MENTORING POLICIES TO INCREASE WOMEN'S PARTICIPATION IN COMMERCIAL SCIENCE

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Introduction

Despite recent advances, women remain underrepresented in scientific fields. Increasing women's participation requires careful interventions by individuals, institutions, and government agencies.[1] The history of women's struggles in science shows that social and economic forces shape women's opportunities in academic science.[2] Even today, women continue to face significant barriers in science. First, female scientists, like other female professionals, face the problem of integrating work and family.[3] Second, discrimination in school admissions, in hiring and promotions, and in equal pay show that a glass ceiling for women persists.[4] Discrimination against women is often no longer blatant but subtle; unconscious social barriers work against women's success in academic culture.[5] Finally, the growing phenomenon of the dual-career academic couple can make it difficult for women in such relationships to seize career opportunities as they arise.[6] The dual-career academic couple affects women's careers

1. Londa Schiebinger, *Introduction*: *Getting More Women into Science and Engineering-Knowledge Issues*, *in* Gendered Innovations in Science and Engineering 1, 6 (Londa Schiebinger ed., 2008).

2. "[W]omen were excluded from modern universities from their founding in the twelfth century until the end of the nineteenth century. . . . Women embarked on modern careers in science after the women's movements of the 1870s and 1880s propelled them into universities. . . . By the 1920s . . . women earn[ed] 14 percent of doctorates in the physical and biological sciences. Between 1930 and 1960, however, the proportion of women PhDs plunged as a result of the rise of fascism in Europe, the Cold War, and McCarthyism in the United States. [W]omen did not regain their 1920s levels of participation in academic science until the 1970s." *Id.* at 6–7.

3. Christine Jolls, *Is There a Glass Ceiling?*, 25 Harv. Women's L.J. 1, 2 (2002); Rochelle Dreyfuss, Girls Just Want to Have Fun: What Can Feminist Theory Tell Us About Incentives?, Keynote Address at the Thomas Jefferson School of Law, San Diego Ruth Bader Ginsburg Lecture 2 (Feb. 9, 2007) (transcript available with the speaker).

4. *See* Jolls, *supra* note 3, at 3.

5. Ben A. Barres, *Does Gender Matter?*, 442 Nature 133, 134 (2006) (exposing the gender discrimination of a fellow Stanford University faculty member, who did not know about Barres's sex change: "Ben Barres gave a great seminar today, but then his work is much better than his sister's."); Schiebinger, *supra* note 1, at 10–11 (noting that people's "subtle, unconscious cultural biases" make it "more difficult for women than for men to succeed within universities and laboratories").

6. Laurie McNeil & Marc Sher, *The Dual-Career-Couple Problem*, Physics Today, August 1999 Part 1, at 32, (1999) (noting that the challenges of finding two professional jobs in a single location can lead to one partner settling for a lesser job, and may lead to some women leaving their fields altogether).

more than men's careers because "[w]omen are more likely than men to have academic partners."[7]

Today, commercial science represents a realm where scientists have new opportunities to gain recognition and reward.[8] Commercial science can be broadly defined as scientific or academic entrepreneurship whose focus is to produce a marketable product, while the focus of academic science is to produce scientific knowledge.[9] Unfortunately, research shows that gender inequity exists even in this increasingly popular field.[10] Public policy decisions should strive to increase gender equity in commercial science. Now is the time to implement policies to address gender disparity—when the relatively new field of commercial science is still being shaped.

Because many factors contribute to current gender inequity in science, no single solution will likely address all the causes of gender inequity. However, legislation and public policy that promote relationship-building, which includes mentoring and developing diverse networks, can be instrumental in increasing gender equity. Because mentoring has historically been a male phenomenon, institutional efforts that increase effective mentoring for women can improve women's participation in commercial science. While researchers have suggested mentoring as a solution,[11] current research has failed to thoroughly analyze the characteristics of mentoring that will effectively increase women's participation and success in commercial science. This Note undertakes that task and also analyzes other institutional policies that can decrease the gender gap. Part I discusses the reasons for promoting gender equity in science. Part II defines commercial science and provides explanations for the rapid growth of this new realm. Part III discusses the evidence for the existence of a gender gap in commercial science. Part IV discusses the issues that effective relationship-building programs must address in order to de-

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7. Londa Schiebinger et al., *Dual-Career Academic Couples: What Universities Need to Know* 13 (2008), http://www.stanford.edu/group/gender/ResearchPrograms/DualCareer/DualCareerFinal.pdf.

8. *See* Waverly W. Ding et al., *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCIENCE 665 (2006).

9. *See* Waverly W. Ding et al., Commercial Science: A New Arena for Gender Differences in Scientific Careers? 1 (2009) (unpublished manuscript, available at http://escholarship.org/uc/item/0m0877rr) [hereinafter New Arena]; Brian R. Shmaefsky, *Tangent Worlds: Academic Science vs Commercial Science,* ACTIONBIOSCIENCE.ORG, Aug. 2002, http://www.actionbioscience.org/education/shmaefsky.html.

10. New Arena, *supra* note 9, at 5.

11. Fiona Murray & Leigh Graham, *Buying Science and Selling Science: Gender Differences in the Market for Commercial Science*, 16 INDUS. AND CORP. CHANGE 657, 680 (2007).

crease the gender gap in commercial science. Finally, Part V explores other institutional policies that can promote women's success in commercial science.

I.
Rationale for Promoting Gender Equity in Science

Increasing women's participation in commercial science is important for equity reasons. As an initial matter, commercial science has become a growing source of income for many scientists. Female scientists, if they have fewer opportunities for commercial work available, will likely earn less income than male scientists as a result.[12] Perhaps more importantly, scientists who participate in commercial science receive non-monetary benefits, including "exposure to (unpublished) research in corporate labs, access to state-of-the-art laboratory equipment, and job leads for graduate students."[13] Because of the importance of participation in commercial science to a scientist's career, women should have equal opportunities for exploring such commercial work as men.

Not only is increasing women's participation in commercial science important for equity reasons, but it will also allow society to (1) fully utilize its intellectual capital to solve the problems of the twenty-first century, (2) address issues and problems that affect women disproportionately, and (3) improve science and promote innovation.

First, society must capitalize on the intellectual potential of all scientists, including female scientists. Women have shown their ability to develop significant innovations in various scientific fields. To list just a few innovations, Dr. Jocelyn Bell discovered the pulsar, a celestial object; women invented the Mars rover and the space suit; Dr. Gertrude Elion developed immunosuppressants that made lifesaving transplants possible; and Dr. Janet Rideout, along with other inventors, developed azidothymidine (AZT) as a treatment for acquired immune deficiency syndrome (AIDS).[14] The current challenges facing science and medicine, such as population growth and the increasing number of elderly people in the United States,[15] compel us to

12. New Arena, *supra* note 9, at 2.

13. *Id.*

14. Ethlie Ann Vare & Greg Ptacek, Patently Female: From AZT to TV Dinners, Stories of Women Inventors and Their Breakthrough Ideas 91–94, 153–158, 160 (2001).

15. *See* A Broken Pipeline? 3 (2008) (noting that the U.S. population is "expanding and aging and, even while treatment outcomes are improving, the societal burden of chronic disease grows ever greater") http://www.brokenpipeline.org/brokenpipeline.pdf.

maximize the potential of all researchers. Increasing globalization has "begun to challenge the longstanding scientific pre-eminence of the United States and, therefore, its economic leadership."[16] To solve the problems of the twenty-first century and to maintain our nation's competitive edge globally, society needs to fulfill the potential of female scientists.[17]

Promoting gender equity in science will solve problems that disproportionately affect women. Recently, increased female participation in scientific research led to a revolution in women's healthcare in the United States.[18] Before 1993, scientists usually tested drugs on men and generalized those results to women, which resulted in women suffering from adverse drug reactions twice as often as men.[19] As a result of the women's healthcare revolution, it became apparent that using non-representative populations "is simply bad science."[20] The NIH Revitalization Act of 1993 mandated that women be included in clinical drug trials.[21] This act along with the establishment of the Office of Research on Women's Health[22] drastically improved women's healthcare. The women's healthcare revolution illustrates how women's participation can improve scientific methods and promote healthcare innovation. Other scientific fields—biology, medicine, archaeology, and primatology, to name a few—have been similarly improved by increased female participation.[23] We should learn from the history of women's participation in science and apply those lessons to the new field of commercial science. We must "capitalize on women's intellectual capital"[24] and give women the chance to seize new opportunities for discovery and progress in commercial science. Increasing women's participation in commercial science will benefit both men and women and promote scientific innovation.

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16. NAT'L ACAD. OF SCI. ET AL., BEYOND BIAS AND BARRIERS: FULFILLING THE POTENTIAL OF WOMEN IN ACADEMIC SCIENCE AND ENGINEERING 13 (2007).

17. *See* Janet Bickel et al., *Increasing Women's Leadership in Academic Medicine: Report of the AAMC Project Implementation Committee*, 77 ACAD. MED. 1043, 1044, 1049, 1053 (2002).

18. Schiebinger, *supra* note 1, at 16.

19. *Id.*

20. *Id.*

21. National Institutes of Health Revitalization Act of 1993, Pub. L. No. 103-43, 107 Stat 122.

22. Schiebinger, *supra* note 1, at 16.

23. *Id.* at 21.

24. *See* Page Morahan & Janet Bickel, *Capitalizing on Women's Intellectual Capital in the Professions*, 77 ACAD. MED. 110, 112 (2002).

