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Promoting Research and Minority Participation in the Mathematical Sciences at Arizona State University, August 11, 2006

Mathematical Theoretical Biology Institute (MTBI[1])

Every Summer MTBI[2] offers sequential research experiences for undergraduate and graduate students and most of the participants come from underrepresented minority groups (see description below). The program, which has been held eleven years in conjunction with Cornell University, Los Alamos National Laboratory, and Arizona State University[3], focuses on the field of applied mathematics and its applications to the biological and social sciences. MTBI provides research mentorship training for students who want to work at the interface of applied mathematics and theoretical and computational biology. Since 1996, MTBI alumni have co-authored 111[4] technical reports. Some of these reports have been published or become the basis of the research efforts of MTBI associated faculty (adjunct and visiting professors from across the USA and other nations), postdoctoral and graduate students, undergraduate students, visitors and faculty. Most of the research efforts have been at the interface of the *social and natural* sciences and mathematics. MTBI has mentored and supported 285[5] undergraduate students, and 31 graduate students, of which 14 had participated previously in MTBI as undergraduate students.

MTBI has sent 128 students from underrepresented minority groups to graduate school over its *first ten*[6] years of existence, and a total of 152 students overall. Furthermore, 53% have been females, including 66 from minority groups. Professor Carlos Castillo-Chavez[7], MTBI Director and founder has led by its director and founder,

In the years 2001 and 2002, prior to MTBI producing Ph.D. graduates, it is worth noting that the U.S. awarded an average of 10 Ph.D.s to Latinos[8]. MTBI's efforts have significantly increased the national rate of production of U.S. Ph.D.'s. In 2005, MTBI alumni received 10 Ph.D.s in the mathematical sciences, 8 of which were awarded to underrepresented minority groups. This is almost 1/4 of the national total. Of those, 6 were Latino, 1/3 for that year (6 out of 18). Of the 10 total MTBI alumni Ph.D. graduates, 7 took on prestigious postdoctoral positions and 1 became an Assistant Professor at the University of Puerto Rico, Mayaguez campus. Looking at female graduates, we produced over 1/3 (6 out of 15) of the total female underrepresented minority groups for 2005. Four of those six were Latino, over half of the national production (4 out of 7).

MTBI Alumni have, or currently are attending universities across the United States, Colombia, Argentina, Britain and Mexico. MTBI sequential summer programs have helped establish large

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[1] http://mtbi.asu.edu/
[2] MTBI model has instigated the establishment of two REU minority programs including the Summer Institute for Undergraduates in Mathematics (http://cuhwww.upr.clu.edu/~simu/) and the newly established Applied Mathematics Sciences Summer Institute (http://www.amssi.org/).
[3] MTBI year round efforts have been supported through grants by the *National Security Agency, the National Science Foundation, the Sloan Foundation, Los Alamos National Laboratory, and the offices of the provosts of Cornell University and Arizona State University.*
[4] Includes the reports of the summer of 2006
[5] This figure includes students from the summer of 2006 who completed their work on July 30, 2006.
[6] This number do not include the admission to graduate school of members of the summer of 2006 MTBI class.
[7] Winner of the 1997 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring
[8] The data for national Ph.D. graduates was obtained from the AMS notices
http://www.ams.org/notices/200602/05firstreport.pdf

communities of underrepresented U.S. minorities at Cornell University[9] (totaling twenty-four[10], eighteen[11] of which are minority), at the University of Iowa[12] (totaling seventeen[13], fourteen of which are minority) and Arizona State University (totaling twenty-five[14], seventeen of which are minority). MTBI Alumni have established a community of minority scholars at ASU and facilitated additional recruitment into our graduate program. We currently have 27 US minorities[15] at ASU including 21 US Latinos and 6 African-American. ASU[16] has just added 5 MTBI alumni[17] (including 3 more US underrepresented minorities) as well as four MTBI recruits (also underrepresented US minorities) to its graduate program in the fall of 2007. ASU has now the graduate mathematics program with the largest US minority student population (33[18]) in the nation[19]. Furthermore, we have extended letters of offer (2007 January admission) to three[20] additional US underrepresented minorities.

MTBI summer research programs are run like NSF-sponsored workshops[21]. New students take three and half weeks of intense training in dynamical systems (broadly understood to include stochastic processes), modeling in the biological and social sciences and become familiar with tools like MATLAB[22], MATHEMATICA[23], XPP-AUT[24], other computational packages and LATEX[25]. Participants form groups of 3-4 students around a project of their own choice at the end of the initial training period. In other words, students set each the research agenda each summer. This philosophy accounts for the diversity of research manuscripts that have been produced[26] over the past decade. Each group gets assigned a faculty advisor and provided with

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[9] Most of the minority students in the mathematical sciences since 1996 had come from MTBI alumni. Four of them completed their Ph.D. in 2005 alone and three are expected to graduate before the end of 2007. The success rate (obtained their Ph.D.) at Cornell University when it comes down to MTBI alumni (the only data that we have) is over 80%.

