting us to compare: the memes possessed and inherited by different generations within a lineage; the memes passed down in one lineage but not another; and for selected labs, the different perceptions of the same training environment held by mentors and students. In addition, we were able to draw on the testimonies of multiple students to inform us about the values, practices, and teachings of a single mentor, enhancing the accuracy of our findings.

This was a purposive sample, focusing on best-case examples of what we call *good workers*, who, in addition, had trained a cadre of students and therefore had the opportunity to pass their memes down. In addition, we selected former students who had significant exposure to the lineage heads. However, we did not know the nature of any given relationship or the extent to which a lineage head's memes would or would not be transmitted to subsequent generations. We speculated that some of their memes would be passed on to their own students, but we did not know which ones, and we had no evidence about the likelihood of transmission to a third generation. We hoped that selecting best-case lineage heads would make it possible to address several key questions about the mentoring process, if observed: How, or by what pathways or means, were memes—especially those encouraging good work—passed down to subsequent generations? What were the characteristics of mentoring relationships that fostered the transmission of memes? Each interview was coded and analyzed with these questions in mind. In the chapters that follow, we report what was learned.

We give a full description of how the study was conducted in the appendixes. We provide a brief overview of the coding and data analysis in Appendix A, the interview protocol in Appendix B, and the coding scheme in Appendix C. Here, we limit ourselves to noting that a meme counted as "transmitted" from one generation to the next if an interviewee explicitly stated or clearly suggested that his or her possession of the meme had been influenced by the mentor within the lineage.

Before proceeding to the book's organization, it would be helpful to clarify two points that may invite misunderstanding. First, do we mean to imply that virtues and values, or other memes, are inherited in the same way as eye or hair color? No. The language of *transmission*, *memes*, and *inheritance* is not meant to suggest a unidirectional process in which the individual passively receives values, beliefs, and knowledge. The terminology is useful shorthand, making it possible to refer collectively to the diverse kinds of intergenerational inheritance; it also highlights the intimate relationship between the proximal interactions of mentor and student on the one hand, and the broader sweep of sociocultural evolution on the other. In fact, the study's findings are consistent with constructivist perspectives on social learning, such as that of the Russian psychologist Lev Vygotsky (for example, Vygotsky, 1978). Such theories recognize that learning is an inherently social-interactive process, and the learner actively constructs the knowledge and attitudes that he or she acquires.

Second, are we suggesting that an individual's approach to professional life—especially the moral compass that guides conduct in ambiguous or difficult situations—is traceable solely or primarily to the influence of mentors encountered during graduate or professional training? Again, the answer is no. Early experiences within the family and community undoubtedly play an important role, particularly in shaping basic values. Mentors encountered before and after entry into the profession may also be formative, and many practitioners have multiple influential mentors during the course of their training years.

The Organization of the Book

Part One of the book (Chapters Two through Four) presents case studies of each of the three lineages. Part Two (Chapters Five through Seven) summarizes what the interviews revealed about the transmission of knowledge, practices, and values across generations, drawing on all three of the lineages simultaneously. Finally, Part Three (Chapters Eight and Nine) summarizes the key lessons learned and draws out some of the implications for practitioners and researchers. We here briefly describe each chapter.

Part One

Like E. O. Wilson, Stephen J. Gould, and other scientists who have communicated the wonders of nature and the joys of scientific discovery to non-scientists, Joseph Gall is a naturalist—he has been drawn to the natural world as long as he can remember. His career as a biologist grew organically out of this lifelong passion, and he continues to conduct his own experiments today, a rarity in a time when most successful scientists leave the bench by midcareer to become lab administrators. He is a model of professional integrity, fairness, and honesty. Facilitated by his mentoring, many of his students, including a remarkable number of women, became professors at elite universities. Moreover, so did many of *their* students. How did the process of intergenerational influence occur? Was Gall's integrity and love of science visible to his students? Did he actively try to kindle a passion for science or a sense of integrity in his students? How did he foster the development of successful female scientists in an era when men dominated the discipline? A description of the Gall lineage is presented in Chapter Two.

Arno Motulsky is an emeritus professor of medical genetics and genome sciences. From his origins in prewar East Prussia, Motulsky spent his youth evading Nazi capture. When he and his family finally reunited in the United States, he pursued a career in medicine with a sense of maturity and mission beyond his years. When he was subsequently offered the opportunity to create a program in medical genetics, Motulsky did not hesitate to embark on a career in the still little-known field. He was attracted by the opportunity to work on cutting-edge scientific problems while at the same time applying scientific insights to the treatment of individual patients. In his work, he has bridged the gap between science and medicine and has taken seriously the ethical charge to use scientific knowledge to benefit the lives of individuals. Motulsky is an exemplary physician-scientist. How did Motulsky's values and practices influence the students and medical fellows who worked with him, as well as a third generation of physician-scientists? What was the impact of his extraordinary life and example on his students? Was he able to pass on the deep concern for humanity that has characterized his approach? Such questions are addressed in the context of a portrait of the Motulsky lineage in Chapter Three. In addition, this case study examines how a former student not only emulates the values and practices of the lineage head, but also modulates and adds to them.