II.
The Growth of Commercial Science

A. *Evidence for the Growth of Commercial Science*

Commercial science is scientific or academic entrepreneurship.[25] Although it is not a new phenomenon, the scientific community has traditionally discouraged participation in commercial science.[26] Today, participation in commercial science is no longer an anomaly. In fact, it represents an important aspect of university scientists' work. Commercial science includes activities by university scientists such as 1) patenting;[27] 2) establishing for-profit biotechnology companies; and 3) serving as members of scientific advisory boards (SABs).[28]

Evidence shows an increase in all aspects of commercial science activities in the past few decades. First, the number of patents issued to universities has risen dramatically. In 1965, fewer than 100 U.S. patents were granted to twenty-eight U.S. academic institutions.[29] By 1992, there was a fifteen-fold increase in the number of patents granted: almost 1500 patents were granted to over 150 academic institutions.[30] This dramatic increase continued through the 1990s; in 1998, universities received more than 3000 patents.[31] Second, venture capital investments in biotechnology companies have increased in recent years, from $6.7 billion in 2002 to $11.6 billion in 2007.[32] Fi-

25. New Arena, *supra* note 9, at 1.

26. *See* Henry Etzkowitz, *The Norms of Entrepreneurial Science: Cognitive Effects of the New University-Industry Linkages*, 27 Res. Pol'y 823, 823–24 (1998) (citing entrepreneurial activities by seventeenth century and nineteenth century scientists, but noting the traditional scientific culture's discouragement of profit-making motives).

27. A recent study of commercial science also analyzes patenting by industrial scientists, Kjersten Bunker Whittington & Laurel Smith-Doerr, *Gender and Commercial Science: Women's Patenting in the Life Sciences*, 30 J. of Tech. Transfer 355, 360 (2005), but this note will focus only on patenting by university scientists.

28. SAB members can have different responsibilities depending on the company, but "at a minimum they are expected to attend board meetings and be available to provide confidential advice to company personnel on scientific matters." SAB members usually receive annual stock grants, and often actively consult with the company. Toby E. Stuart & Waverly W. Ding, *When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences*, 112 Am. J. Soc. 97, 112 n.13 (2006).

29. Paula E. Stephan et al., *Who's Patenting in the University? Evidence from the Survey of Doctorate Recipients*, 16 Econ. Innovation & New Tech. 71, 72 n.1 (2007).

30. *Id.*

31. *Id.*

32. Technology, Talent and Capital: State Bioscience Initiatives 2008 36–37 (2008), http://www.bio.org/local/battelle2008/State_Bioscience_Initiatives_2008.pdf.

nally, serving on scientific advisory boards remains an important activity in today's research community.[33]

During the past three decades, universities have undergone a revolution that incorporates commercial science as part of their mission. This has culminated in "technology transfer,"[34] or the trade of viable technology between industry and university. Technology transfer can involve the following:

> 1) the product originates in the university but its development is undertaken by an existing firm,
> 2) the commercial product originates outside of the university, with academic knowledge utilised to improve the product, or
> 3) the university is the source of the commercial product and the academic inventor becomes directly involved in its commercialization through establishment of a new company.[35]

Elite universities like the Massachusetts Institute of Technology and Stanford University have made millions from taking equity stakes in companies and from licensing agreements.[36] Other universities have followed the lead.[37] Many state and local governments act as funding centers to encourage universities themselves to generate new economic activity.[38] Not only are universities encouraging entrepreneurship among students and faculty, they are also building programs to increase the number and success of technology-licensing deals.[39] For example, the University of Southern California has focused on turning university research projects into profit-making companies.[40] The benefits of these technology-licensing deals are to "make money for students, faculty, and universities and [to] create broad economic benefits in society."[41]

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33. *See* Stuart & Ding, *supra* note 28, at 122.

34. *See* Etzkowitz, *supra* note 26, at 827.

35. *Id.*

36. Rebecca Buckman, *More Universities Increasing Support For Campus Start-Ups*, WALL ST. J., Nov. 27, 2006, at B1.

37. The Milken Institute ranks U.S. and Canadian universities for success in commercialization and in technology transfer based on factors such as patents issues, licensing income, and start-ups created. Rankings of the universities based on 2000–2004 data are: 1) Massachusetts Institute of Technology; 2) the University of California system; 3) California Institute of Technology; 4) Stanford University; 5) University of Florida; 6) University of Minnesota; 7) Brigham Young University; 8) University of British Columbia; 9) University of Michigan; 10) New York University. *Id.*

38. Etzkowitz, *supra* note 26, at 831.

39. Buckman, *supra* note 36.

40. *Id.*

41. *Id.*

The trend of commercialization is most notable in the life sciences,[42] which have become the "primary locus of university technology transfer."[43] Commercialization occurs in the life sciences because the field engages in not only basic research but also applied research,[44] and applied research translates more easily to industry. Other fields that have a strong emphasis on applied research, such as engineering, are also more receptive to patent protection.[45] Fields without such an emphasis on applied research, such as theoretical particle physics, have low rates of patenting.[46] Researchers working in the biomedical field account for a majority of both the issued patents and the revenues resulting from innovation at most universities[47] partly because the medical/clinical setting includes more applied versus basic research.

Life sciences faculty have increased participation in all aspects of commercial science. First, rates of patenting by faculty in the life sciences have increased dramatically.[48] Second, academic scientists' involvement in for-profit companies has risen since the 1970s.[49] A study of faculty authors in fourteen biomedical journals found that one third of the articles included at least one author who held patents, an equity position, or an advisory position in a biotechnology firm related

42. Life science is "a broad field that studies life. [It c]ontains many other fields of study like biochemistry, botany, cell biology, genetics, [and] molecular biology. Life Science Definition, http://www.biochem.northwestern.edu/holmgren/Glossary/Definitions/Def-L/life_science.html (last visited Nov. 2, 2009). The life sciences also include medical science, biochemical engineering, and bioengineering. Murray & Graham, *supra* note 11, at 658 n.1.

43. New Arena, *supra* note 9, at 3–4; *see also* Walter W. Powell & Jason Owen-Smith, *Universities and the Market for Intellectual Property in the Life Sciences*, 17 J. POL'Y ANALYSIS & MGMT. 253, 258–259 (1998).

44. Basic research consists of "systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind." OFFICE OF MGMT. & BUDGET, EXECUTIVE OFFICE OF THE PRESIDENT, OMB CIRC. NO. A-11 § 84, at 8 (2008). Applied research consists of "systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met." *Id.*

45. Stephan et al., *supra* note 29, at 8.

46. *Id.* Of course, basic researchers do sometimes patent. For example, a patent was granted for a process generating light of a particular wavelength, the serendipitous result of a basic research project in the field of astrophysics. *Id.* at 8, n.13; Jeanette Colyvas et al., *How Do University Inventions Get Into Practice?*, 48 MGMT. SCI. 61, 69 (2002).

47. Stephan et al., *supra* note 29, at 8.

48. New Arena, *supra* note 9, at 4; Whittington & Smith-Doerr, *supra* note 27, at 356.

49. New Arena, *supra* note 9, at 3.

to their research.[50] Academic scientists founded approximately half of the original publicly traded biotechnology firms that still exist today.[51] Finally, academic scientists continue to be scientific advisors to nearly all of those biotechnology firms.[52]

B. Why Are Science and Industry Embracing Commercial Science?

1. The Legal and Commercial Landscape

Federal legislation has facilitated the growth of commercial science by promoting universities' commercial involvement and industrial firms' increased reliance on academic science. Most importantly, the Bayh-Dole Act of 1980[53] permitted universities to receive patents and grant licenses, including exclusive licenses, on patents that arose from federally funded research.[54] Before Bayh-Dole, patents funded by federal research were assigned to the federal government, who could grant commercial entities non-exclusive licenses to the patented item.[55] The previous system failed because it did not make economic sense for companies to obtain a non-exclusive license.[56] The goal of the Bayh-Dole Act was to incentivize universities to commercialize inventions from federally funded research and to more quickly bring the benefits of university research to consumers.[57] The Act encouraged universities to develop technology transfer relationships with industry.[58]

Critics argue that the patenting and licensing activity made possible by the Bayh-Dole Act restricts the dissemination of academic research, and attempt to show a positive correlation between faculty's commercialization efforts and their denial of requests by other scientists for research results.[59] However, while commercial activity may

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50. S. Krimsky et al., *Scientific Journals and Their Authors' Financial Interests: A Pilot Study*, 67 PSYCHOTHERAPY AND PSYCHOSOMATICS 194, 198 (1998).

51. New Arena, *supra* note 9, at 4.

52. *Id.*

53. Pub. L. No. 96-517, 94 Stat. 3015.

54. Whittington & Smith-Doerr, *supra* note 27, at 356; Stephan et al., *supra* note 29, at 2.

55. COUNCIL ON GOVERNMENTAL RELATIONS, THE BAYH-DOLE ACT: A GUIDE TO THE LAW AND IMPLEMENTING REGULATIONS (1999), http://www.ucop.edu/ott/bayh.html.

56. Carmen J. McCutcheon, *Fairplay or Greed: Mandating University Responsibility Toward Student Inventors*, 2003 DUKE L. & TECH. REV. 26, 1 (2003).

57. Matthew Rafferty, *The Bayh-Dole Act and University Research and Development*, 37 RES. POL'Y 29, 29 (2008).

58. *Id.*

59. David Blumenthal et al., *Withholding Research Results in Academic Life Science: Evidence from a National Survey of Faculty*, 277 J. AM. MED. ASS'N 1224, (1997); Karen Seashore Louis et al., *Entrepreneurship, Secrecy, and Productivity: A*

be correlated with secrecy, it is not clear that commercial activity *causes* secrecy. The tendency to deny colleagues access to information appears more closely associated with issues of scientific priority: scientists compete to be the first to publish.[60] To the extent that this secrecy is a problem, researchers believe that it would continue to exist even without licensing.[61]

Additional criticism—namely, that the Bayh-Dole Act has decreased the quality of university patents and decreased basic science research—also fails. These critics argue that the potential financial returns from licensing the results of federally funded research have diverted faculty from basic to applied science research.[62] A decreased emphasis on basic science would perversely slow scientific progress, thus hurting consumers even though discoveries are more quickly commercialized.[63] However, evidence suggests that financial incentives are not diverting faculty from basic to applied research.[64] First, recent research suggests that any changes in university research activity started before the passage of the Bayh-Dole Act, challenging the criticism that the Act has decreased emphasis on basic science research.[65] Emerging technological possibilities associated with the rise in biomedical research during the 1970s may actually be the main factor causing changes in the patenting and research and development behavior of universities.[66] A survey of firms that license from universities suggests that the main reason for increased collaboration with

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Comparison of Clinical and Non-Clinical Life Sciences Faculty, 26 J. TECH. TRANSFER 233, 238–39 (2001).

