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Women in Science at Harvard

The Last 375 Years

By Vivian Ling

When Harvard University was founded in 1636, the idea of women leading scientific endeavors – much less going to college – was inconceivable. Fast forward 375 years, and the idea of science without women at the forefront is equally hard to imagine.

When Harvard met Radcliffe

Despite the indispensable roles of women in science at Harvard today, the transition from the alpha male domain of John Harvard was neither seamless nor immediate. Radcliffe College was not founded until 1879, 243 years into Harvard's existence; it was was established as the "Harvard Annex" where women could be educated by Harvard faculty. Women were not allowed to attend Harvard classes with men until 1943. This separation of genders continued until 1977, when Harvard and Radcliffe signed a formal agreement to merge the two institutions, but the full execution of the agreement did not take effect until twelve years ago, in 1999 (1).

Despite the slow process by which women were fully integrated into the Harvard community, once the merge was complete, women quickly made significant process. Women have slowly but surely filled the ranks not only as students, but also as faculty and researchers. Today, women occupy some of the university's highest positions; Drew Gilpin Faust is our first female President. Of the Harvard University faculty, approximately thirty percent are women (2). In 2005, Harvard offered four out of 32 positions to female professors. In 2009, 16 out of the 41 professors who received tenure were female, more than tripling the percentage annually of women being honored with tenure (3).

Given these statistics, it is easy to forget that Radcliffe was only fully and officially incorporated in Harvard just over a decade ago, when most current undergraduates were still in grade school. Yet, despite this progress, there are some who still question the ability of women to succeed in academia, particularly in scientific fields. In 2005, Lawrence Summers, then President of Harvard, suggested that the reason there aren't as many women in science and engineering was due to inherent genetic inferiorities (4). His remarks generated outrage and a surge of protest from the female scientific community as well as the Harvard community at large. Summers later apologized and resigned from his post as President.

Though Summers's remarks did not in any way mark the beginning of tremendous female progress in the sciences at Harvard, the resulting backlash drew attention to the true power of women in science at the University and the progress they have made since it was founded. Since women were allowed to attend the college, female scientists at Harvard have made significant contributions towards recognizing women in science at Harvard and toward advancing science at Harvard as a whole. Some of the most interesting research done today is being conducted by bright female scientists.

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There will be new blood (and bone)

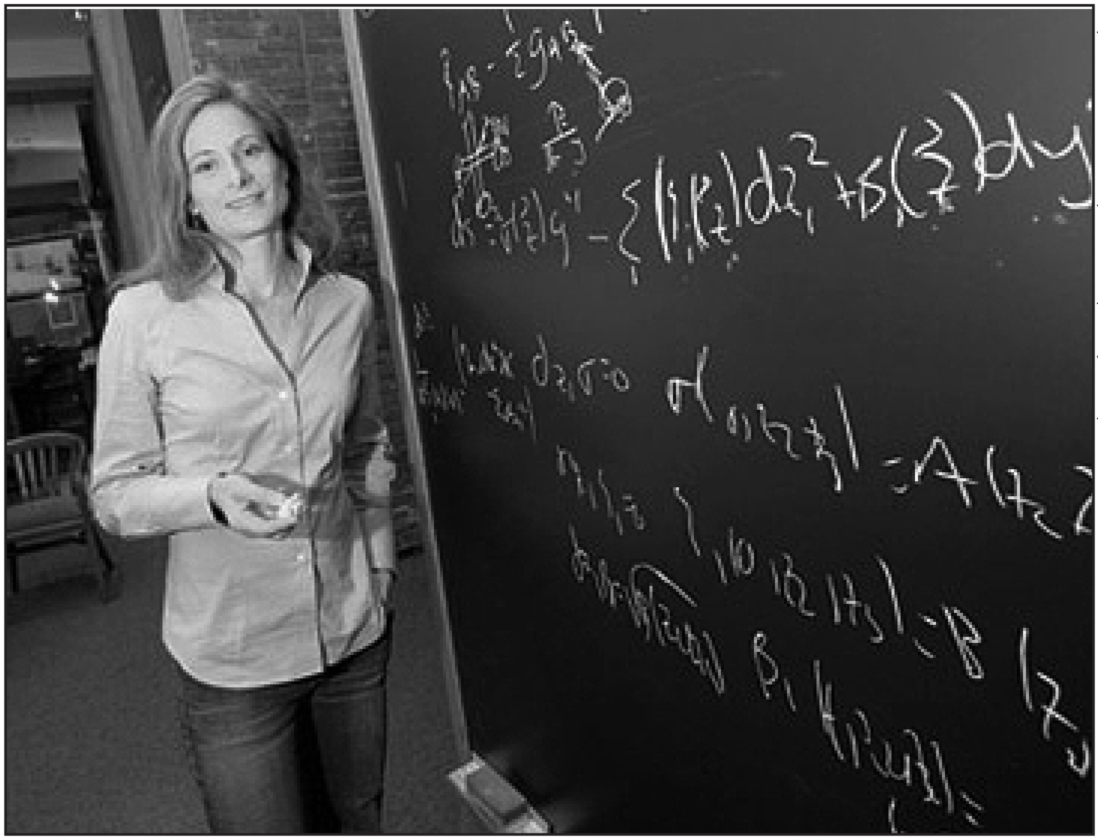
In the past decade, tremendous progress has been made in stem cell research. As tissue regeneration and stem cell graft transplantation may one day offer potentially revolutionary medical treatments, it is only fitting that this new era has been ushered in with strong female leadership.