[10] That is, 24 MTBI alumni have enrolled in a mathematical sciences program at Cornell University. Students enrolled in the departments of biological statistics and computational biology, statistics and the applied mathematics program.

[11] Three US minorities receive a MS by 2000 and left. Six US Minorities have received their Ph.D.s with three more expected by December of 2006. Five more will receive their degrees over the next two years and one will transfer to a Ph.D. program elsewhere.

[12] The Mathematics Department at the University of Iowa has created a model in which most if not all members of the mathematics faculty participate. It recruits heavily in Puerto Rico, Historically Black Colleges and MTBI. The Mathematics Department at the University of Iowa received a 2004 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

[13] That is, 17 MTBI alumni (participated in summer program) have enrolled in a mathematical sciences program at the University of Iowa—most are in the mathematics department.

[14] There are 25 MTBI alumni who have enrolled at ASU. Twenty-three of them have enrolled in the mathematical sciences (mathematics and statistics) and two in the sciences. This group includes 20 permanent residents or US citizens and five international students.

[15] Twenty-seven minority students in the mathematics department most recruited or partially supported by MTBI.

[16] The premier graduate program in the mathematical sciences is Richard Tapia's at Rice University. Richard who received a 1997 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring has been the largest producer of US minority Ph.D.'s over the past two decades. Additional strong efforts led in part by Raymond Johnson, have been carried out at the University of Maryland. In December of 2000 alone, three African-American women received their Ph.D. in applied mathematics from the University of Maryland.

[17] This group includes four US-underrepresented minorities, a US female student and a female international student.

[18] One left with an MS in the summer of 2006.

[19] The mathematics department at the university of Iowa has had an average number of 23 US minority students over the past few years (David Manderscheid, chair mathematics department, personal communication), has graduated 2-3 US minorities per year over *at least* the past two years.

[20] We expect that these three students will accept ASU support offers. Their expected admission will bring the number of US underrepresented minorities *within the mathematics* department at ASU to **36** and the number of MTBI alumni, which include this group, who have enrolled at ASU will have reached **30**.

[21] Our efforts have been carried out with the active collaboration of the Santa Fe Institute (NM) and the Center for Statistical Genetics and Genome Science Training Program at the University of Michigan.

[22] MATLAB is a product of MathWorks (http://www.mathworks.com/).

[23] It is a product of WOLFRAMRESEARCH (http://www.wolfram.com/).

[24] http://www.math.pitt.edu/~bard/xpp/xpp.html

[25] http://www.latex-project.org/

[26] MTBI alumni are prolific writers. *Am I too fat? Bulimia as an epidemic* has appeared in the Journal of Mathematical Psychology (47 (2003) 515-526); and the article *Effects of education, vaccination and treatment on HIV transmission*

appropriate graduate student support. Between 20% and 33% of the undergraduates participate in two summers and most of the 31 graduate students have participated three times with some as many as seven times. MTBI's summer workshop produces an *average* of **10** technical reports per year. The research productivity of each summer group of young investigators has instigated the research of a large percentage of its participants (students, faculty and postdoctoral students) over the past decade.

MTBI alumni[27] enrolled at MTBI's home institution[28] have received support for their graduate studies leading towards the Ph.D.'s via fellowship, research assistantships and research training grant support negotiated and/or administered by MTBI. The area of study has been dictated exclusively by the students' objectives. Recent alumni (Cornell) have received their Ph.D.'s in numerical analysis, mathematics of finance, statistics, computational biology, mathematical physiology, mathematical epidemiology, biometry and dynamical systems. At Cornell University, sixteen MTBI associated minority students were the recipients of *sixteen* Sloan Fellowships while about six MTBI alumni were supported by an RTG[29] grant (pre-IGERT) in computational biology. MTBI at ASU has worked hard to establish similar forms of support. In fact, *nine* Sloan fellowships have been awarded to MTBI alumni which is but one of the ways that MTBI and its partners[30] have found to maintain the philosophy of the *New American University* alive and well.

MTBI philosophy adheres to the principles of the *New American University*[31] that is, MTBI is an institute that, like is home institution ASU[32], wants to be judged by the quality of the research and academic accomplishments of its students and alumni rather than by their academic pedigree or prior access to *selective* educational settings; MTBI wants to be an institute whose alumni, while pursuing their scholarly and scientific interests, "also consider the public good[33]"; MTBI also wants t be an institute whose students, alumni, faculty, and staff "transcend the concept of community service to accept responsibility for the economic, social, cultural, and environmental vitality of the communities they serve[34]."