60. *Id.* at 1226.

61. *See* Jerry G. Thursby & Marie C. Thursby, *University Licensing and the Bayh-Dole Act*, 301 SCIENCE 1052 (2003) (noting that the problem of secrecy "is more likely related to research that is company sponsored rather than federally funded").

62. Rebecca Henderson et al., *Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988*, 80 REV. ECON. & STAT. 119; Tom Coupé, *Science is Golden: Academic R&D and University Patents*, 28 J. TECH. TRANSFER, 31 (2003).

63. Rafferty, *supra* note 57, at 29.

64. *Id.* at 39 (finding data more consistent with the theory that changes in university behavior resulted from other changes to the technological landscape of biomedical and pharmaceutical research in the 1970s); Thursby & Thursby, *supra* note 61.

65. David C. Mowery et al., *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980*, 30 RES. POL'Y 99, 104, 116 (2001) (suggesting that the Bayh-Dole Act did not cause the dramatic increase in university patent activity but simply accelerated and amplified trends that already were occurring).

66. *Id.* at 108–14 (showing that patent activity at the University of California and Stanford University increased in the 1970s with the growth of biomedical and pharmaceutical research); Rafferty, *supra* note 57, at 39 (finding that a shift toward more basic research and development and toward greater industry financing started during the 1970s, before the Bayh-Dole Act).

universities was receptivity to licensing, rather than an increase in faculty research in applied science.[67] Also, after correcting for truncation bias,[68] studies conclude that the quality of university patents has not declined since Congress passed the Bayh-Dole Act.[69] Finally, the increased licensing activity may actually be consistent with universities' ongoing basic research efforts because most licensing occurs for basic research.[70] Overall, without the Bayh-Dole Act, certain technologies would not have been commercialized.[71] Faculty involvement in further developing university technologies is an important element in commercializing technologies.

In addition to the Bayh-Dole Act, other changes in the legal landscape made conditions ripe for the commercialization of science. The landmark Supreme Court decision *Diamond v. Chakrabarty* established that bioengineered life forms constitute patentable subject matter, making more forms of biological research protectable and thus promoting research.[72] Next, in 1983, Congress created the Court of Appeals for the Federal Circuit, which changed the appeals process for patent cases.[73] The goal of the Federal Circuit was to "streamline the resolution of patent disputes which should reduce the uncertainty involving patent rights."[74] A combination of the Federal Technology

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67. Jerry G. Thursby & Marie C. Thursby, *Who Is Selling the Ivory Tower? Sources of Growth in University Licensing*, 48 MGMT. SCI. 90, 101–102 (2002).

68. Truncation bias is bias caused by analyzing a short time span, which causes patents to appear to be low quality "because not enough time has passed for researchers to cite the patent." Rafferty, *supra* note 57, at 30.

69. David C. Mowery & Arvids A. Ziedonis, *Academic Patent Quality and Quantity Before and After the Bayh-Dole Act in the United States*, 31 RES. POL'Y 399, 414–15 (2002) (finding that the importance and generality of patents from the University of California and Stanford University did not decline significantly after the Bayh-Dole Act if one considers a longer time span of data); Bhaven N. Sampat et al., *Changes in University Patent Quality After Bayh-Dole: A Re-Examination*, 21 INT'L J. INDUS. ORG. 1371, 1388 (2003) (finding that patent quality does not decline after accounting for truncation bias and changes in the temporal distribution of patent citations).

70. Rafferty, *supra* note 57, at 30; Thursby & Thursby, *supra* note 61 ("Our study of over 3400 faculty at six research universities from 1983 to 1999 suggests that the portion of research that was basic has not changed even though licensing increased by a factor greater than 10.").

71. Intellectual property rights help universities to commercialize "embryonic" inventions, which require further development. *See* Colyvas et al., *supra* note 46; Thursby & Thursby, *supra* note 61.

72. 447 U.S. 303, 318 (1980).

73. Rafferty, *supra* note 57, at 39.

74. *Id.*

Transfer Act of 1986[75] and the National Technology Transfer Competitiveness Act of 1989[76] encouraged the industrial sector to partner with universities and federal laboratories to commercialize federally funded research.[77]

In addition to the Bayh-Dole Act and other legislative changes discussed above, the Economic Recovery Tax Act of 1981 gave tax credit to for-profit firms that funded university science.[78] Backed by legislative support and the growth of biotechnology, the investment community became interested in sponsoring biotechnology firms: the initial public offering (IPO) of Genentech, in 1984, set a record for the fastest increase in stock price for an IPO.[79] Venture capitalists now advise future scientific entrepreneurs that the best way to initiate a company "is to remain on campus and work with students to develop the early stages of their technology," further linking the private sector with academia.[80]

2. *The Scientific Landscape*

Even though conditions have been ripe for the commercialization of science, the question remains why scientists themselves have decided to pursue commercial science. Because the norms of science traditionally condemned profit-making motives,[81] scientists initially viewed commercialization as fundamentally incompatible with their norms. According to Robert Merton's description of the sociology of science, scientists form a self-regulating community that openly shares information and extends knowledge within itself,[82] norms reinforced and perpetuated by example and by graduate training programs.[83]

Analyses of scientists show that Merton's formulation of the scientific norms does not represent how scientists actually behave.[84] The

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75. Pub. L. No. 99-502, 100 Stat. 1785 (allowing government researchers to collaborate directly with industry, just as university researchers do under the Bayh-Dole Act).

76. Pub. L. No. 101-189, 103 Stat. 1352 (making technology transfer a mission of government-owned, contractor-operated laboratories and their employees).

77. Annetine C. Gelijns & Samuel O. Thier, *Medical Innovation and Institutional Interdependence: Rethinking University-Industry Connections*, 287 J. AM. MED. ASS'N 72, 73 (2002); Margot Carmichael Lester, *Government Funding Spurs Private Innovation*, LARTA.ORG (2003) (on file with author).

78. Pub.L. 97-34, 95 Stat. 172; Whittington & Smith-Doerr, *supra* note 27, at 356.

79. The stock price increased from thirty-five dollars at offering to eighty-nine dollars in only twenty minutes. New Arena, *supra* note 9, at 26.

80. Etzkowitz, *supra* note 26, at 831.

81. *Id.* at 824.

82. *See* Stuart & Ding, *supra* note 28, at 100-01.

83. *Id.*

84. *Id.* at 101.

norms serve as scientific ideals rather than scientific descriptors.[85] Surely, the puzzle-solving nature of research satisfies scientists' innate curiosity and search for scientific truths, but scientists also have "an interest in winning the game," and they care about reputation and recognition.[86] Because of incentives ranking scientists based on their positions on author lists, scientists may debate over the authorship of a scientific paper.[87] The guidelines for determining scientific authorship vary depending on discipline. In some disciplines, the lead author is the individual making the greatest intellectual contribution, followed sequentially by those making progressively lesser contributions; the final-author position can be reserved for a laboratory head or project initiator.[88] Scientists even quarrel over speaker order at conferences,[89] and they fight over priority of discovery—being first is crucial to a scientist's reputation and future career.[90] Setting aside idealism, competition in the sciences is not a new phenomenon.

When university scientists first considered participation in commercial science, opponents nonetheless argued that privatizing scientific discoveries went against the scientific norms. In the early 1980s, Derek Bok, former President of Harvard University, expressed his reservations about commercial science: "[C]ommercial motives can introduce a . . . threatening form of secrecy. In order to maintain a competitive advantage that could be worth large sums of money, scientists who engage in business may be tempted to withhold information until their discoveries can be further developed to a patentable state."[91]

Elite scientists agreed that profiting directly from research findings was not appropriate conduct for academic scientists. For instance, scientists Georges Köhler and César Milstein, who received the Nobel Prize in Physiology or Medicine in 1984 for developing

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85. *See id.*

86. *See* Stephan et al., *supra* note 29, at 73.

87. *See Games People Play with Authors' Names*, 387 NATURE 831 (2006).

88. William F. Laurance, *Second Thoughts on Who Goes Where in Author Lists,* 422 NATURE 26 (2006); *see Games People Play with Authors' Names*, *supra* note 87 (alphabetical listing "reduces scope for debates about credit," but the scientist whose name appears first still reaps the advantage of that recognition).

89. Stephan et al., *supra* note 29, at 73.

90. *See id.*

91. DEREK CURTIS BOK, BEYOND THE IVORY TOWER: SOCIAL RESPONSIBILITIES OF THE MODERN UNIVERSITY 150 (1982).

monoclonal antibody technology,[92] dismissed patenting. They believed that it would be "inappropriate" to patent the technique.[93]

Although scientists were at first hesitant to participate in commercial science, they changed their minds. Early critics of commercial science, perhaps influenced by the changes to the legal and commercial landscape discussed above, began to embrace it. For example, Nobel Prize winner Joshua Lederberg decided to combine his research with financial reward.[94] Nobel Prize winner Arthur Kornberg surprised himself by advocating the importance of commercial science, recognizing its benefits for both science and business.[95] Stanley Cohen, one of the scientists who discovered the technique for joining and copying recombinant DNA (rDNA), was persuaded by Stanford's aggressive head of technology transfer to patent rDNA.[96] Scientists are increasingly involved in commercial science early on in their careers. One study shows that in 1970, scientists became involved in patenting approximately twelve years out of graduate school.[97] In the early 1990s, scientists became involved only five years out of graduate school—a dramatic change.[98] Moderate involvement in commercial science is now increasingly the norm.[99]

Today, scientists see the benefits to participating in commercial science. Many believe participation "increases their academic visibility and status by reaffirming the novelty and usefulness of their

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92. A monoclonal antibody is

> an antibody that is mass produced in the laboratory from a single clone and that recognizes only one antigen. Monoclonal antibodies are typically made by fusing a normally short-lived, antibody-producing B cell . . . to a fast-growing cell, such as a cancer cell . . . . The resulting hybrid cell, or hybridoma, multiplies rapidly, creating a clone that produces large quantities of the antibody.
>
> Monoclonal antibodies engendered much excitement in the medical world and in the financial world in the 1980s, especially as potential cures for cancer.