One of the world's leading evolutionary geneticists and professor of zoology at Harvard University is Richard Lewontin, whose brilliance as a scientist has been matched only by his reputation as a social critic with a Marxist outlook and socialist values. While earning his doctorate in the 1950s, Lewontin was mentored by the leading population geneticist of his time, Theodosius Dobzhansky. The Russian-trained Dobzhansky was known as a moralist—someone who "knows what is right" and has strong moral convictions. Lewontin enjoyed a privileged relationship with Dobzhansky and regarded him as a moral exemplar in many respects. Lewontin's socialist politics were tightly linked to a set of distinctive professional practices. How did his political views influence his practices as a mentor? Did he influence his students' political views, their approach to science, or both? Chapter Four provides a portrait of the Lewontin lineage and a vivid illustration of students' selective responsiveness to an admired mentor's characteristics—in this case, political and scientific beliefs.

Part Two

What values and practices characterize the three exemplars of good work, and to what extent have any of these memes survived them, shaping future generations? Each lineage head discussed practices, values, or goals that the other two senior scientists did not. In Chapter Five, we explore whether these memes differentially characterized the lineage that a scientist headed, which would provide evidence that signature variants of good work can be propagated through multiple generations of mentor-student relationships. In addition, we examine whether memes supporting good work that are shared by all three lineage heads have come to characterize all of the lineages. If so, it may be that some principles of good work are more universally supported through mentoring relationships. In this chapter, we also identify which memes were transmitted most often and which least often, and discuss the implications for the perpetuation of professional excellence and ethics.

How are values and practices taught and learned? In Chapter Six, we describe the pathways by which mentors influence their students. The popular image of mentoring is that of an intense, sustained, multifaceted dyadic interaction, as exemplified by Niels Bohr's exchanges with the young scientists who visited his institute. In the apprenticeships we studied, mentors interacted with their students, but to a great extent the Bohr model did not pertain. Through what means, then, did good mentoring occur? Chapter Six describes the key pathways by which values, knowledge, and practices were transmitted from one generation to the next.

Mentoring relationships can be fraught with challenges. What were the most common relationship difficulties that we discovered in our sample? We discuss these in Chapter Seven, before turning to the characteristics of positive relationships. We found that successful mentoring relationships were facilitated by students' initial admiration for their mentors. Beyond this power of attraction, the defining quality of positive mentor-student relationships was support, which proved to be multifaceted in graduate school. This chapter describes the multiple dimensions of support found in strong mentoring relationships, drawing on the perspectives of both mentors and apprentices.

Part Three

In Chapter Eight, we reflect on some of the book's central findings and discuss questions and issues that they raise. We consider the evidence for whether mentors can have a significant impact on the professional values and practices of their students, and if so, how. Also, each mentor possesses a signature approach to science. Do these values and practices survive across multiple generations? What conclusions can be drawn concerning pathways of influence and the characteristics of mentoring relationships?

We end by suggesting in Chapter Nine how the lessons drawn might be used by prospective mentors, mentees, and their institutions in the sciences and other professions. For example, all successful professionals face extraordinarily heavy demands on their time. How can they make the time to mentor well without burning out? We also identify some of the most promising lines of inquiry that the investigation opens up. The lineage heads are exceptional scientists and mentors. Does this mean that good mentoring is the sole province of paragons? The stakes are high, and the role of mentoring is potentially great for the teacher, the student, and the future of the professions.

Reflecting on Mentoring

We hope this book will inspire those responsible for graduate and professional education to appraise systematically their own practices and examine reflectively the type of mentoring that is worth embracing. Were one's practices consciously chosen and critically examined, or did they develop haphazardly, outside awareness? What conditions and motives drive one's work with students? Are one's practices effective? Our hope is that readers will come to see mentoring as more than an assumed skill and an invisible process, and will instead treat it as a crucial and creative endeavor benefiting from analysis, refinement, and dialogue among practitioners. We also hope this book will help students appreciate, and take into account, how a prospective mentor may lastingly shape the kind of professional they become over and above the knowledge, skills, and resources conferred on them.