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ABSTRACT

The purpose of Project Kaleidoscope is to be a catalyst for action to encourage a national environment for reform in undergraduate education in science and mathematics in the United States. This report, the second of two volumes, presents ideas from Project Kaleidoscope that involve changing undergraduate science and mathematics education through continued dialogue and partnerships between funders, policy makers, and science and mathematics educators. Section 1 of this volume focuses on planning facilities for undergraduate science and mathematics. The perspectives on the planning process come from administrators, faculty, and design professionals, each underscoring the need for a clear vision of the institutional mission and of the way science and mathematics relate to and undergird that mission. The architectural layouts provided suggested approaches to designing facilities that support good teaching and learning in science. Section 2 presents a discussion and inventory of the research undertaken as a part of Project Kaleidoscope. The greater part of this section is made up of four appendixes providing information on institutional classifications, a paper describing some limitations of the data, a set of 57 tables, and maps showing locations of Hispanic Association of Colleges and Universities, institutions and Historically Black Colleges and Universities. Section 3 consists of selected writings that address aspects of the liberal arts experience that must be reviewed as reforms are being considered. (PR)

PROJECT KALEIDOSCOPE

What Works: Building Natural Science Communities

A Plan For Strengthening Undergraduate Science and Mathematics

Volume Two

What Works: Resources For Reform

Strengthening Undergraduate Science and Mathematics

A Report of Project Kaleidoscope

Volume Two

In August 1989, The Independent Colleges Office (ICO), based in Washington, D.C., received a grant from the National Science Foundation (NSF) in support of a project to develop an agenda for strengthening science and mathematics in this nation's liberal arts community. Project Kaleidoscope also received support from the Pew Charitable Trusts, the Camille and Henry Dreyfus Foundation, Inc., the Exxon Education Foundation, and the Kellogg Foundation.

Called Project Kaleidoscope, this effort paralleled similar NSF-funded projects focused on the undergraduate sector at two-year institutions, at public comprehensive universities, and at major research universities. The history and present condition of the nation's scientific and educational infrastructure, as well as the challenges facing the country's liberal arts colleges and other predominantly undergraduate institutions, established the context for Project Kaleidoscope.

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In June of this year, the committees of Project Kaleidoscope presented a plan of action for strengthening undergraduate science and mathematics to Dr. Walter Massey, Director of the National Science Foundation, and to educational leaders across the country. As the basis for that plan of action, we described the learning communities that succeed in motivating students to learn and **enjoy** science and mathematics, and to grow in self-esteem through faculty and peer recognition of expanding competence. These are the natural science communities that liberal arts colleges strive to create; where learning is investigative and personal, and the curriculum is lean, but rich in hands-on experiences in classroom and lab. In presenting that plan of action, we challenged ourselves and all others responsible for building and supporting strong undergraduate programs in math and science to move ahead quickly to make the reforms in teaching and learning that we advocate.

Our claim is that we know what works in science and mathematics and that it is time for action. The primary barrier to reform is not money, but will--which must be driven by a compelling vision of what works. Faculty, administrators, and trustees, executives of private foundations, and staff of government agencies need to work together to develop a national climate for reform that will make science and mathematics a more integral and exciting part of educational life for all our students.

In Volume II, *What Works: Resources for Reform*, we explore issues that were introduced at the National Colloquium and in our earlier report. Section I focuses on the planning of facilities for undergraduate science and mathematics, an activity that is now underway at countless campuses across the country. We hope that the discussions presented in Volume I of the report of Project Kaleidoscope, supplemented by those presented here, will make that planning more productive.

I would like to make note of a significant contribution to this volume, and to the larger effort of Project Kaleidoscope in the work of Dr. Carol Fuller, who served as Research Associate during the past two years. Section II of this volume is the product of years of careful study of the patterns of institutional productivity in undergraduate science and mathematics. Dr. Fuller provides us with a new perspective on the national data, depicting institutional and sector productivity in these disciplines--disaggregated by field, race, and gender. Significant issues of public and institutional policy depend on understanding the broader picture from this perspective. In reviewing her data, we see that there are successful undergraduate programs in science and mathematics in colleges and universities of all types and sizes. We also begin to have a clearer sense of how to shape reforms based on the experience of strong programs and, equally important, to establish means to evaluate the effectiveness of those reforms.

The Executive and the Advisory/Action Committees of Project Kaleidoscope join me in expressing great pleasure in sharing these materials with you. We hope they are useful as you join us in the work of building natural science communities in colleges and universities across the country.

Daniel F. Sullivan
Chair, Project Kaleidoscope Executive Committee

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BACKGROUND

THE PROJECT KALEIDOSCOPE NATIONAL COLLOQUIUM was held on February 4 & 5, 1991 at the National Academy of Sciences. THE PROJECT KALEIDOSCOPE VOLUME I: "WHAT WORKS: BUILDING NATURAL SCIENCE COMMUNITIES," published June, 1991, offered suggestions for future change--based on documented successes of WHAT WORKS in strong programs in undergraduate science and mathematics in the nation's liberal arts colleges.