Amy Wagers, a researcher at Harvard's Joslin Diabetes Center and an Associate Professor of Stem Cell and Regenerative Biology at Harvard University, has been a key player at the forefront of this field. While much of the research being done on stem cells focuses on embryonic stem cells, Wagers's work focuses on adult stem cells already present in the body. A recipient of several prestigious awards, including the Howard Hughes Medical Institute Early Career Scientists Award, Wagers focuses on the biology and development of bone marrow or blood (hematopoietic) stem cells as well as adult skeletal muscle precursor cells.

credit: http://www.hsci.harvard.edu/newsroom/keck-award-goes-amy-wagers-hsci-executive-committee-member

Wagers's initial interest began when she signed up to become a bone marrow donor. She found herself fascinated by the ability of adult hematopoetic stem cells that are already present in the body to regenerate blood cells (5). Her lab focuses on identifying what allows these cells to continue growing and to migrate from the bone marrow to the blood vessels. Her lab eventually made the convincing demonstration that a single adult blood stem cell holds the ability to completely regenerate the entire blood system (6). In 2008, Wagers and her lab identified a key transcription factor, EGR-1, which, when significantly downregulated, induces hematopoietic stem cells in the bone marrow to proliferate and migrate into the blood vessels (7). Since the effectiveness of blood stem cell transplantion relies on the number of cells transplanted and their ability to migrate and repopulate the bone marrow, the discovery of EGR-1 has strong implications for further research into the mechanisms and signaling pathways that control migration, expansion, and differentiation of these HSCs.

These HSCs, however, do not have the ability to transdifferentiate. Stated otherwise, though they are precursors to becoming eventual adult blood cells, adult HSCs do not have the ability to become anything besides blood (8). As a result of this knowledge, Wager became interested in identifying other adult stem cells that have the potential to generate different classes of tissues. In 2004, her lab successfully isolated a population



http://www.radcliffe.edu/print/about/quarterly/w06_update.htm

of adult skeletal myogenic precursors in mice (9). Her lab currently focuses on studying these adult skeletal muscle precursor stem cells, which, like adult hematopoietic stem cells, are also present in all adult tissues and have vast regenerative potential. Her lab is currently working on further deciphering the cell lineage relationships and signaling pathways that are essential to maintain these populations and investigating methods to potentially use them for disease treatment. She also hopes to expand this approach to discover similar precursor cells for other organs such as the heart and the pancreas. Wagers' work holds great promise for contributing to future treatments for diseases such as cancer, diabetes, and muscular dystrophy.

She's got the world held by its strings

While Amy Wagers' lab is answering questions about mammalian development, Lisa Randall sits down with pen and paper and tries to explain the world through theoretical physics. While female particle physicists are rarely featured in Vogue, Randall proves her contributions are very much "in vogue." Her work has received numerous accolades, including a National Science Foundation Young Investigator Award and recognition as one of TIME Magazine's 100 Most Influential People in 2007.

"The Randall-Sundrum model suggests that we are living in a 3-dimensional 'brane,' membrane-like objects to which particles can adhere within a higher dimensional universe."

credit: http://www.epa.gov/region5fields/htm/methods/gps/index.html

Furthermore, as the first woman to receive tenure in the Princeton physics department as well as the first tenured female theoretical physicist at MIT and Harvard, Randall has silenced critics riding on the shoulders of Summers who dare to suggest that women cannot handle the rigor of academia in the hard sciences (10, 11).

While studying physics, Randall became interested in string theory, also known as the "Theory of Everything," which attempts to explain the relationship between all of the forces of the universe. String theory postulates that all the particles that make up the universe, down to the individual parts that make up an atom, are one-dimensional "strings" that can vibrate and interact with one another. Furthermore, string theory suggests that there are actually eleven dimensions of space time in addition to the three-dimensional world with which most people are already familiar: ten spatial dimensions and one of time (12).