Monoclonal Antibody, http://www.encyclopedia.com/topic/monoclonal_antibody.aspx (last visited Nov. 2, 2009); *see* G. Kohler & C. Milstein, *Continuous Cultures of Fused Cells Secreting Antibody of Predefined Specificity,* 256 NATURE 495 (1975).

93. *See* Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW U. L. REV. 77, 94 (1999); Stuart & Ding, *supra* note 28, at 102–03.

94. Etzkowitz, *supra* note 26, at 823.

95. *Id.* at 823–824.

96. Sally Smith Hughes, *Making Dollars Out of DNA: The First Major Patent in Biotechnology and the Commercialization of Molecular Biology*, 1974–1980, 92 ISIS 541 (2001); Stuart & Ding, *supra* note 28, at 102.

97. Whittington & Smith-Doer, *supra* note 27, at 360.

98. *Id.*

99. Etzkowitz, *supra* note 26, at 831.

work."[100] Potential employers of scientists also believe that participation in commercial science reflects a scientist's value and productivity.[101] One 2005 study cites a university dean who expects tenure decisions to depend on academic scientists' "number of patents, number of companies . . . and the impact on the economy."[102] Whether or not that prediction is true remains unclear, but what is clear is the growing importance of commercial science to academic scientists.[103]

Many incentives induce scientists to engage in commercial science. Practically, academic scientists can receive large gains in personal wealth by engaging in commercial science.[104] Scientists also frequently explain that "monies made from commercializing their research will be applied to furthering their basic research interests."[105] Interactions with industry can provide scientists with intellectual inspiration for their academic research.[106] In one study, sixty-five percent of the scientists interviewed believed that "interacting with industry has had a positive influence on their experimental work."[107] Participation in commercial science can also lead to significant increases in research funding and better access to research equipment.[108] Finally, participation in commercial science can enhance scientists'

100. Jason Owen-Smith & Walter W. Powell, *To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer*, 26 J. TECH. TRANSFER 99, 108 (2001).

101. Whittington & Smith-Doer, *supra* note 27, at 361.

102. Daniel Lee Kleinman & Steven P. Vallas, *Contradiction in Convergence: Universities and Industry in the Biotechnology Field*, *in* THE NEW POLITICAL SOCIOLOGY OF SCIENCE: INSTITUTIONS, NETWORKS, AND POWER 35, 43 (Scott Frickel & Kelly Moore eds., 2006).

103. *See, e.g.*, Press Release, Thorp Elected Carolina's 10th Chancellor (May 8, 2008), http://www.unc.edu/chan/search/index.php. Scientist Holden Thorp's success in commercial science partly contributed to his recent selection as the Chancellor of the University of North Carolina at Chapel Hill (UNC-CH): he 1) has nineteen issued or pending U.S. patents; 2) co-founded Viamet Pharmaceuticals; and 3) serves as an advisor, co-founder, or consultant with several small companies, including Novalon Pharmaceuticals, MaxCyte, Osmetech, OhmX, and Plextronics. Before becoming chancellor-elect, Thorp was Kenan Professor of Chemistry, chair of the Department of Chemistry, and Dean of the College of Arts and Sciences. UNC-CH President Erskine Bowles described Thorp as "a brilliant scientist, a successful inventor and entrepreneur." *Id.*

104. Whittington & Smith-Doer, *supra* note 27, at 367.

105. Etzkowitz, *supra* note 26, at 827.

106. Edwin Mansfield, *Academic Research Underlying Industrial Innovations: Sources, Characteristics, and Financing*, 77 REV. ECON. & STATISTIC 55, 62–64 (1995).

107. Donald S. Siegel et al., *Assessing the Impact of Organizational Practices on the Relative Productivity of University Technology Transfer Offices: An Exploratory Study*, 32 RES. POL'Y 27, 42 (2003).

108. Stephan et al., *supra* note 29, at 75; Whittington & Smith-Doer, *supra* note 27, at 367.

prestige[109] and increase the scientist's attractiveness to prospective graduate students, post-doctorates, and other academic and industry collaborators to explore research interests.[110] Given the importance of commercial science for scientific recognition and for promoting innovation, it is important to acknowledge and correct any gender inequities that exist in this new realm. The first step is to analyze the evidence for gender inequity in commercial science.

III.
Gender Inequity in Commercial Science

A. *Evidence for Gender Inequity in Commercial Science*

The first revolution in scientific academia saw the incorporation of research into academia.[111] However, society steered female scientists into colleges that only emphasized teaching instead of also incorporating research.[112] This policy disadvantaged female scientists, who were forced to delay their research and scholarly work and had more difficulty establishing themselves as either scientists or scholars.[113] Partly due to this revolution, women had difficulty in obtaining the same scientific prestige and respect as their male peers. Today, scholars believe incorporating commercial science into academic research represents the second revolution in scientific academia.[114] Involvement in commercial science represents a new way to gain respect and success.[115] Unfortunately, this second revolution of commercial science, like the first revolution, has begun to disadvantage women.

Certainly, women have made significant progress in science. Female scientists have been graduating from U.S. colleges and universities in record numbers.[116] In 2005, women earned fifty-six percent of science bachelor's degrees, compared to forty-six percent of science bachelor's degrees in 1985.[117] In 2005, women earned forty-five percent of all science doctorate degrees, an increase from thirty-one per-

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109. Stephan et al., *supra* note 29, at 75.

110. Whittington & Smith-Doer, *supra* note 27, at 367.

111. Etzkowitz, *supra* note 26, at 833.

112. Shirley M. Clark & Mary Corcoran, *Perspectives on the Professional Socialization of Women Faculty: A Case of Accumulative Disadvantage?*, 57 J. Higher Educ. 20, 34 (1986).

113. *Id.*

114. Etzkowitz, *supra* note 26, at 832.

115. *See* Whittington & Smith-Doer, *supra* note 27, at 367.

116. *See* Michael Heylin, *Radical Changes for U.S. Science*, Chemical & Engineering News, Mar. 10, 2008, at 67.

117. *Id.*

cent in 1985.[118] One recent study even concludes that female graduate students are slightly more likely than male graduate students to attend top twenty doctorate programs, and women today are graduating to become part of the junior faculty in prestigious research universities.[119] The increase of gender equity is especially prevalent in the life sciences, and particularly biology.[120] In 2005, women earned forty-nine percent of bioscience doctorates and forty-one percent of natural science doctorates; in 1985, women only earned thirty-three percent of bioscience doctorates and twenty-five percent of natural science doctorates.[121]

Unfortunately, full recognition and reward for women in science has been slow in coming.[122] Evidence shows "that women in science still routinely receive less research support than their male colleagues, and they have not reached the top academic ranks in numbers anything like their growing presence would suggest."[123] The tenure gap has remained steady despite the increased presence of female science majors and graduate students in the past two decades.[124] At top-ranked institutions, the percentage of female full professors reaches double digits only in the social, behavioral, and life sciences; in those fields, women comprise approximately fifteen percent of full professors.[125]

Commercial science represents a complicated challenge in obtaining gender equity because it overlaps both science and industry. Not only does gender inequity exist in science, it is also well-documented in entrepreneurial ventures.[126] A recent study shows that men found new businesses at approximately twice the rate that women do.[127] Evidence concerning venture capital-backed companies is illustrative of the gender gap in industry. Growing entrepreneurial firms have been able to use increased equity financing opportunities due to

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118. *Id*.

119. New Arena, *supra* note 9, at 5.

120. *See* New Arena, *supra* note 9, at 4–5; Gerhard Sonnert & Gerald Holton, *Career Patterns of Women and Men in the Sciences*, 84 AMERICAN SCIENTIST 63, 66 (1996).

121. Heylin, *supra* note 116.

122. *See id.*

123. Cornelia Dean, *Women in Science: The Battle Moves to the Trenches*, N.Y. TIMES, Dec. 19, 2006, at F1; *see generally* Dreyfuss, *supra* note 3, at 1–3 (discussing reasons for the absence of women in fields of science and potential legal solutions).

124. Connie J. G. Gersick et al., *Learning from Academia: The Importance of Relationships in Professional Life*, 43 ACAD. MGMT. J. 1026, 1027 (2000).

125. Dean, *supra* note 123.

126. New Arena, *supra* note 9, at 5; Murray & Graham, *supra* note 11, at 662.

127. Henry Wong, *Study: Men Twice as Likely to Start a New Business*, CNNMONEY.COM, Apr. 24, 2008, http://money.cnn.com/2008/04/24/smbusiness/kauffman_index.fsb/index.htm.