Designed from the beginning to be a catalyst for action, the goals of both the National Colloquium and Volume I were to:

- ♦ inform the educational and scientific communities what our project had discovered;
- ♦ spotlight the national need to build and sustain strong undergraduate science and mathematics programs;
- ♦ initiate the development of partnerships for continued strengthening of undergraduate science and mathematics;
- ♦ make a public statement about the crucial contribution that undergraduate institutions of liberal learning make to the nation's science and mathematics infrastructure;
- ♦ encourage an atmosphere in which more informed decisions can be made regarding undergraduate science and mathematics;
- ♦ provide a forum for cross-disciplinary dialogue involving science and mathematics faculty and administrators for institutions of liberal learning across the country; and
- ♦ equip institutional teams to take a leadership role in strengthening undergraduate science and mathematics on their campuses and nationwide.

Unless everyone with a stake in undergraduate science and mathematics education makes tough decisions now about strategic priorities--about dollars, people, space, and time--effective reform will not happen. Unless all partners work together, this nation's educational shortcomings will not be addressed adequately. Effective reforms take money, to be sure. But more important is an environment for reform that encourages planning, fosters creativity, and rewards useful innovation. The environment for reform must be based on a driving vision of what works.

Now is the time for action. There is a national consensus about the nature of the problem and the need to address it. All the partners--schools, colleges and universities, federal and state governments, professional associations, and private foundations are moving from analysis to action.
-Project Kaleidoscope, What Works, *Volume I, 1991.*

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GOALS OF PROJECT KALEIDOSCOPE

The environment for reform must be based on a driving vision of what works.
-Project Kaleidoscope, What Works, *Volume I, 1991.*

Project Kaleidoscope is to be a catalyst for action, to encourage a national environment for reform directed toward the following goals:

GOAL I. Increase the number, quality, and persistence of individuals in careers relating to science and mathematics, and educate citizens to understand the role of science and technology in their world.

A. To kindle the interest of all students in science and mathematics.
B. To focus faculty and institutional energy on student learning.
C. To increase the total number of students, especially those under-represented in math and science, completing the baccalaureate degree in science and mathematics.
D. To promote the professional development of those who teach science and mathematics at all levels.

GOAL II. Promote understanding of "what works" in teaching and learning undergraduate science and mathematics.

A. To foster the development of learning communities for the study of the natural sciences and mathematics.
B. To promote an investigative, hands-on curriculum.
C. To document and strengthen the critical link between faculty scholarship and teaching.
D. To advocate the teaching of science, mathematics, and technology in context, emphasizing connections across the curriculum and impacts on contemporary life.

GOAL III. Increase recognition of and support for the essential role of the liberal arts colleges in meeting the challenges faced by our nation in science and technology.
A. To ensure that the contributions of liberal arts institutions are taken into account in the development of national policy on education and research in science and technology.
B. To develop coherent, long-range plans at the institutional, regional, and national levels to sustain the contributions of liberal arts colleges.
C. To build partnerships among all those committed to strengthening undergraduate science and mathematics.
D. To develop strategies for dissemination and evaluation of "what works."

WHAT WORKS:
BUILDING NATURAL SCIENCE COMMUNITIES

The most important attribute of undergraduate programs that attract and sustain student interest in science and mathematics is a thriving community of students and faculty. Such "natural science communities" offer students a learning environment that is demonstrably effective:

♦ Learning that is experiential, investigative, hands-on, and steeped in investigation from the very first courses for all students through capstone courses for science and mathematics majors.

♦ Learning that is personally meaningful to students and faculty, that makes connections to other fields of inquiry, that is embedded in the context of its own history and rationale, and that suggests practical applications related to the experience of students.

♦ Learning that takes place in a community where faculty are committed equally to undergraduate teaching and to their own intellectual vitality, where faculty see students as partners in learning, where students collaborate with one another.

Programs organized around these guiding principles motivate students and give them the skills and confidence to succeed. Thus empowered, students learn science and mathematics.

Building such natural science communities requires informed leadership at both the institutional and the national level--leadership with a commitment to a vision of what works and with a clear understanding of how to foster an environment for reform.

INTRODUCTION

Alice: Would you please tell me which way I ought to go from here?
Cheshire Cat: That depends on where you want to get to.
Lewis Carroll

The themes that thread through this volume, *What Works: Resources for Reform,* expand upon the discussion presented in Volume I of the report of Project Kaleidoscope, *What Works: Building Natural Science Communities.* These volumes are designed to complement each other--to be used as resources by individual faculty and administrators, by departments and campus-wide committees, and by others actively involved in the national effort to strengthen science and mathematics education, at all levels.

How can this be used as a resource for reform? As with the first volume, a goal of this volume of our report is to illustrate that strong undergraduate programs in science and mathematics can be found today on campuses across the country. All those committed to strengthening undergraduate science and mathematics can have a clearer sense of direction by examining what is happening at a single campus, and by reading some of the more provocative writings from those leading the educational reformation. The challenge then is to understand how to incorporate such theories and practices into our own efforts.

Section I of this volume focuses on planning facilities for undergraduate science and mathematics. The perspectives on the planning process come from administrators, faculty, and design professionals, each underscoring the need for a clear vision of the institutional mission and of the way science and mathematics relate to and undergird that mission. The architectural layouts suggest some creative approaches to designing facilities that support good teaching and learning in the sciences.

In Section II, we present an extended discussion and inventory of the research undertaken as a part of Project Kaleidoscope. This material will help all of us understand better the role that various sectors within the educational community--and ndividual institutions within sectors--play in the larger national effort to attract a stronger and more diverse pool of talented students into the study of science and mathematics.

The selected writings highlighted in Section III can be used by institutional teams as they begin to plan together. These studies address various aspects of the liberal arts experience that must be considered as reforms--within individual courses or campus wide--are being considered.