Like most successful programs, MTBI's efforts have not been carried alone. MTBI support by the Cornell University's administration[35] was terrific and we have had no less support at ASU[36]. Crucial to all our efforts have been the partnership that we have developed with the Hispanic Research Center. Albert McHenry, Gary Keller, Antonio Garcia and Michael Sullivan are simply the partners that every university dreams to have. MTBI successes have been possibly because of the leadership and hard work of Al, Gary, Tony, Michael and the wonderful HRC staff.

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in homosexuals with genetic heterogeneity has appeared in the Journal Mathematical Biosciences (187 (2004) 111-133) are but two examples of how prolific our students are.

[27] The term MTBI alumni has been used throughout to identify primarily those who participated in one or more summer research experiences. However, MTBI does not focus *exclusively* on summer research experiences. In fact, it has had a large number of support programs that involve sponsored research at the interface of the mathematical and natural and social sciences as well as the administration of various human resource programs including RTGs, Sloan Fellowships, Mentorship Programs and Additional Educational and Training Programs K-20 and beyond.

[28] Cornell University (1996-) and Arizona State University (2004+)

[29] I was the PI or co-PI or this NSF RTG grant for over a decade

[30] The rate of growth in its minority graduate student population would have not been possible without the support programs instigated by the Hispanic Research Center led by Gary Keller and the openness of the mathematics faculty that has embraced MTBI/HRC efforts to make a difference.

[31] http://www.asu.edu/president/newamericanuniversity/arizona/

[32] Here, I am paraphrasing ASU's mission, as described in its web site, but in the context of the work that we carried out by MTBI.

[33] http://www.asu.edu/president/newamericanuniversity/arizona/

[34] http://www.asu.edu/president/newamericanuniversity/arizona/

[35] Malden Nesheim, Don Randel, Biddy Martin, Frank Rhodes, David Call, Hunter R Rawlings III and W. Kent Fuchs.

[36] Michael Crow, Milton Glick, David Young, Maria Allison, Marjorie Zatz, Jon Fink, Andrew Webber and Peter Crouch have done everything possible to help the goals and the vision of MTBI.
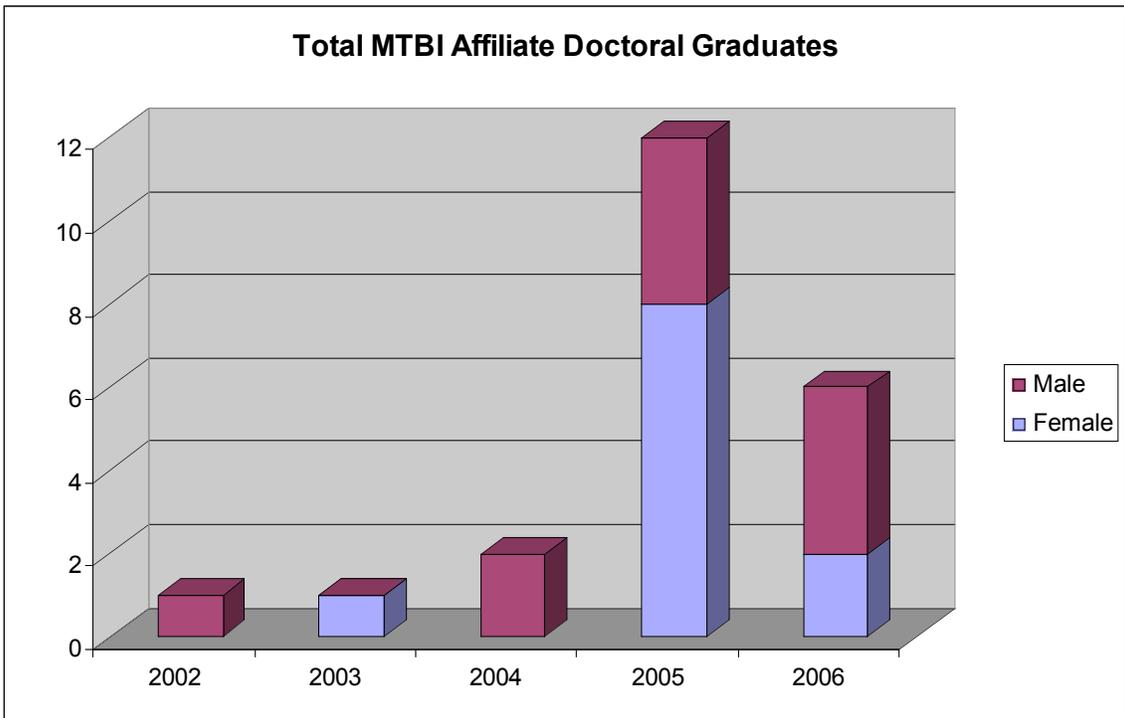
* Underrepresented U.S. minorities included U.S. citizens and permanent residents only.
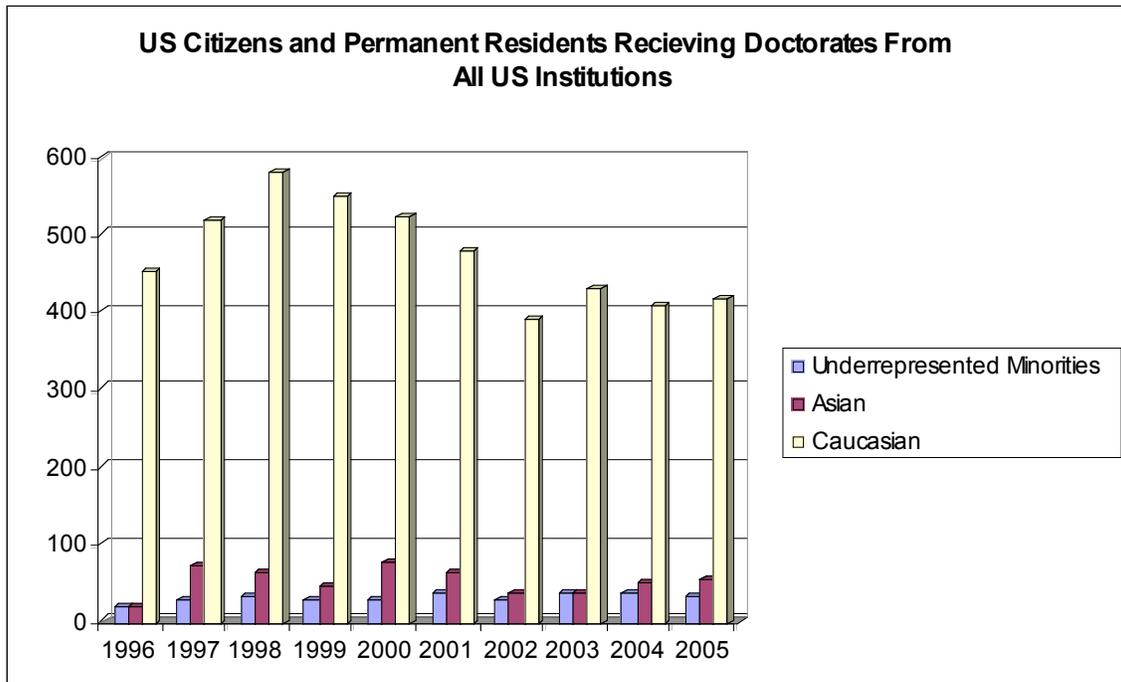