"[t]he worldwide expansion of the venture capital industry in recent years."[128] Though the industrial sector was formerly focused on computer hardware and energy products, it has broadened to include investments in medical/health products and biotechnology.[129] "Since substantial investment funds are typically required to commercialize university science, access to venture capital or other forms of funding" is necessary in order for academic scientists to launch a new company.[130] Venture capital-backed companies play a large role in "innovation, job creation, economic growth and industrial renewal."[131] Even though female entrepreneurship has seen growth and improvement, "private equity and venture capital remains unfamiliar to most women entrepreneurs."[132] In 1996, 1200 new firms received venture financing, but only thirty were run by women.[133] An estimated two percent of the $33 billion venture capitalists invested between 1991 and 1996 went to female-run firms.[134] This trend has continued; in 2002, only "six percent of the $69 billion in venture capital funding . . . was invested in companies led by a female chief executive officer."[135] Today, even though women own approximately thirty percent of businesses, "they receive as little as 5 percent of venture capital."[136]

Female life scientists are also less likely than men to join the SAB of a biotechnology firm.[137] New SAB members must be invited by the company to participate.[138] One study suggests that women are underrepresented on SABs not because they refuse opportunities to join, nor because they lack interest in commercial science, but because women simply receive fewer invitations to join SABs.[139] The same study also found other factors that increase gender equity in SAB participation. First, clear signals of scientific or administrative success increase the likelihood of SAB participation for women much more

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128. Patricia G. Greene et al., *Patterns of Venture Capital Funding: Is Gender a Factor?*, 3 VENTURE CAPITAL 63, 63 (2001).
129. *Id.* at 63–64.
130. New Arena, *supra* note 9, at 7.
131. Greene et al., *supra* note 128, at 63.
132. *Id.* at 68.
133. *Id.*
134. *Id.*
135. New Arena, *supra* note 9, at 5.
136. Todd Nelson, *Diana Project Helps Women's Hunt for Capital*, STAR TRIBUNE, Feb. 19, 2007, at 1D.
137. New Arena, *supra* note 9, at 3; *see also* Murray & Graham, *supra* note 11, at 659.
138. New Arena, *supra* note 9, at 2.
139. *Id.* at 4; *see also* Murray & Graham, *supra* note 11, at 669–671.

than for men.[140] Additionally, female participation can be improved when female scientists have "[d]irect social ties to co-authors who serve on SABs."[141] Third, female faculty members who work at universities with "institutionalized sources of support for commercial science" benefit more than their male peers.[142] The second and third factors will be explored in more detail later in this Note.

Significant gender inequity exists in academic patenting. Disproportionately fewer female scientists decide to patent, and those who do patent do so less than their male peers.[143] In terms of patenting activity, male scientists patent at a rate of 0.1 patents per year, while female scientists patent at a rate of 0.03 patents per year.[144] In terms of patenting quantity, male scientists hold an average of 1.5 patents, while female scientists hold an average of 0.4 patents.[145] One encouraging study shows that the quality and impact of female scientists' patents equals or surpasses that of male scientists' patents.[146] In assessing patent quality, researchers measure "generality" and "originality" to assess an invention's "interdisciplinary nature and its breadth of scientific 'applicability.' "[147] A "general" patent is cited by future patents from a broad variety of technological categories, and an "original" patent cites previous patents that belong to a wide range of fields.[148] Men and women do not differ in average originality, and marginal differences in generality suggest that female scientists' inventions tend to be more broadly applicable than those of male scientists.[149] However, the overwhelming trend in quantitative studies show that over the past few decades, female life sciences faculty have participated less meaningfully in commercial science than their male peers.[150]

B. Recognizing Gender Inequity in Commercial Science

Recognizing the absence of significant numbers of women in commercial science as a problem is an important step to increasing

140. New Arena, *supra* note 9, at 4; Murray & Graham, *supra* note 11, at 681; *see, e.g.*, Dreyfuss, *supra* note 3, at 18.
141. New Arena, *supra* note 9, at 3.
142. *Id.*
143. Murray & Graham, *supra* note 11, at 667–668.
144. Whittington & Smith-Doerr, *supra* note 27, at 362.
145. *Id.*
146. *Id.* at 365.
147. *Id.*
148. *Id.*
149. *Id.*
150. *See, e.g.*, Ding et al., *supra* note 8, at 667; Murray & Graham, *supra* note 11, at 682.

women's participation in commercial science.[151] A recent study shows that senior scientists and junior scientists perceive the gender gap differently.[152] Many junior scientists believe that equal opportunity in science "now or soon will be a reality."[153] This optimistic belief may be a matter of perspective: early during a scientist's career, he or she may focus on research and publication; it is not until later that many scientists allocate time for commercial science, which could produce needed revenue once a scientist retires.[154] Junior female scientists have not been exposed to the difficulties of obtaining funding for independent research and of developing that research commercially. Many senior female faculty members do not make the transition to patenting because of exclusion from industry relationships and thus failure to understand how commercial science works.[155]

Although some junior scientists who experienced patenting during doctorate and post doctorate training may be undaunted by the challenges of combining academic and commercial science, they should be aware of the barriers for women in commercial science. These barriers may be overlooked because women who leave science or who do not participate in commercial science tend to be less visible and influential.[156] "[M]any young women, surrounded by women peers and unaware of their predecessors' struggles,"[157] assume that women can participate in commercial science just as men do. Junior female scientists must understand the challenges of pursuing commercial science and learn how to overcome those challenges.

IV.
RELATIONSHIP-BUILDING & GENDER EQUITY IN COMMERCIAL SCIENCE

Relationship-building, which includes mentoring and building diverse networks, can help female scientists reap the benefits of commercial science and bridge the current gender-equity gap. Mentoring women and minorities[158] can raise their expectations about academic

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151. Morahan & Bickel, *supra* note 24, at 111.
152. *See* Murray & Graham, *supra* note 11, at 672–76.
153. Bickel et al., *supra* note 17, at 1049.
154. Stephan et al., *supra* note 29, at 77; *see* David Audretsch & Paula Stephan, *Knowledge Spillovers in Biotechnology: Sources and Incentives*, 9 EVOLUTIONARY ECON. 97, 101–102, 105 (1999).
155. Ding et al., *supra* note 8, at 667.
156. Bickel et al., *supra* note 17, at 1049.
157. *Id.*
158. Although historically underrepresented minority groups may face extra challenges, it is important to note that the analysis in Part IV can also help increase racial

careers, prepare scientists for the commercial market, and help scientists manage their careers.[159] While researchers and legislators have begun to recognize the importance of mentoring,[160] the simple existence of mentoring programs will not be enough to increase gender equity in commercial science. National standards for mentoring must be set.[161] Mentoring programs must specifically address gender issues to effectively increase women's participation in commercial science.

A. A Scientist's Stages of Socialization

Before delving into the characteristics of a successful mentor, an understanding of a scientist's stages of socialization will be important. Graduate science education programs socialize students and teach them professional norms.[162] Sociologists identify three stages of socialization. During the first two stages, students develop commitment to work and internalize occupationally relevant attitudes and behaviors that sustain productivity and continued achievement throughout their careers.[163] A typical graduate student spends six years obtaining her

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minority representation in commercial science. A detailed analysis of the racial divide in commercial science is beyond the scope of this Note.

159. *See* Linda K. Johnsrud, *Enabling the Success of Junior Faculty Women Through Mentoring*, *in* MENTORING REVISITED: MAKING AN IMPACT ON INDIVIDUALS AND INSTITUTIONS 53, 60 (Marie A. Wunsch, ed., 1994); William McHenry, *Mentoring as a Tool for Increasing Minority Student Participation in Science, Mathematics, Engineering, and Technology Undergraduate and Graduate Programs in* DIVERSITY IN HIGHER EDUCATION: VOL. 1, MENTORING AND DIVERSITY IN HIGHER EDUCATION 115 (Henry T. Frierson ed., 1997).

160. Section 7008 of the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Act requires all proposals for National Science Foundation grants that will support postdoctorate candidates to "include a description of the mentoring activities that will be provided . . . [to be] evaluated under the Foundation's broader impacts merit review criterion." Pub. L. No. 110-69, § 7008, 121 Stat. 680. For additional evidence of increased recognition of the importance of mentoring, see, for example, Peg Boyle & Bob Boice, *Systematic Mentoring for New Faculty Teachers and Graduate Teaching Assistants*, 22 INNOVATIVE HIGHER EDUC. 157, 158 (1998); Jean E. Girves et al., *Mentoring in a Post-Affirmative Action World*, 61 J. SOC. ISSUES 449, 451 (2008); Belle Rose Ragins & John L. Cotton, *Mentors Functions and Outcomes: A Comparison of Men and Women in Formal and Informal Mentoring Relationships*, 84 J. APPLIED PSYCHOL., 529, 531 (1999); Beryl Lieff Benderly, *Making Mentoring Mandatory*, SCI. CAREERS, Oct. 5, 2007; National Mentoring Month 2008 in High Gear, http://www.hsph.harvard.edu/chc/wmy2008/nmm/intro.htm (designating January as National Mentoring Month).

161. Girves et al., *supra* note 160, at 474 ("A national, searchable, online database of best practices should be created . . . .").

162. Stuart & Ding, *supra* note 28, at 108.

163. More specifically, the first stage, anticipatory socialization, occurs when the individual chooses an occupation and gradually assumes the values of that occupation. The second stage, occupational entry and induction, "includes or is preceded by for-

doctorate degree, during which time she develops the skills needed for scientific research. Graduate students then become postdoctorate students, who are newly qualified research scientists.[164] The postdoctoral experience is a period of apprenticeship for scientists to gain scientific, technical, and professional skills to advance their professional career.[165] By the time the postdoctoral experience is over, the scientist has internalized attitudes about professional norms. The third stage of role continuance occurs when the new member has "internalized role specifications, a sense of satisfaction with work, and a high degree of job involvement and commitment."[166] A postdoctorate scientist then assumes faculty positions, progressing to assistant professor, associate professor, and, finally, full professor.[167] During later stages of a career, a scientist can participate in organizational leadership roles.[168] This is often the time when a scientist embraces commercial science activities.

During a female scientist's career, she works in an environment that becomes more male-dominated as she moves up the hierarchy. Social identity theory and organizational demography are important theoretical frameworks for understanding the problem of hierarchy in advancing women's careers. Social identity theory explains "how social structure informs the meaning people attach to their membership in identity groups, such as sex, and how this in turn shapes their social interactions with members of their own and other identity groups."[169] Identity represents "the location of an individual in social space."[170] The social structure of universities inform the meaning that female scientists attach to their membership in academia and how women interact with other female as well as male researchers. "[O]rganizational demography investigates the disproportionate representation of some identity groups over others" and views this dispro-

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mal schooling, preparation, or training for the occupation," and learning while doing. Clark & Corcoran, *supra* note 112, at 23.

164. Avi Spier, *Postdoc Production: Negative Selection of the Scientists of the Future*, SCI. CAREERS, Sept. 13, 2002.

165. *See* NAT'L ACAD. OF SCI. ET AL., ENHANCING THE POSTDOCTORAL EXPERIENCE FOR SCIENTISTS AND ENGINEERS: A GUIDE FOR POSTDOCTORAL SCHOLARS, ADVISERS, INSTITUTIONS, FUNDING ORGANIZATIONS, AND DISCIPLINARY SOCIETIES (2000).