Our goal is that Project Kaleidoscope contributes to building the partnerships--on an individual campus and between institutions across the country--that are essential if we are to set a new course for undergraduate science and mathematics. Several further Project Kaleidoscope activities are in the planning stages. In these, we will continue to focus on the various facets of undergraduate science and mathematics that must be considered, separately and as a whole, if our reform efforts are to succeed.

PLANNING FACILITIES FOR UNDERGRADUATE SCIENCE AND MATHEMATICS

PERSPECTIVES AND ILLUSTRATIONS

SECTION I

INTRODUCTION

Our spaces both reflect and shape what happens in them.

Nowhere is this more evident than when we begin to consider facilities for undergraduate programs in science and mathematics. A look at facilities--how space has been designed, how space is being used and maintained--gives a clear clue to the vision behind the program accommodated therein.

This integral relationship between space and program is the first reason for the attention given to facilities throughout the work of Project Kaleidoscope. If we are to encourage the daily interaction between student and faculty and between student and student; the relationship of offices, laboratories, common areas, and traffic patterns has to promote such interaction. If we are to attract students to disciplines which have a reputation of being difficult, forbidding and impersonal, the spaces need to provide a humane environment, where students feel welcome to take an active role and become personally involved in their learning. If we are to give students access to the technology that can make their learning most exciting and productive and that will suggest career options, then our spaces need to provide an environment in which sophisticated instruments can be used and maintained with ease.

> ***[Students should have] access to instruction that generates enthusiasm and fosters long-term learning; access to a curriculum that is relevant, flexible and within their capabilities; access to a human environment that is intellectually stimulating and emotionally supportive; and access to a physical environment that support the other three dimensions. (Emphasis added.) These crucial components are strongly interrelated; weakness in any one diminishes the quality of undergraduate education.***
>
> *Sigma Xi, 1989*

The second reason for our attention to the physical environment is because of the current crisis in undergraduate science facilities. Not only are existing spaces inadequate to accommodate strong programs, many buildings are deteriorating, structurally inflexible, and obsolete. Many need to be brought up to standards for health and safety; many need to be renovated to accommodate computer networks and other sophisticated technologies that are now an integral part of the undergraduate experience.

Our hope is that by providing examples of successful efforts, those campuses that are just beginning the process of planning to build and renovate spaces for science can proceed more efficiently, and more cost- effectively. The crisis in undergraduate facilities is compounded by the present fiscal climate. But, although colleges, universities, and governmental agencies have limited resources, the facilities dilemma must be addressed if this country is to have undergraduate programs that meet the needs of present and future students in science and mathematics.

MOVING FROM INSTITUTIONAL VISION TO PHYSICAL REALITY

Arthur J. Lidsky, AICP

Colleges can be described as institutions with long life, animated by balancing continuity and change. Nowhere is that balancing so challenging these days as in math, computer science, and the sciences. Within the last several decades, the very foundations of these disciplines have changed. As a result, the sciences are more interrelated and interdisciplinary. Emerging fields such as biochemistry, biophysics, environmental sciences, geochemistry, geophysics, and neuroscience are examples of a blurring of the boundaries between traditionally distinct disciplines.

Planning for science buildings should be a participatory process.

These changes force a rethinking of teaching methods, curriculum, equipment needs, and research activities. With these changes has come pressure to change undergraduate science buildings which, typically, were never designed for the sophisticated equipment, intensive teaching, and breadth of research programs evident today.

How can a college respond to these fundamental changes in science teaching, research, and instrumentation, and plan for the future? How do these changes help shape the institutional vision and help convert that vision into physical reality?

Too often a college moves from the recognition of a perceived need to selection of an architect and preparation of designs before it has clearly defined its needs, cost parameters, and site criteria; and before a collegial planning and decision-making process has fully taken place. Regretfully, the resulting renovation or new construction project can be disastrous.

A PARTICIPATORY PLANNING PROCESS

For reasons that are obvious to all, colleges and universities must identify and apply logical and rigorous planning methods to analyze, justify, select, and document facility improvements.

For functional, technical, financial and aesthetic reasons, science building improvements and new construction should be planned through a systematic and rational process; one that involves all those responsible for administering, managing, staffing, and operating the facilities thus created.

Such a participatory process is desirable and necessary to produce concepts, programs, and plans that are realistic and achievable, and to avoid the difficulties and embarrassments of designs that are flawed and counter-productive because they were not well conceived.

- How should administrators structure a process that will provide the space planning framework for making short-term and long-term decisions?

A mission statement might include:
1) the primary values which animate the college;
2) the larger intended goals, in light of those values;
3) the rights and responsibilities of students; and
4) the relationship of the college to its broader constituencies.
-Lloyd Averill, Learning to Be Human, *1983.*

- What type of process is required to articulate the spatial implications for informed decision making?

There are three planning activities that can be modified and tailored to varying institutional circumstances, resources, experiences, and aspirations to define feasible projects: I. Campus Master Plan; II. Facility Development Strategy; and III. Facility Program. Their position in a paradigm planning, programming, design, and construction cycle is shown on page 19. These planning activities should precede the architectural design cycle, which leads then to the bidding and to the actual renovation/construction, and finally to occupancy.