National graduation statistics from the Annual Survey of the Mathematical Sciences, minority compared to non-minority (AMS Notices)
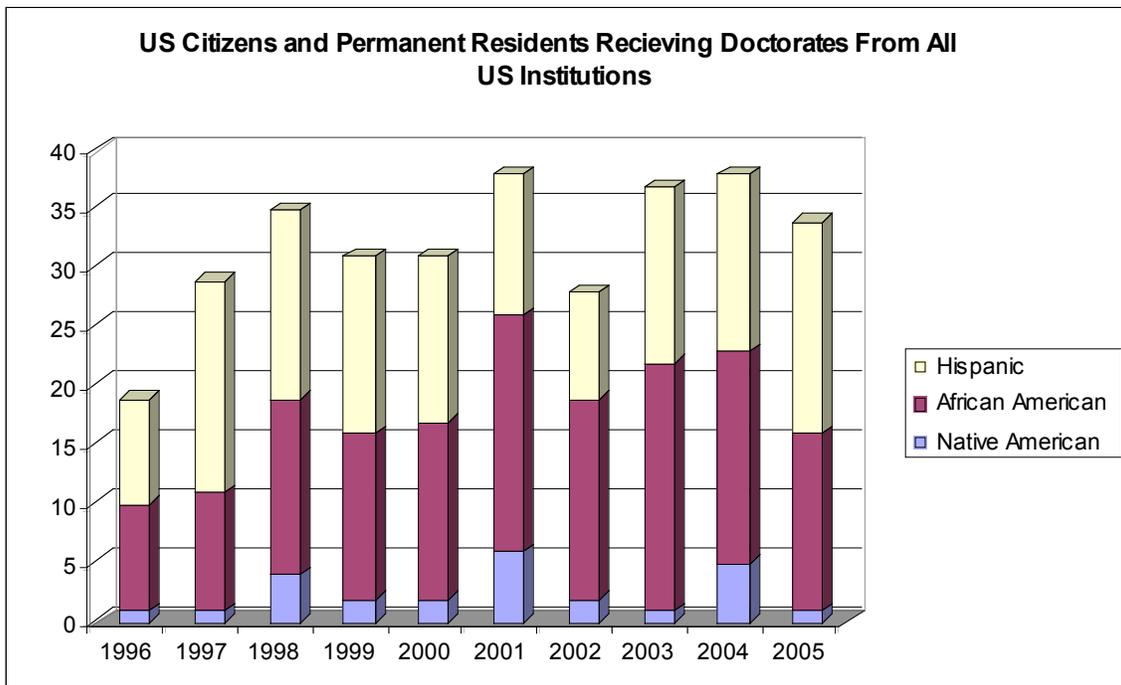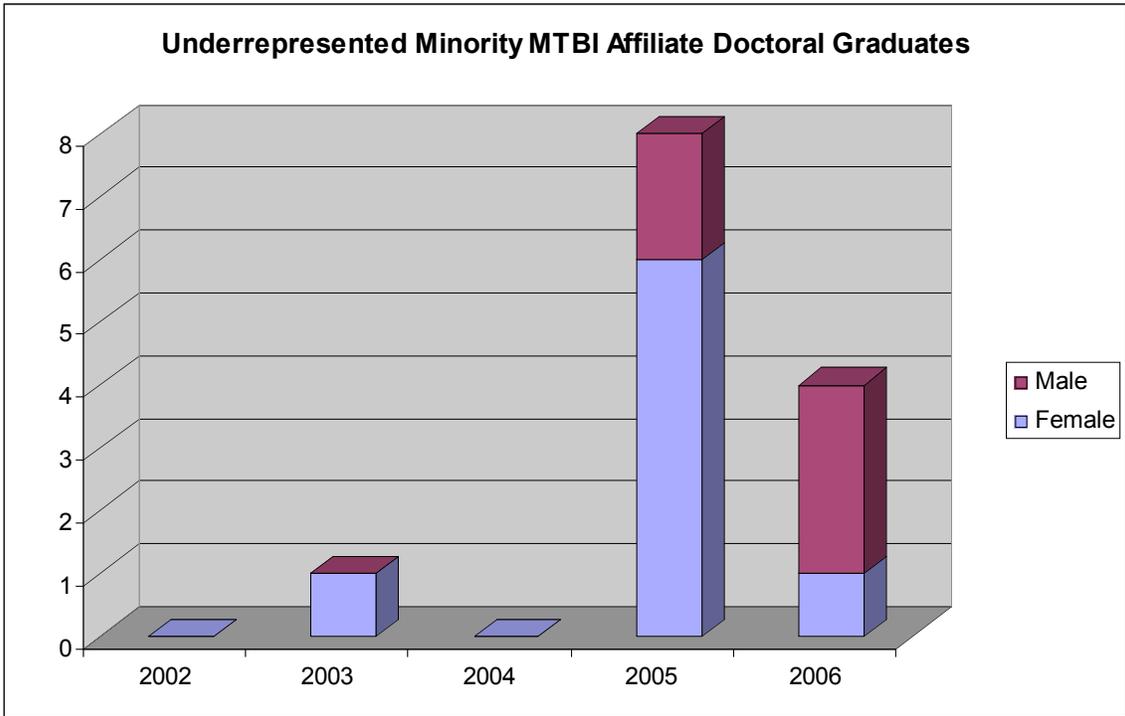