166. Clark & Corcoran, *supra* note 112, at 23.

167. In some institutions, a post doctorate scientist may become a staff scientist before assuming faculty positions. Spier, *supra* note 164.

168. *See* Clark & Corcoran, *supra* note 112, at 23.

169. Robin J. Ely, *The Effects of Organizational Demographics and Social Identity on Relationships Among Professional Women*, 39 ADMIN. SCI. Q. 203, 204 (1994).

170. Viktor Gecas et al., *Social Identities in Anglo and Latin Adolescents*, 51 SOC. FORCES 477, 477 (1973).

portionality "as an important factor in the social structure of the work environment."[171] Disproportional representation in the upper hierarchies creates problems for an organization.[172]

In commercial science, because there are few women at the senior faculty level, "gender may continue to be a negative status indicator for women, despite balanced representation" at the junior faculty level.[173] Shared gender between junior women and their senior female colleagues provides little basis for validation and support when the scientific community appears to restrict women's access to commercial science.[174]

Certain mentoring policies, including an increase in cross-gender mentoring and an emphasis on instrumental help, can change the social framework so that women have more access to commercial science. The next sections will explore mentoring policies that can change current university culture regarding women's participation in commercial science.

B. The Mentoring Relationship[175]

A mentoring relationship is a developmental relationship—the mentor "provides needed support for the enhancement of [the mentee's] career development and organizational experience."[176] A mentor can provide 1) instrumental or practical help, 2) socioemotional help, and 3) serve as a role model for the mentee.[177] First, instrumental help involves a mentor who coaches the mentee and gives technical advice and instructions.[178] Second, socioemotional help focuses on empathy and personal counseling. The mentor acts as a

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171. Ely, *supra* note 169, at 204.

172. *See id.* at 207 (noting that "that the disproportionate representation of men over women in senior organizational positions may highlight for women their limited mobility and reinforce their lower status as women, even in work groups composed entirely of women.")

173. *See id.* at 204–05.

174. *See id.* at 228 (finding such a lack of validation and support within "firms that appeared to restrict women's access to [senior] positions").

175. Sociologists make distinctions between different types of developmental relationships. For the purposes of this Note, the term "mentor" will be used more in its colloquial sense to broadly encompass characteristics of various developmental relationships, including "sponsor" and "role model" relationships. *See* Roberta A. Downing et al., *The Perceived Importance of Developmental Relationships on Women Undergraduates' Pursuit of Science*, 29 PSYCHOL. OF WOMEN Q. 419, 420 (2005).

176. *See* David A. Thomas, *The Impact of Race on Managers' Experiences of Developmental Relationships (Mentoring and Sponsorship): An Intra-organizational Study*, 11 J. ORGANIZATIONAL BEHAV. 479, 480 (1990).

177. *See* Downing, *supra* note 175, at 420.

178. *Id.*

"champion, cheerleader, compatriot, [and] guide" for the mentee.[179] Third, the mentor's position as a role model, someone that the mentee wishes to resemble, forms the core of many mentoring relationships.[180] One aspiring academic entrepreneur remembered that a male departmental colleague who had formed a firm provided him advice and served as a role model.[181] Women have traditionally suffered from a lack of same-sex role models in scientific academia.[182] Increasing the number of role models for women will increase the likelihood of female scientists accepting the legitimacy of commercial science and exploring the possibility of founding for-profit companies based on their research.[183]

Effective mentoring can improve a young scientist's research experience and allow her to achieve career goals.[184] A recent study suggests that mentoring in college may be more important than mentoring in high school, perhaps because "the rigors of college-level science and math courses make guidance especially valuable to students."[185] Extending that logic, mentoring in later stages of a scientist's career may be as important as, if not more important than, mentoring in college. Mentoring for graduate programs, postdoctorate fellows, and even junior faculty will be important to increasing women's participation in commercial science.

Women face obstacles in receiving effective mentoring in both the commercial arena and the scientific arena. In the commercial arena, men make up the overwhelming majority of venture capitalists.[186] As a result, there is an incredibly strong male influence in the rules, practices, and norms of this commercial environment.[187] If women do not have mentors who help them access male networks,[188]

179. John D. Robinson & Dawn Cannon, *Mentoring in the Academic Medical Setting: The Gender Gap*, 12 J. CLINICAL PSYCHOL. MED. SETTINGS 265, at 269.

180. *Id.*

181. Etzkowitz, *supra* note 26, at 829.

182. *See* Christy Chandler, *Mentoring and Women in Academia: Reevaluating the Traditional Model*, 8 NAT'L WOMEN'S STUDIES ASSOC. J. 79, 80 (1996).

183. *See* Etzkowitz, *supra* note 26, at 829 (arguing that availability of role models can increase the likelihood of founding a firm based on academic research).

184. Laura Haynes et al., *Mentoring and Networking: How to Make It Work*, 9 NATURE IMMUNOLOGY 3, 5 (2008).

185. Downing et al., *supra* note 175, at 425.

186. Greene et al., *supra* note 128, at 69.

187. *Id.*

188. *See* Howard E. Aldrich, *Networking Among Women Entrepreneurs*, *in* WOMEN-OWNED BUSINESS 103 (O. Hagan, C. Rivchun & D. Sexton eds., 1989) (discussing the lack of overlap between women's and men's networks).

then women can be excluded from venture capital networks that consist predominantly of males.[189]

In the scientific arena, female scientists also face more obstacles than their male peers in obtaining mentorship to advance their careers.[190] The fact that graduate students regard their faculty relationships as the most important indicators of the quality of their graduate experience[191] underscores the importance of mentoring. However, women's mentoring stories portray struggles with exclusion from the old boy's club—women have been left out of important mentoring relationships and benefit less from the mentors that they do find.[192] Female scientists may experience an "accumulative disadvantage" when they do not become mentees of productive, established mentors and do not join collegial networks where useful advice, advocacy, and patronage are provided.[193] If women begin in "a position of insecurity rather than from an assumption of support with regard to essential career resources," then this disadvantage results in "a more hesitant or defensive approach toward relationships and network building."[194]

The mentoring relationships described by female scientists include less career help, and in fact more harm to female scientists, than the relationships described by male scientists.[195] Mentors may more actively encourage male than female mentees to participate in professional activities outside the university, such as commercial science.[196] In one study, women were three times more likely than men to report their mentor taking credit for their work.[197] One student caught on "to the dangers of attaching [herself] to any . . . sugar-daddy type person who might absorb me into his research reputation."[198] These examples underscore the obstacles that female scientists face in mentoring relationships.

Although female scientists encounter more obstacles than male scientists in obtaining effective mentoring, those obstacles can be overcome. Universities must institute mentoring programs that teach mentors the skills and ethical practices needed for effective mentoring. Tenure and promotion decisions should only be made after consider-

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189. *See* Greene et al., *supra* note 128, at 71.
190. *See* Bickel et al., *supra* note 17, at 1047.
191. Clark & Corcoran, *supra* note 112, at 31.
192. Bickel et al., *supra* note 17, at 1047, 1057.
193. Clark & Corcoran, *supra* note 112, at 24.
194. Gersick et al., *supra* note 124, at 1041.
195. *Id.* at 1038.
196. *See* Bickel et al., *supra* note 17, 1057.
197. *Id.*
198. Clark & Corcoran, *supra* note 112, at 36.

ing the faculty member's effectiveness as a mentor.[199] Effective mentoring programs must identify and chastise poor mentors and reward effective mentors. While outside mentoring prizes[200] are important in promoting mentoring, institutions themselves must also provide incentives for effective mentors. One way to combat the problem of the unethical mentor is through mentoring programs outside of the university. These outside mentoring programs, which can include online mentoring,[201] can help the mentee gain confidence and recognize any possible abuses by her mentor. An increase in the quality and quantity of student conferences, gatherings, and other networking opportunities will allow scientists to gather and discuss their research and experiences, to facilitate peer mentoring, and to share information and strategies for successful mentoring relationships.[202] Of course, while outside mentoring and gatherings can help, a full solution to the obstacles faced by female scientists requires institutionalized mentoring programs that encourage and sustain a culture of mentoring.

Universities need to set up structured mentoring programs that provide training for mentors. These programs should have a clearly defined purpose, flexibility in implementing and modifying activities for individuals, and visible support from the administration. Mentors need not only knowledge about scientific research and careers, but also training in social skills necessary for effective mentoring.[203] To increase women's participation in commercial science, mentoring programs should expose women to the benefits of commercial science and help women establish networks important for commercial science. Because women find it harder to penetrate informal networks, mentors

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199. *See, e.g.*, Promotion and Tenure Policy Task Force, *New Promotion and Tenure Policy for New Mexico State University* 18, Apr. 2007, http://www.nmsu.edu/~fsenate/ptp/P&TPolicy.pdf (including examination of effectiveness of faculty mentoring in evaluation of faculty leadership); School of Engineering and Applied Science, University of Virginia, *Promotion and Tenure Guidelines*, May 18, 2005, http://www.seas.virginia.edu/policies/promotionmay2005.pdf (examining evidence of advising and mentoring in evaluating teaching performance).

200. *See*, *e.g.*, AAAS Mentor Awards, http://www.aaas.org/aboutaaas/awards/mentor/index.shtml (mentoring awards provided by American Association for the Advancement of Science honor individuals who demonstrate extraordinary leadership to increase the participation of underrepresented groups in science careers).

201. *See*, *e.g.*, MentorNet, E-Mentoring Network for Diversity Engineering and Science, http://www.mentornet.net (an award-winning nonprofit e-mentoring network that aims to increase the retention and success of women and other under-represented scientists).

202. *See* Girves et al., *supra* note 160, at 473–474.

203. *See* S. S. Pisimisi & M.G. Ioannides, *Developing Mentoring Relationships to Support the Careers of Women in Electrical Engineering and Computer Technologies. An Analysis on Mentors' Competencies*, 30 EUR. J. ENGINEERING EDUC. 477, 479 (2005).

need to help establish formal networks for women. Mentoring programs must be an integral rather than a peripheral part of the university's culture and infrastructure; they must be institutionalized to ensure their continued existence and impact.