These interrelated planning activities proceed from the conceptual to the concrete; from general descriptions to detailed descriptions; from the broadbrush to the precise. At each step in the sequence, construction and project cost estimates can be prepared; and at each step, estimates will become more accurate as information becomes more precise. (Construction cost is the amount of money typically paid to the contractor. Project cost includes construction cost and such other costs as furniture, fees, administrative costs, etc.--the total expenditure for the facility.)

The first three steps in the sequence are described below. Each is an activity that provides the decision-making framework for the step that follows. Each step requires different levels of decision-making, participation, and review.

I. THE CAMPUS MASTER PLAN. The Campus Master Plan is based on the college's Mission Statement, which is the most important component in the planning process. The Mission Statement articulates an institution's point of view regarding programs, services, staffing, facilities, and fiscal resources. The internal discussions and decisions required to develop the Mission Statement are as essential as the statement itself. This overview helps avoid *ad hoc* space decisions.

The Campus Master Plan is an overall strategy for realizing the institutional mission, goals, and objectives over a ten- to twenty-year period. The Plan provides a framework and establishes priorities so that subsequent decisions required during the next two phases can be made in a sensible and timely fashion. (Obviously, items farther out in time will be less precise than immediate proposals.)

A typical master plan articulates a point of view about the campus environs, land use, circulation, parking, building use, landscape, infrastructure, campus design concepts and components, and implementation costs and sequence. The plan will describe the continuing use or reuse of existing facilities to achieve a functional and attractive physical environment and an appropriate sense of place. It also will identify sites appropriate for new construction or for enhanced landscape development.

II. FACILITY DEVELOPMENT STRATEGY. The Facility Development Strategy is used to gain approval to proceed with a project and to test and prove assumptions, costs, and availability of funding. It is also used to affirm overall project goals and objectives. To avoid serious problems, institutions should prepare a Facility Development Strategy at the start of any significant project. It is counter-productive if projects that are not well planned or evaluated proceed, with the hope that by moving them along, space needs, project design, project costs, and funding will come together through unstructured consensus.

Participatory planning is a way to adjust the vision to existing circumstances.

This form of participatory planning articulates programmatic requirements with the depth of detail needed to determine if the project is justified and feasible, only then should Facility Programming and fund-raising begin. Taking this approach avoids heavy investment in plans and designs that may not be realizable. It is also a productive way to adjust the vision to existing circumstances.

The Facility Development Strategy is intended to answer the following questions:

- What are the existing space resources?
- What are the programmatic needs?
- What are the space type, size, and configuration requirements?
- What are the critical spatial relationships?
- What program elements can be accommodated in existing space; what will require new space?
- What are the projected construction, renovation and operating costs?

This process starts by collecting background material; reviewing priorities, programs, and services; and analyzing existing space and facility needs. This leads to a clearer understanding of what exists and what is needed. A series of alternatives is then developed to address those needs. Costs and benefits are weighed. One alternative--or a synthesis of alternatives--is chosen as most appropriate. The alternative is then summarized in draft formats for institutional review and approval, and final documentation.

To be successful, this *must* be a participatory planning process involving faculty, staff, and students.

III. DETAILED FACILITY PROGRAM. The Detailed Facility Program is both a process and a product. The Facility Program becomes an institutional management tool for reviewing designs and documents during design and construction. It is used to ensure that the program requirements are adhered to and that designs and costs are congruent. If they are not, the Program is the basis on which to reevaluate assumptions, program, design, and funding.

The Detailed Facility Program informs, triggers, and guides the renovation or construction cycle. It must be prepared with the involvement of those who will be using and operating the space. It describes each space in detail. It establishes design criteria and standards. It reaffirms construction and project cost targets that were established in the preceding planning activities--or rationalizes adjustments when such are justified through the programming process.

A typical Facility Program contains a description of project goals and objectives, project cost estimates, schedule, and a comprehensive description of each space that constitutes the project. Each space description may include over 80 different physical characteristics, such as: user; space type; net square feet; height; occupancy; workstations; doors; windows; wall, floor, and ceiling finishes; acoustics; heating, ventilating and air conditioning requirements; plumbing; environmental controls; access and location requirements; furniture and equipment; and spatial relationships.