National graduation statistics from the Annual Survey of the Mathematical Sciences (AMS Notices)
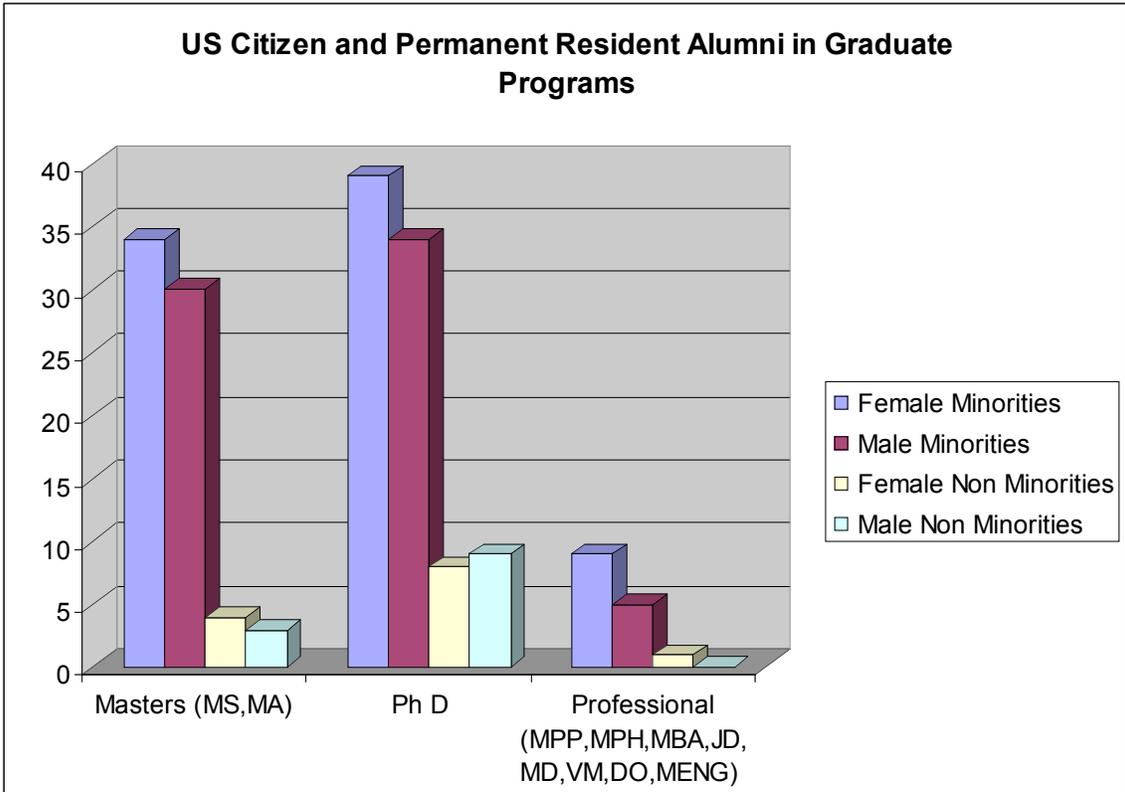
Total MTBI Affiliate Doctoral Graduates