C. Challenges and Benefits of Men Mentoring Women

Effective mentoring programs should encourage cross-gender mentoring relationships. Because of the juxtaposition between the rising proportions of female science students and the static male-dominated gender composition of faculties, female students face disadvantages in locating female mentors, or any mentors at all. Because of the lack of women at the top,[204] there is a dearth of senior female mentors, a cycle that risks perpetuating itself. Since male scientists still comprise the bulk of tenured faculty, female scientists may need to form mentoring relationships with male mentors to receive the same level of respect as their male peers.

Therefore, because male mentors may have a stronger influence than female mentors due to the lack of senior women,[205] male mentors should learn to effectively mentor female mentees. Successfully navigating cross-gender mentoring relationships presents a challenge for male mentors. Many men have difficulty effectively mentoring women because "students and faculty of the same sex interact most comfortably."[206] Mentors must realize "that styles and advice that worked for the mentors may not work for their protégés."[207] Effective mentoring requires recognition of different mentoring styles. Men are often associated with dictating instructions to the mentee, while women are often associated with asking or advising the mentee.[208] While the accuracy of these associations is debatable, it is clear that mentors with increased ability to recognize discomfort caused by a particular mentoring style can modify mentoring styles to suit the individual mentee.

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204. *See* Bickel, *supra* note 17, at 1045–47.

205. *See* Downing et al., *supra* note 175, at 424–25. The discussion in Part I *supra* analyzes why gender equity has beneficial effects for everyone.

206. Helen M. Berg & Marianne A. Ferber, *Men and Women Graduate Students: Who Succeeds and Why?*, 54 J. HIGHER EDUC. 629, 639 (1983); *see also* Herminia Ibarra & Lynn Smith-Lovin, *New Directions in Social Network Research on Gender and Organizational Careers*, *in* CREATING TOMORROW'S ORGANIZATION: A HANDBOOK FOR FUTURE RESEARCH IN ORGANIZATIONAL BEHAVIOR 359, 364–65 (Cary L. Cooper & Susan E. Jackson eds., 1997) (noting the potential difficulty of finding "network contacts who are both homophilous (i.e. similar on the basis of gender) and influential").

207. Bickel et al., *supra* note 17, at 1047.

208. Robinson & Cannon, *supra* note 179, at 270.

Mentors need to admit that gender does play a role in science. A candid discussion of the existence of the gender gap in commercial science can increase the trust in a mentoring relationship and improve the quality and effectiveness of that relationship. Mentors who at least discuss the potential of commercial science increase the possibility that the mentee will participate in the future.

Mentors can provide socioemotional help to alleviate or at least address female scientists' concern that pursuing commercial opportunities might hinder university careers. In one study, while male scientists described their patenting decisions as unproblematic, "female faculty expressed concern about the potentially negative impact that patenting might have on education, collegiality, and research quality."[209] Female scientists' concern may be caused by under-exposure to commercial science. Male mentors, who have successfully participated in commercial science more than female mentors, can show mentees that participation does not entail corrupting scientists' integrity.[210] Men see many examples of successful venture capital-funded, male-owned biotechnology firms.[211] For women, however, success stories are less visible.[212] One study reports that between 1982 and 1995, roughly four percent of business ownership articles in the *New York Times* mentioned women.[213] Exposing women to commercial science will empower women to participate and succeed in commercial science.

While socioemotional help is important, instrumental or practical help for women should not be overlooked.[214] In a variety of studies, women told significantly fewer stories than men did about mentors providing instrumental help.[215] The women's stories also show "a notable lack of strategizing for reputational gain."[216] Emphasis on fe-

209. Ding et al., *supra* note 8, at 666.
210. *See* Murray & Graham, *supra* note 11, at 683.
211. *See* Greene et al., *supra* note 128, at 68 (noting that the vast majority of firms receiving venture capital funding have been male-owned).
212. *Id.*
213. *See* Ted Baker et al., *Invisible Entrepreneurs: The Neglect of Women Business Owners by Mass Media and Scholarly Journals in the U.S.A.*, 9 ENTREPRENEURSHIP & REGIONAL DEV. 221, 227 (1997).
214. *See* Downing et al., *supra* note 175, at 424 (noting that instrumental help "can be more influential to advancement in one's field than the other developmental relationships").
215. *See, e.g.*, *id.*; Gersick et al., *supra* note 124, at 1040; Aaron Groff Cohen & Barbara A. Gutek, *Sex Differences in the Career Experiences of Two APA Divisions*, 46 AM. PSYCHOL. 1292, 1296 (1991); Debra Umberson et al., *The Effect of Social Relationships on Psychological Well-Being: Are Men and Women Really So Different?*, 61 AM. SOC. REV. 837, 851 (1996).
216. Gersick et al., *supra* note 124, at 1040.

male faculty proving themselves worthy "strongly contrasts with the emphasis on strategy from men's [mentoring relationships].[217] At one large financial services company, senior males gave more instrumental help, while senior females gave more socioemotional help.[218] Mentors, especially male mentors who have been exposed to commercial science, need to provide female mentees with instrumental advice and instructions about how to get involved in commercial science. Information about who to contact, how to assess the patentability of an invention, and how to negotiate the technology transfer office are all important to exposing a female scientist to commercial science. If a mentor himself does not have expertise in commercial science, he should refer the mentee to other contacts who can provide the mentee with the practical information.

While problems exist with cross-gender mentoring, successful cross-gender mentoring should be awarded by universities because it will incentivize future successful relationships. If being an effective mentor becomes a scientific norm, then pressure from the scientific community could prevent the emergence and continuance of abusive mentors.

D. Mentors Must Help Mentees Build Diverse Networks

A mentor also has a crucial role in helping the mentee build a large and diverse network of relationships. Ties with the right people, in the right configuration, may increase an individual's access to organizational influence and career mobility.[219] Recent conferences held at Columbia University and the City University of New York graduate center have addressed the underrepresentation of women in the top ranks of academia, focusing on the exclusion of women from networks.[220] The mentorship process historically often resulted in homo-

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217. *Id.*

218. Gail M. McGuire, *Do Race and Sex Affect Employees' Access To and Help From a Mentor? Insights from the Study of a Large Corporation*, *in* MENTORING DILEMMAS: DEVELOPMENTAL RELATIONSHIPS WITHIN MULTICULTURAL ORGANIZATIONS 105, 112–13 (Audrey J. Murrell, Faye J. Crosby & Robin J. Ely eds., 1999).

219. *See generally* Herminia Ibarra, *Homophily and Differential Returns: Sex Differences in Network Structure and Access in an Advertising Firm*, 37 ADMIN. SCI. Q. 422, 422 (1992) (noting that "the differential allocation of network rewards may partially account for gender differences in career outcomes").

220. Dean, *supra* note 123. Organizers of these events dismissed the comments of Lawrence H. Summers, former president of Harvard, who suggested that women are handicapped as scientists because women as a group are innately deficient in mathematics. They focused instead on evidence that women do not receive the same degree of support as men, suggesting that if advisers do not help women form networks, women should proactively form networks on their own. *Id.*

geneous networks,[221] rather than heterogeneous networks. Contemporary mentors should focus on building networks for women that are heterogeneous at several levels. One way to promote heterogeneity is to make the network functionally diverse, including other mentors as well as peers.[222] Researchers with coauthors who had become academic entrepreneurs were more likely to venture into commercial science, especially when those coauthors were well connected in industry.[223] The network should also be diverse in terms of position, including both senior faculty and junior faculty, and location, including people from within the same department, from other departments, or outside the university entirely.[224] These two forms of diversity can help to address differences in the manner in which young women scientists network: female faculty's informal networks will tend to be "less extensive and less likely to include superordinates or colleagues from previous institutions."[225] Increased diversity could also decrease "pervasive feelings of isolation and loneliness" found to be more pronounced among female faculty, especially as they reach senior levels within an institution.[226] As a third form of diversity, the network should be varied in terms of gender, race, age, and culture.[227] Diversity is important along all these levels to foster a large network that can help the mentee at different stages of her career.

Because women may be excluded from, and exclude themselves from, the development of informal networks,[228] mentors must help women build diverse, formal networks as well as encourage women to proactively build networks themselves. Mentors can help provide women with important contacts to commercialize their research.[229]

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221. *See* Clark & Corcoran, *supra* note 112, at 26 (citing classic studies of mentoring relationships).

222. Thomas, *supra* note 176, at 106; *see also* Clark & Corcoran, *supra* note 112, at 35 (noting that peer relationships are important for minorities to engage in "informal discussions, exchanges of aid and support, and friendships" to facilitate scientific learning and research).

223. Stuart & Ding, *supra* note 28, at 100, 109.

224. Thomas, *supra* note 176, at 106.

225. Bickel et al., *supra* note 17, at 1049.

226. *See* Virginia E. O'Leary & Jeanette R. Ickovics, *Cracking the Glass Ceiling: Overcoming Isolation and Alienation*, *in* WOMANPOWER: MANAGING IN TIMES OF DEMOGRAPHIC TURBULENCE 7 (Uma Sekaran & Frederick T. L. Leong eds., 1992).

227. Thomas, *supra* note 176, at 106; *see also* Herminia Ibarra, *Race, Opportunity and Diversity of Social Circles in Managerial Networks*, 38 ACAD. MGMT J. 673 (1995) (finding that that minorities with high potential managerial ratings tended to form same- and cross-race mentorship relationships, while their peers with lower potential ratings tended to have networks dominated by whites).

228. Ibarra, *supra* note 219, at 422 (referring to voluminous anecdotal and survey research on women's exclusion from networks).