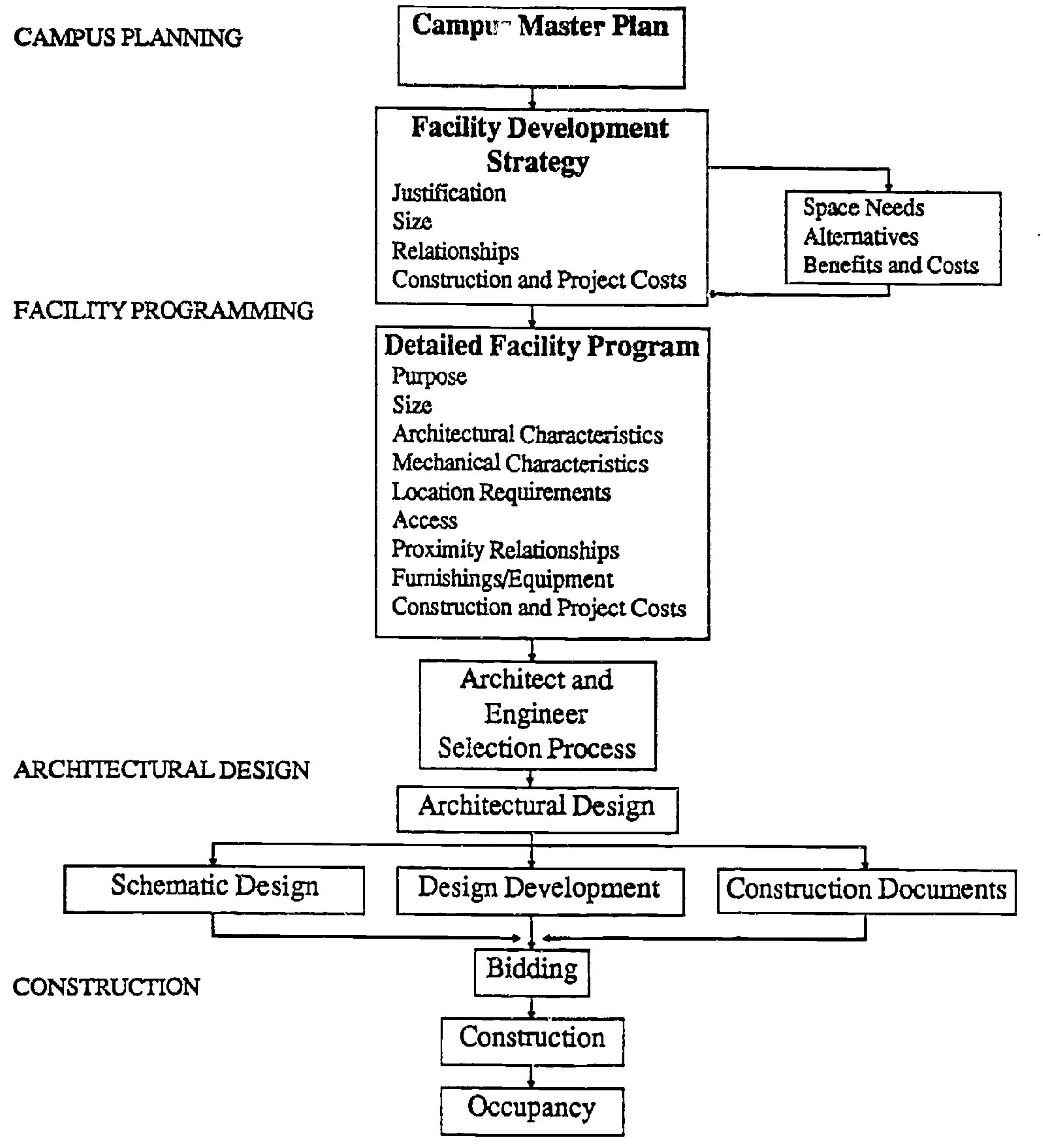
The Facility Program establishes precise and appropriate standards and guidelines for architectural design as well as providing a mechanism for the institution to evaluate those designs. As such, it is a productive means for implementing the project in accordance with the Campus Master Plan and the Facility Development Strategy.

Once established, the Facility Program then launches the next steps in the process: Architectural Selection, Architectural Design (Schematic Designs, Design Development, Construction Drawings and Documentation), Bidding, Construction/Renovation, and Occupancy.

SUMMARY

For many institutions, the replacement value of all campus buildings is as great as, or greater than, the value of their endowment. The physical plant is an important financial asset. The process for maintaining and enhancing the physical plant must be as sophisticated and rigorous as that applied to maintaining and enhancing the financial resources of the institution. The planning steps described above can provide a system for decision-making that can guide an institution from vision to reality as science and technology continue to manifest change and challenge.

PLANNING, PROGRAMMING, DESIGN AND CONSTRUCTION CYCLE



SHAPING SPACES

Planning & Design Considerations For Science and Mathematics Facilities

Michael Reagan, AIA

Architecture and facilities must support good teaching and learning.

GOALS

Contemporary learning environments for undergraduate science and mathematics require facilities different from traditional science and mathematics facilities. The planning and design of undergraduate science and mathematics facilities which support hands-on, experiential, lab-rich, problem-solving programs also demands a process involving institutional representatives and architects different from the process required for other types of academic buildings.

The planning and design process starts with a clear understanding of project goals and a well-defined process for achieving those goals. Faculty, administrators, and architects must have a clear and common vision about an environment that:

- Promotes interaction
- Supports new curriculum and alternative teaching styles
- Is safe and inviting
- Complements and enhances the campus context

INTERACTIONS. Learning is enhanced by in- and out-of-class interactions between faculty and students. This is especially true in the sciences, where learning must be active and experiential, and where faculty and students work together on a day-to-day basis. When we begin to think about new science and mathematics facilities, one primary goal is to provide areas that promote interactions in a variety of forms, such as lounges, conference table settings and study carrels, as well as classrooms and laboratories.

Spaces must not only provide the appropriate amenities but must also be shaped to support the type of interactions desired. Informal interactions typically involve small groups of people and the spaces provided must likewise be planned and designed to be appropriately intimate. Most often, spaces to serve larger groups and/or several smaller groups are best located along major circulation corridors. Areas for smaller groups may be used more often if they are away from the main traffic flow, in a location that is removed, and quiet, yet easily accessible.

For example, in a recent project, we provided several types of areas for interactions in addition to the appropriate laboratories, support spaces and offices. Areas included small lounge areas for informal faculty/student discussions immediately adjacent to faculty offices, small alcoves with built-in work tables for one or two students, larger study rooms with study carrels and lounge seating, and large lounges for groups of students to gather before or after classes.