Current doctoral graduates as of July 2006

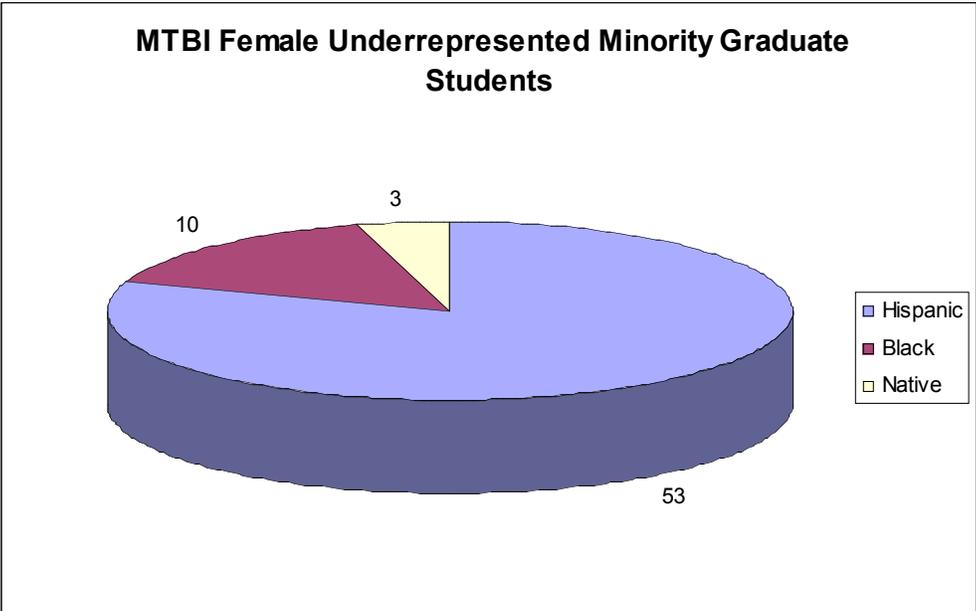**Cumulative Total MTBI Affiliated Doctoral Graduates**
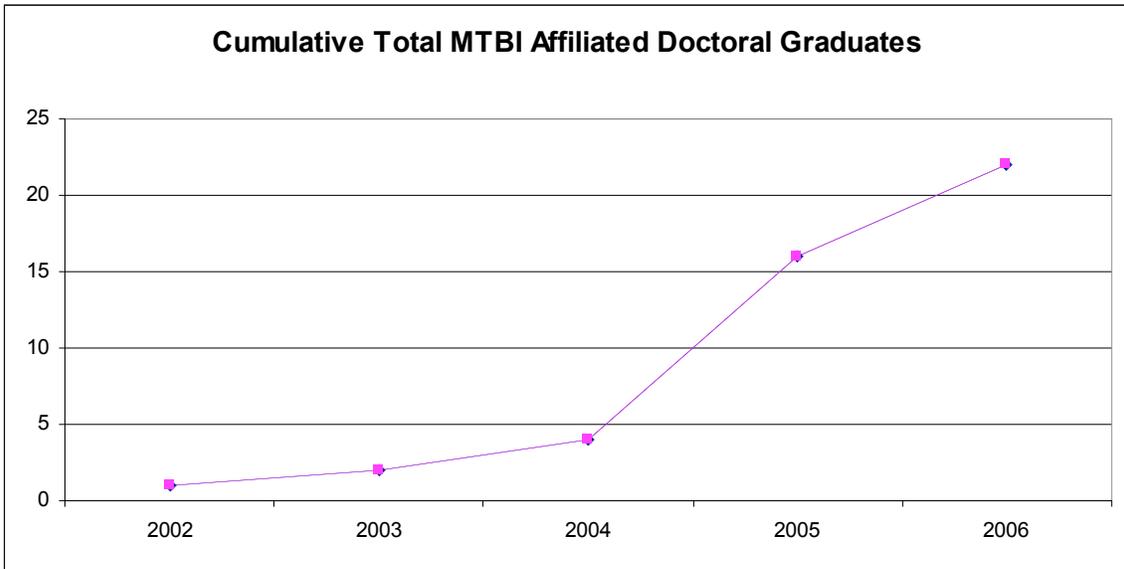
The total number of doctoral graduates, minority and non-minority