229. Murray & Graham, *supra* note 11, at 683.

With these connections, women would find it less time-consuming "to gauge whether an idea was commercially relevant."[230] Men, who are more frequently provided industry contacts, have described such contacts "as a precursor to patenting."[231] Diverse networks will increase exposure to the commercial sector and increase women's industry contacts. A mentor's ability to increase the mentee's diverse network can increase the number of female scientists who found for-profit companies. The structure of the venture capital industry is a network of referrals from which women have been absent.[232] According to social network theory, the presence of social ties, "such as access or membership in associations, plays a key role in business success."[233]

Mentors should encourage women to build networks with men as well as with women. Networks that include only women can be helpful,[234] but cross-gender networks may be even more helpful. In one study, "each gender tended to interact with itself" and built "two informal, segregated networks" within the organization.[235] In the segregated networks, women were perceived as less influential than men by both supervisors and nonsupervisors.[236] Interestingly, company members perceived women who formed integrated workgroups as more influential than women in segregated workgroups.[237] Company members also perceived men who formed integrated workgroups as more influential than those in segregated workgroups.[238] Because women in integrated workgroups were seen as equally influential with the men in these groups,[239] it can be inferred that members perceived women in integrated groups as more influential than men in segregated groups. The study thus demonstrates that both men and women should be "encouraged to build contacts with members of the other gender."[240] Female scientists with diverse networks of both men and

230. Ding et al., *supra* note 8, at 666.
231. *Id.*
232. Suzanne MacNeille, *Shaking the Venture Capital Tree*, N.Y. TIMES; Mar. 11, 2001, at 3.2.
233. Greene et al., *supra* note 128, at 70.
234. ELLEN DANIELL, EVERY OTHER THURSDAY: STORIES AND STRATEGIES FROM SUCCESSFUL WOMEN SCIENTISTS xi–xiii (2006) (describing a group of female scientists who met regularly for more than twenty-five years to talk about their professional triumphs and travails, turning themselves into mentors and role models for one another).
235. Daniel J. Brass, *Men's and Women's Networks: A Study of Interaction Patterns and Influence in an Organization*, 28 ACAD. MGMT. J. 327, 339 (1985).
236. *Id.* at 340.
237. *Id.*
238. *Id.* at 341.
239. *Id.* at 340–41.
240. *Id.*

women will be perceived as strong, influential scientists who can take the additional step of participating in commercial science.

Strong ties are important for junior female scientists, and a mentor should continue to provide those strong ties for the mentee. For example, women would closely collaborate with male colleagues to initiate the patenting process.[241] These coauthors influenced fellow scientists either by influencing scientists' "attitudes toward the acceptability of commercial activity" or by opening portals for network building.[242]

Strong ties will also benefit female scientists who decide to start for-profit companies. Prominent scientists are more likely to become academic entrepreneurs,[243] perhaps because to succeed in the private sector, venture capitalists must provide financial support.[244] During the beginning of the biotechnology industry, only prominent scientists had the necessary reputations to attract the interest of investors.[245] Also, the perceived threat of reputation loss when scientists became entrepreneurs did not deter high prestige scientists confident in their reputations.[246] The prominent members of any group tend to be role models and opinion leaders, so high prestige scientists are more likely to sway colleagues to participate in commercial science.[247] Since many of these prominent scientists are male, they should encourage their female mentees to participate in commercial science.

Although strong ties are important and also more easily available than weak ties, weak ties may be equally as important as or more important than strong ties.[248] Weak ties are people to whom an individual "is marginally connected and has little contact," while strong ties include people with whom an individual interacts frequently, such as relatives, friends, or co-workers.[249] Women's networks often lack weak ties,[250] which presents a problem because weak ties are "valuable sources of information, resources, and support that would, in turn,

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241. Ding et al., *supra* note 8, at 667.
242. Stuart & Ding, *supra* note 28, at 136.
243. *Id.* at 125.
244. *Id.* at 138.
245. *Id.*
246. *Id.*
247. *Id.* at 139.
248. *See* Mark Granovetter, *The Strength of Weak Ties: A Network Theory Revisited*, 1 Soc. Theory 201, 209 (1983).
249. Linda F. Crowell, *Weak Ties: A Mechanism for Helping Women Expand Their Social Networks and Increase Their Capital*, 41 Soc. Sci. J. 15, 16 (2004).
250. *See id.* at 17. (noting that "for women, limited contacts mean their personal ties lack the ability to mediate the passage of vital information").

translate into influence and upward mobility in the organization."[251] Weak ties provide "access to information and resources" that would not be available in one's normal social circle.[252] A social system that has no weak ties "will be fragmented and incoherent," stunting attempts at scientific endeavors.[253] To demonstrate the importance of weak ties, consider an individual with a collection of close friends (strong ties) and a collection of acquaintances (weak ties), few of whom know one another.[254] Each of the acquaintances will likely have their own close friends and "be enmeshed in a closely knit clump" of a different social structure.[255] The weak tie between the individual and her acquaintance becomes "a crucial bridge between the two densely knit clumps of close friends."[256] Women need access to these weak ties so that they can be part of a wider network and thus have access to industry ties. Online mentoring, conferences, and gatherings can help women establish weak ties.

V.
Other Institutional Solutions

A. Research Funding

In additional to effective mentoring programs that promote strong, diverse networks, increased funding for junior scientists represents another solution to the problem of women's under-representation in commercial science. A coalition of research institutions and the Howard Hughes Medical Institute (HHMI) independently called for increased National Institute of Health (NIH) funding to support young scientists.[257] A report by this coalition, released in connection with the call for funding, profiled twelve early career scientists who have the "training, drive, and intellectual firepower to improve America's health through their innovative research."[258] Eight out of those twelve scientists featured are female.[259] When skilled scientists leave academic science, it represents a failure to capitalize on their intellectual

251. Brass, *supra* note 235, at 341.
252. Granovetter, *supra* note 248, at 209.
253. *Id.* at 202.
254. *See id.*
255. *Id.*
256. *Id.*
257. *See* Sophie L. Rovner, *Young Scientists Get Backing: Research Institutions Plead for More Federal Funding and Proffer Early-Career Scientists New Awards*, Chemical & Engineering News, Mar. 17, 2008, at 8.
258. A Broken Pipeline?, *supra* note 15, at 15.
259. *Id.* at 9–13.

potential.[260] Consistent and robust funding for junior scientists can allow those scientists to explore research interests and participate in commercial science. This increased funding will allow young scientists, many of whom are female, to fulfill their scientific potential and to improve the health of all people.[261]

The coalition also reports that senior scientists, many of whom act as mentors of young investigators, feel the pressure to keep their own research going as the vise tightens around the NIH budget.[262] This circumstance may lead to undesirable consequences because mentors are less likely to give female mentees credit for their research. Junior investigators compete for limited resources with their well-established mentors, have less success doing it, and get "smaller piece[s] of the already small NIH funding pie."[263] Because many of the junior investigators are increasingly women, the fact that junior investigators appear to be having the hardest time in getting funding for their research is not an encouraging statistic.

Providing increased funding for junior scientists will allow female scientists to conduct independent research and to develop inventions that can lead to commercial science. HHMI recently announced that it will provide $300 million to early-career researchers.[264] The organization will select up to seventy young scientists and fund six years of their research. This funding should serve as an example for future private organizations. Although private funding for junior scientists will help, it cannot be a complete solution to women's under-representation in commercial science because NIH provides much of the funding for biomedical research.[265] Increasing biomedical research, especially for junior scientists, could lead to increased opportunities for women's participation and success in commercial science.

B. Role of the Technology Transfer Office

Universities can further increase gender equity in commercial science by setting up strong technology transfers offices (TTOs)[266] to educate academic scientists about the patent process. Even male

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260. *See id.* at 16.
261. *See id.* at 19.
262. *See id.* at 15.
263. *Id.* at 4. "The year 2008 marks the NIH's fifth consecutive year of no real budgetary growth, representing a 13% drop in purchasing power since 2003." *Id.* at 3.
264. Rovner, *supra* note 257.
265. *See id.*; A BROKEN PIPELINE?, *supra* note 15, at 5.
266. "[A] TTO evaluates the commercial potential of the technology and decides whether to patent the innovation." Siegel et al., *supra* note 107, at 29.

scientists report lack of knowledge about the patenting system and commercial science. One male scientist believes that to increase participation in commercial science, scientists would have to "be more sophisticated than most of us are—than I certainly am—to know when to [patent] or what sort of thing should trigger it."[267] Research shows that TTOs seem to more significantly help female scientists than their male peers.[268] TTOs can provide women with "a roadmap to commercialization,"[269] including industry contacts, advice, and encouragement. Strong technology transfers offices (TTOs) can help women achieve success in commercial science.

CONCLUSION

Scientists are increasingly embracing the new field of commercial science, which presents many opportunities to gain recognition and reward. Commercial science has arisen at a critical time, when the United States' aging population is resulting in an increase in demand for new innovations, just as the United States' global preeminence in research and innovation appears jeopardized.[270] Unfortunately, research shows that a gender gap persists in the new field of commercial science,[271] which wastes the intellectual capacity of scientists. Exploring ways to increase gender equity in commercial science can improve innovation.

Effective, institutional mentoring programs can decrease the gender gap in commercial science. First, mentors should be instructed on addressing difficult gender issues. Mentors should also provide not only socioemotional help but also instrumental help regarding who to contact about commercial science opportunities and what skills are necessary to become a successful entrepreneur. Third, mentors should facilitate development of diverse networks for mentees. Institutions should award effective mentors and chastise poor mentors, thus creating a scientific culture that values mentoring. Finally, institutional policies such as strong TTOs and increased funding for junior faculty can additionally decrease the gender gap in commercial science. A combination of these strategies will allow female scientists to fulfill

267. Owen-Smith & Powell, *supra* note 100, at 112. University faculty member Jim Helfenstein "has never disclosed an invention, though his research has many potential commercial applications." Stephan et al., *supra* note 29, at 76 n.10.

268. Murray & Graham, *supra* note 11, at 681.

269. *Id.* at 681.

270. *See* NAT'L ACAD. OF SCI. ET AL., *supra* note 16, at 13.

271. New Arena, *supra* note 9, at 9, 41.

their intellectual potential, to empower society to solve problems that disproportionately affect women, and to promote progress and innovation.