TEACHING STYLES. A variety of individual teaching and learning styles is supported and encouraged by a responsive design of the space. This flexibility also should allow for spaces to accommodate small or large groups, multiple and single group configurations, faculty and students working alone, in small teams, with easy access to equipment and library. The architect always considers the degree to which the facilities are designed to be inviting and hospitable to users. Since today's science and mathematics teaching and learning is not an activity restricted to normal business hours, the architect has the responsibility to provide facilities that students and faculty enjoy and choose to use and occupy, not only during normal class hours, but before and after class.

Passive learning--being talked-at, watching others do the work--is no longer tolerated by faculty or by students.

Most important, however, in the planning and design of contemporary learning environments for undergraduate science and mathematics is the need to accommodate an academic program in which students are engaged in hands-on, investigative problem-solving activities and research at every stage of their career as undergraduates.

A SAFE ENVIRONMENT. In addition, research and teaching laboratories must be designed so that the users feel safe. This includes providing the appropriate safety devices, such as emergency showers, eyewashes, first aid kits, and fire blankets. The arrangement of the elements within the space, such as lab benches, fume hoods, and chemical storage cabinets, must also be located in such a fashion so individuals have a sufficient number of circulation options should an accident occur. The laboratory should be designed to include multiple exits, access to operable windows and to the available safety devices.

THE CAMPUS CONTEXT. The architect always seeks to design facilities that will enhance and complement its setting. This does not mean that the architectural design should match, brick for brick, the design of other buildings on campus. On the contrary, the design of a new science facility should follow an exploration of a variety of design options and should not be determined from preconceived notions.

But there are special considerations to be made in designing science facilities, which because of requirements of laboratories (computer technologies, instrumentation, safety codes, heat, cold, ventilation), are often taller, wider, and generally bigger than other academic building types. The architectural challenge is to mediate between the forces which affect the larger size of these facilities and the smaller scale elements generally found on academic campuses. Here again, having a clear sense of institutional identity and mission, gained through ongoing discussions with faculty and administrators, is critical.

THE PLANNING AND DESIGN PROCESS

To be successful, the design of interactive science and mathematics teaching and research facilities must begin with and include ongoing communication between the college and the architect about institutional goals, and about the current and future curriculum which supports those goals. The architect *must understand* the dreams and aspirations of the faculty and administration, in addition to understanding the purely spatial statistics typically documented in the project's program.

Architecture is a very special functional art; it confines space so we can dwell in it, creates the framework around our lives.
-Steen E. Rasmussen, Experiencing Architecture, *1991.*

Coming to this common understanding might involve visits and analyses of other science facilities, including successful facilities as well as facilities that no longer meet the programmatic requirements for which they were designed. It will certainly involve a thorough investigation of alternate layouts, configurations, and designs, so that the resulting solution is a product of a continual shared exploration involving the faculty, administration, and the architect.

PREDESIGN -- GETTING STARTED

There are a number of steps that must be taken before the actual design process begins. This includes the selection of the architect, the completion of the program, and the selection of the campus "point person." A feasibility study may also be necessary.

ARCHITECT SELECTION. The selection of the architect is a critical decision. You are seeking someone who has experience with this building type and is competent in dealing with technical issues, thus the search should include site visits to projects which the architect has recently completed. You are also seeking someone experienced in collaborating with faculty and administration, so you should speak with those involved in recent projects. The architect must be able to keep the process moving, maintain realistic budgets, yet not restrict the creative process that leads to the development of unique and interactive learning environments.

Because undergraduate science and mathematics educational facilities must support the efforts of the faculty, the architect must understand how to listen to the faculty and to communicate what information is needed. If interactive learning is the goal of the building, "interactive" can also be used to describe the working relationship between the architect and the campus community. This is necessary in order to create a "fit" between the goals of the college and the eventual building design.

PROGRAMMING. Once selected, the architect reviews the project "program" or assists the college in developing it. The project program typically provides a summary of the project requirements, including goals and objectives, as well as a listing of the individual spaces required and the various environmental requirements for each space. The program should also include the necessary adjacencies between the spaces.

Ideally, the program phase should be undertaken only after a number of academic issues are resolved, such as the academic year (trimester vs. semester), number of faculty (current and future), curriculum (current and future), number of students (total student body, students per year, course size, individual class size, students per faculty, etc.), and teaching methodology. Completing the program involves representatives from the faculty as well as from the administration, including departments responsible for maintaining buildings and grounds.

The final program provides the architect with all of the information needed for the subsequent design phases. At this stage, it is important for the architect to have one on-campus person as the institutional representative, responsible for keeping the dialogue open with the campus community.

FEASIBILITY STUDY. Following the completion of the program and prior to the commencement of the design phases, the college may decide to have a feasibility study to analyze the proposed site(s) and to make a preliminary estimate of the costs associated with the project. Very often, budgets are established prior to the completion of a program based on considerations outside the purview of the faculty and architect. A feasibility study provides a foundation on which to base a more realistic preliminary cost estimate and on which to base planning and fund-raising efforts.

Serendipity--the chance discovery of an idea--is common in the daily practice of science and mathematics. Facilities should support serendipity.
-Project Kaleidoscope, What Works, *Volume I, 1991.*

The primary benefit of undertaking the feasibility study is to identify design issues associated with contemporary science and mathematics facilities and the related costs *prior to the commencement of the design phases.* A cost estimate completed as part of a feasibility study can provide a reasonably accurate projection of the associated costs and therefore provide a solid foundation for the subsequent design phases. These phases may then proceed more quickly with fewer problems.