Annual MTBI production of Ph.D. graduates in the mathematical sciences

MTBI alumni students who are either in graduate school or who have completed their graduate program

MTBI Female Underrepresented Minority Graduate Students

Includes M.S. and Ph.D. students who are currently in graduate school, and those who have graduated

Underrepresented Female PhD Students in all Citizenships
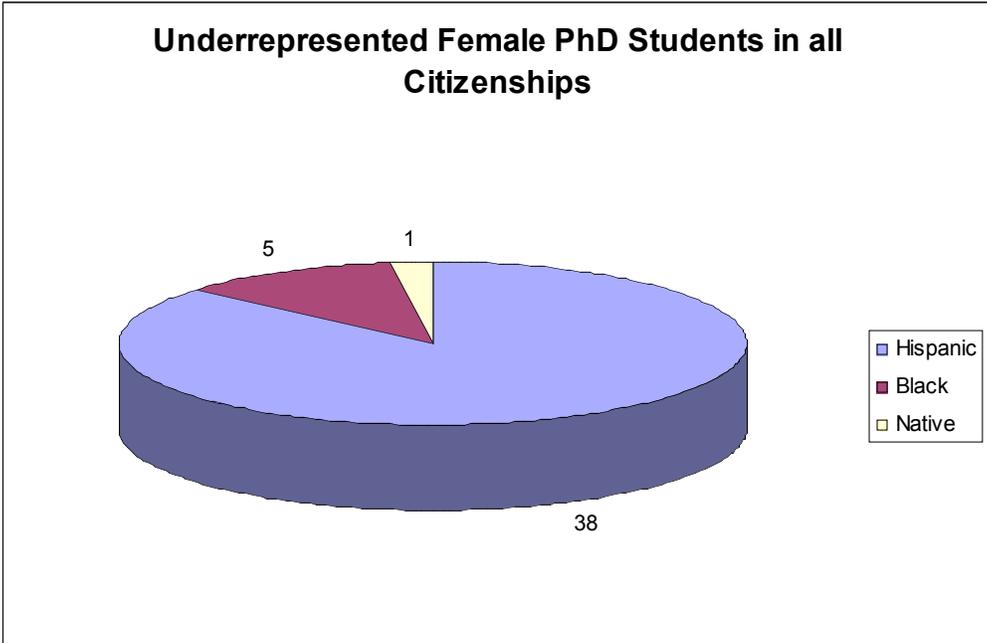
U.S. citizens, permanent residents and internationals, including both students who are currently in graduate school, and those who have graduated

Institute for Strengthening Understanding of Mathematics and Science (SUMS)

SUMS[37] Math-Science Honors Program is an intense academic program that provides motivated students an outstanding opportunity to begin college mathematics and science studies before graduating from high school. Participants are selected on the basis of their academic achievement, financial need, and personal/career objectives. During the first eleven years of its existence, participants of the Math-Science Honors Program were students from underrepresented minority groups exclusively. In 1996, the program broadened its focus and participation was opened to all Arizona high school students meeting the program's academic and socio-economic criteria to include students who are underrepresented in the fields of mathematics, science and engineering. All program expenses are provided by ASU.

In 1985, 32 minority students from Phoenix area high schools were brought to the ASU campus and immersed in an intense learning experience in mathematics. Encouraged by the students' response, the program content was strengthened to challenge participants with a college-level mathematics course for credit the following summer. Today, high school students from across the state of Arizona including the surrounding American Indian reservations compete for participation in the Math-Science Honors Program. As of the summer of 2006, 2,098 students have attended the Math-Science Honors Program with a freshman class of 24 entering ASU in the fall of 2006.

The philosophy of the Math-Science Honors Program is that success in mathematics is predicated on discipline and hard work. Each summer, high school students from across the state are brought to the ASU campus and enrolled in a university level mathematics or science course for college credit. Classes are intense and rigorous and standards are high. Features of the program include instruction in a traditional format, daily problem solving sessions, frequent testing, and one-on-one tutoring. Participants reside on the ASU campus for the entire duration of the program.