Unsatisfied with the models explaining these extra dimensions, Randall set out to find a solution of her own. In 1999, along with her colleague Raman Sundrum, she published the Randall-Sundrum model, also known as the 5-dimensional warped geometry theory (13). This revolutionary model suggests that we are living in a 3-dimensional "brane," membrane-like objects to which particles can adhere within a higher dimensional universe (14). According to Randall's calculations, these extra dimensions could be exponentially large. Furthermore, the relative weakness of gravity in comparison to electromagnetism is explained through the model's mathematical demonstration of the warped geometry of these dimensions, which suggests that gravity has relative strength depending on where in the universe it is. Furthermore, while Newton's law suggests that we live in four non-compact dimensions, Randall has also published work that posits a

credit: http://www.das.harvard.edu/news-events/publications/profiles/radhika-nagpal

3-brane model in five dimensions (15). Randall's current research focuses on using the Large Hadron Collider to examine experimental evidence in support of these theories of higher dimensions, as well as of the existence of dark matter (16, 17).

Making robots out of anthills

Meanwhile, from a more technological niche, Radhika Nagpal, the Thomas D. Cabot Associate Professor of Computer Science at the School of Engineering and Applied Sciences at Harvard University and a recipient of numerous awards, including the Borg Early Career Award in 2010 and the Microsoft New Faculty Fellowship award in 2005, combines the biological world with computer science. Her research focuses on self-organizing multi-agent systems, or in other words, many individuals doing simple tasks and working together to perform intricate and complicated tasks. As models, Nagpal looks at systems in nature such as multicellular organisms in biology and social insects such as bees and ants. She is interested in applying the principles that guide the consistency and strength of these systems to computer systems and programmable structures. Just as the loss of a few ants does not destroy the function of the entire colony, and similarly how biological systems are incredibly adept at adapting to changing external environments, Nagpal and her group hope to design robots that act as though they are systems that exist in nature (18).

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Nagpal specifically studies the relationship between local and global behavior, applying traditional computer science techniques to run the systems as a whole combined with lessons learned from biological models for flexibility and robustness at the local level. Her work is split into three main focus areas: studying artificial multi-agent models based on "self-organizing and self-repairing behavior in biology," programming and design tactics that based on systems such as those of ants which rely on vast quantities of "relatively cheap and simple agents," and using mathematical and computational models to study how individual cells in a biological system work together to function as one expansive unit, such as muscle tissue (19). Some examples of her work have included a table that can keep itself level regardless of the state of the surface on which it is placed as well as groups of small robots that work together to perform a task such as holding a balloon (20). Her work has many applications across many disciplines such as medicine, engineering, and physics -- from developing devices to treat ankle injuries to optimizing and changing the way machines work together to complete both complex and repetitive tasks.

Undergraduates taking the reins

While the achievements of female

researchers already in the field are definitely outstanding, female undergraduates in the sciences are making great waves of their own. Since 2008, when more women than men graduated from the College, Harvard has consistently kept its female to male ratio more or less equivalent (21). Within the community of female undergraduates, upward trends have been observed, with more women concentrating in the sciences. This increase in female science concentrators is evidenced even in computer science, which historically has been the concentration with the most extreme gender imbalance. The number of women of the class of 2013 who declared as Computer Science concentrators brought the number of undergraduate women in the department up to 25 percent, almost doubling the fraction from the year before (22).

Many factors have contributed to the strong female presence in the sciences, including the formation of organizations focused specifically on the advancement of women in the sciences. Clubs such as Women in Science at Harvard-Radcliffe (WISHR) are dedicated to addressing "political, social, and academic concerns of undergraduate women in the sciences" (23). In addition to sponsoring events that tackle such issues and provide forums in which to discuss issues that women face in the sciences, WISHR works diligently to foster a close community and build a network for women in the sciences at Harvard. More recently further efforts to expand this network into a national movement have come forward. In 2009, WISE Words Magazine was founded by Julia Tartaglia '11 as WISHR's science publication. However, Tartaglia, noting the lack of a strong community of women in the sciences across college campuses, decided that there was still a distinct lack of opportunities for young female scientists to connect with one another and to find strong mentors, and consequently started the Harvard chapter of WISE Words. She is currently working full-time on its expansion to other institutions across the country (24).

Despite this progress, the disparity between males and females in particular areas of the sciences is still apparent. While the number of women in the biology department has been on the rise, the gender disparity in more "technical" areas such as math, computer science, and physics remain skewed. The popularity of concentrations such as computer science has increased dramatically due to classes such as David Malan's CS50: Introduction to Computer Science. This success largely stems from an extremely active effort on Malan's part to make the major more accessible as a whole and not to attract women specifically. From a broader perspective, the day when the number of female and male concentrators is equal within all scientific disciplines is still in the future. Through the leadership of role models such as Wagers, Randall and Nagpal as well as student leaders such as Tartaglia, this day will hopefully come sooner rather than later.

There remains room for progress, but there is no question that women have come a long way since 1636. Science would not be what it is today without the bright minds, diligent work and superb innovation generated since women have joined and revolutionzed scientific fields. There is still work to be done for women and men to reach a complete level of equality, both in the sciences and in other arenas. However, significant progress is being made everyday and will continue to be made as long as the women such as those at Harvard continue to explore, question, and assert their minds toward contributing to the sciences and to the betterment of society.

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