Whether the proposed project includes the renovation of existing buildings or a new structure, a feasibility study identifies how the proposed program would fit within the allocated area. A feasibility study may also include a preliminary code analysis (including life safety code requirements), zoning, and other building code requirements that may affect the overall cost of the project.

Feasibility studies can be completed by the college or university and/or the architect. The advantage of including the architect at this stage is that the architect becomes more familiar with the project prior to the start of the design. The feasibility study should include the participation of both faculty and administrative representatives.

THE DESIGN PHASES

There are two design phases: 1) schematic design, and 2) design development. The product of the schematic design phase includes preliminary drawings and other documents describing generally the design of the project, including its size, general form, and organization of spaces on each floor. In the design development stage, the detailed design of the project is completed, refining the generalities established earlier.

SCHEMATIC DESIGN. The schematic design phase includes exploring general organization of the spaces and configuration of the elements within the spaces, and the overall size and shape of the building. Each of these three design aspects must be carefully considered, analyzed, and reviewed with regard to their ability to address the institutional goal of supporting active, investigative communities of learners.

Some examples: In the organizational development of spaces on each floor, it is important to consider the relationship of faculty offices to teaching laboratories and other teaching spaces, and to faculty and student research facilities. The grouping of similar space types such as teaching laboratories and research laboratories has the benefit of localizing the mechanical, electrical, and plumbing services that are required. There is a cost-benefit to locating these spaces adjacent to one another. However, this type of organization may isolate faculty offices, lounges, and other non-lab areas

Student participation in the actual process of discc ·ery is essentia. undergraduate research challenges students to think in new, demanding, wholly unanticipated ways, strengthening and expanding their independence, intellectual flexibility, and imagination.
CUR Position Paper, 1991.

to other parts of the floor and/or building, thereby failing to support the interaction desired. On the other hand, the grouping of faculty offices, lounges, and other non-lab areas may also have the benefit of increasing interaction between faculty, and offering students access to many faculty members in one area. This configuration was used in Boston College's new science building, where three or four faculty offices are grouped in areas adjacent to the research labs and adjacent to student/faculty lounges.

Locating faculty offices adjacent to faculty research space near the appropriate teaching laboratories, and perhaps next to the student research facilities, may provide a greater number of potential opportunities for faculty and student interaction. This configuration was used in a recent project, where two faculty offices share a small student/faculty lounge and are adjacent to both student/faculty research laboratories and the appropriate teaching laboratory. Each institution should carefully consider how the configuration and arrangement of these spaces would affect the potential for and the type of interaction desired.

Similarly, the configuration of the elements within each space should be studied to determine its effect on the proposed interaction. The best example of how arrangement of elements within a space directly affects the interaction can be seen in the various ways lecture halls can be arranged. At one end of the spectrum is the typical arrangement, which provides fixed seating and tablet-arm writing surfaces. The non-movable, forward-facing seats direct the students' attention toward the front of the lecture hall. This type of lecture hall design is conducive to audiovisual presentations and lectures. Effective student-to-student interaction is difficult and easy access to other resource materials is limited.

A lecture hall that would support student-to-student interaction in a problem-solving format might include an arrangement of seats which tilt and swivel behind counter-type tables arranged in a deep "U" configuration. Space behind seats allows students to walk to other resources in the room. The deep "U" configuration allows students to face one another and encourages student to student discussion, and the counter-type tables provide sufficient space for laptop computers and other resource materials. Teaching laboratories can be organized to support a variety of teaching styles as well as interactive learning. A general introduction to laboratory procedures and concepts typically involves teaching laboratories organized in long rows of laboratory benches. Fume hoods and other laboratory equipment and instrumentation located at the perimeter of the laboratories allows for the efficient sharing of these facilities but does not advocate "ownership" of the elements.

However, teaching laboratories organized as a series of smaller workstations, each with its own lab bench and sink, and perhaps shared fume hood, provide a student with a semblance of the elements and configuration of a research environment and may provide a more personalized environment that would promote additional interaction with students occupying adjacent workstations. This organization can be seen at University of Pennsylvania's organic chemistry teaching laboratories, where the student workstations consist of a six-foot lab bench (including sink) and share a six-foot fume hood. Care must be taken to arrange the various elements properly, particularly fume hoods and other large laboratory equipment, so as not to impede the ability of instructors to monitor the students' activities visually. As it more closely resembles a research environment, this type of organization may promote active learning and attract and sustain student interest in the sciences.

The configuration of the elements contained within each teaching space, as well as its location in relation to other spaces within the facility, influences the resulting quality of the environment. Spaces located in interior zones without access to views and daylight may not encourage the extended use of those spaces. Lecture halls, equipment rooms, and other support-type spaces not occupied for extended periods, are likely candidates for interior zones without access to daylight and views. Offices, research labs, teaching labs, and other spaces that require extended use, are most successful when exterior windows or even interior corridor windows are provided.

DESIGN DEVELOPMENT. The design development phase involves developing the detailed design elements, including all interior and exterior fenestration elements. Whereas schematic design can resemble a planning exercise, the design development phase includes the more aesthetic elements of architecture. The product of the design development phase is a set of drawings and other related documents, such as specifications, which describe all aspects of the facility design and which will allow the architect to complete construction documents that will be used to actually construct the building.

Throughout this and the previous schematic design phase, the architect should make every effort to communicate the intentions of his/her efforts and ensure that the institution's representatives not only understand the direction of the design, but also participate in the development of design elements. This is where the institutional representative plays a critical role.