The structure of the Math-Science Honors Program facilitates interaction among culturally diverse students in an academically challenging environment. Students join a diverse community of peers with similar interests. The program structure also includes dedicated and experienced faculty and staff that interact frequently with the participants and closely monitor their progress.

Students who participate in the Math-Science Honors Program learn about commitment, self-discipline, and perseverance. Many participants enroll at ASU after graduation from high school. They enter the university with increased self-confidence and an awareness of the opportunities available to them. The Math-Science Honors Program continues to support and encourage these students to maintain high academic standards as they pursue their educational and career choices. In 1993, the SUMS institute developed as an outgrowth of the Math-Science Honors program, which was established in 1985 by Professor Joaquín Bustoz Jr.[38], who led the program until his untimely death on August 13, 2003. Professor Carlos Castillo-Chavez took over its leadership in 2004.

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[37] Winner of a 2003 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring

[38] Winner of a 1996 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring: Joaquin was a member of the inaugural class of recipients of this prestigious award.

Ten Selected Recent Publications Involving MTBI Participants and/or Alumni.

1. **Baojun, S., Garsow-Castillo, M, Castillo-Garsow, C., et. al**., "Raves Clubs, and Ecstassy: The Impact of Peer Pressure," Volume 3, Number 1, January 2006 pp. 1–18, *Journal of Mathematical Biosciences and Engineering*.

2. **Gjorgjieva, J., Smith K., Chowell, G., Sanchez, F., Snyder J., and C Castillo-Chavez**, "The Role of Vaccination in the Control of SARS." Volume 2, Number 4, October 2005 pp. 753–769, *Journal of Mathematical Biosciences and Engineering*.

3. **Kribs-Zaleta, C., Lee, M., Román, C., Wiley, S., & Hernández-Suárez, C.M.** "The effect of the HIV/Aids epidemic on Africa's truck drivers." *Mathematical Biosciences and Engineering*, 2, (4), 771-788. 2005.

4. **Chowell, G., Cintron-Arias, A., Del Valle, S., Sanchez, F., Song B., Hyman, J. M. and C. Castillo-Chavez**. "Homeland Security and the Deliberate Release of Biological Agents." In: *Modeling The Dynamics of Human Diseases: Emerging Paradigms and Challenges*. Gumel A. (Chief Editor), Castillo-Chavez, C., Clemence, D.P. and R.E. Mickens, **American Mathematical Society** (in press).

5. **Kasseem, G. T., Roudenko, S., Tennenbaum, S. and C. Castillo-Chavez**. "The Role of Transactional Sex in Spreading HIV/AIDS in Nigeria: A Modeling Perspective." In: *Modeling The Dynamics of Human Diseases: Emerging Paradigms and Challenges*. Gumel A. (Chief Editor), Castillo-Chavez, C., Clemence, D.P. and R.E. Mickens, **American Mathematical Society** (in press).

6. **Rios-Soto, K.R., Castillo-Chavez, C., Neubert, M., Titi, E.S., and A-A Yakubu**. "Epidemic Spread in Populations at Demographic Equilibrium." In: *Modeling The Dynamics of Human Diseases: Emerging Paradigms and Challenges*. Gumel A. (Chief Editor), Castillo-Chavez, C., Clemence, D.P. and R.E. Mickens, **American Mathematical Society** (in press).

7. **Sanchez, F., Engman, M., Harrington, L. and C. Castillo-Chavez**. "Models for Dengue Transmission and Control." In: *Modeling The Dynamics of Human Diseases: Emerging Paradigms and Challenges*. Gumel A. (Chief Editor), Castillo-Chavez, C., Clemence, D.P. and R.E. Mickens, **American Mathematical Society** (in press).

8. **Del Valle, S., Morales Evangelista, A., Velasco, M.C., Kribs-Zaleta, C.M., Hsu Schmitz, S.F.** "Effects of education, vaccination and treatment on HIV transmission in homosexuals with genetic heterogeneity" *Mathematical Biosciences*, 187, 111-133. 2004.

9. **González, B. Huerta-Sánchez, E., Ortiz-Nieves, A., Vázquez-Alvarez, T., & Kribs-Zaleta, C.** "*Am I too fat? Bulimia as an epidemic*". *Journal of Mathematical Psychology*, 47, 515-526. 2003.

10. **Chowell, G., P. W. Fenimore, M. A. Castillo-Garsow and C. Castillo-Chavez**. "SARS Outbreaks in Ontario, Hong Kong and Singapore: the role of diagnosis and isolation as a control mechanism**."** *J. Theoretical Biology*, **224, 1-8, 2003**.