The architect should not rely entirely on conventional graphic documents typically used by the profession, such as floor plans, elevations, and sections. Other means, such as perspective drawings, axonometric drawings, study models of both interior and exterior design issues, as well as full-scale mock-ups of interior and exterior elements, either out of paper and cardboard or out of actual materials, should be used to communicate the evolution of the project. If sufficient funds and space exist, a full-scale mock-up of a particularly unique teaching space may be desirable to allow faculty and students to use the proposed design prior to committing to several rooms of a similar design.

SUMMARY

Before the design process can begin, the college or university should carefully select an architect experienced in the design of science and mathematics facilities and in the interactive process required. The completion of a program and a feasibility study will provide the information the architect will need to design the project and provide a basis for the estimated costs. Throughout the design phases the architect should work closely with faculty and administration representatives and together explore the various ways that the teaching environment can support hands-on, experiential, lab-rich programs.

CREATING NEW ENVIRONMENTS FOR THE TEACHING OF SCIENCE: A DEAN'S EYE VIEW

Peggy Garrett, Ph.D.

Curricula can inspire good architecture, but good architecture can also inspire a new understanding of teaching.
T. W. Vaughan, Academe, *July-August 1991.*

When Presidents and Boards of Trustees at private liberal arts colleges think about building science facilities, the financial obstacles appear overwhelming: the economy is "sluggish" at best, the press is leading a critique of the entire educational enterprise and the scientific establishment, and state and federal government is placing more and more of the burdens for financial aid, and hence, "equal opportunity" on the shoulders of individual institutions. Development officers shrug their shoulders and say "going to individual donors will be about as useful as a bake sale." Yet last year alone, new science buildings were opened in many liberal arts colleges across the country. When costs are high and prospects are bleak, we know that some powerful lobbying must have gone on in these institutions.

What's the story?

The story begins in the science classroom and laboratory. If the need for such a daunting project cannot be argued forcefully by the faculty to the dean, nothing will happen. (Nancy Baxter, Chair of our Mathematics and Computer Science Department, looking over my shoulder, amended that last statement to say "nothing should happen!")

The argument at Dickinson College began about five years ago. At that time, the entire science division banded together, formed an organization called the Science Executive Committee. This group, composed of the chairs of all the disciplines with two junior faculty representatives, began to write grant proposals to enable all the mathematical and natural sciences to rethink their programs. It was this body--which has assumed mythic proportions among the rest of the faculty who forget that it was self-generated and who complain that equipment and laboratory interests in the other divisions are unattended--that made the case for the close connection between curriculum and physical spaces.

Their arguments were born of experience in teaching environments that had become inadequate, unsafe, and uninspiring. As has been most recently demonstrated by Project Kaleidoscope, a real revolution is underway in the liberal arts college in regard to the "doing" of science: students are active in the laboratory from the first day of the freshman year right through to their senior research project. Large lecture halls with demonstration benches a long distance from most students are relics of another age. What is required instead is laboratory space that permits faculty and students to test, compare, and seek to generalize. Increasingly expensive and fragile instrumentation, and computer linkage to that instrumentation must be available to further these investigations. On our campus, and elsewhere, no discipline in the natural and mathematical sciences is immune from these advances in technology. And suddenly, we were talking about renovation and construction for a whole division of the college.

Obviously, such conversations demand long-range planning, major financial campaigns, and the setting of priorities. Our scientists did not wait for our new president to move in before they began sending him the message: we must invest in science if we are to maintain a balanced curriculum. He heard them and hired a consulting firm to give us a global view of our college and to help us ask some critical questions:

- What is the picture that emerges of the place, space, and impact of the sciences within that larger picture?
- If we were to build, where would we do that? Is location "all" in the placement of science buildings?
- What does location say about the role of the science in the life of all students?
- What sciences should be housed together?
- How is a science community fostered by the physical spaces in which it lives and works?

Here again, the Science Executive Committee, which quickly changed from a group that brainstormed on curricular matters to a lobbying machine, had some answers. They knew the advantages of dialogue, of talking across their disciplines in matters of curriculum and pedagogy. They knew that much more would be accomplished if all the science faculty were more centrally located allowing them to encounter one another on a more regular basis. As Harry Gray recently pointed out to the Dickinson community, the lines between the disciplines in science are beginning to blur. Certainly the sharing of research problems as well as pedagogical strategies could be invaluable.

This especially argued for the rescue of the Mathematics and Computer Science faculty--physically bringing them from the far reaches of the campus to a more central location. It also made us question whether or not each science should be tucked into its own separate building. Our science majors are in a minority at Dickinson, as they are at many similar schools. What if physics majors regularly encountered math majors in computer laboratory spaces or in generous common spaces? Wouldn't this demonstrate to them that each group was part of a larger "interpretative community"--a group of people who asked similar questions about the world about them?

When the brainstorming stopped and the cold light of fiscal reality dawned, however, we realized that the chief development officer was right: we had to try for major foundation support. We all also realized that some priorities had to be set. When you need at least two new science facilities for three or perhaps four disciplines, that decision means some hard thinking must follow. Even though the needs of Chemistry were great, how realistic is it to try to build a "wet" science building for a college of 2,000 students for under $6.5 million that the major foundation guidelines called for?

Well, we asked an architectural firm to take a stab at that and we quickly realized it was impossible. We also realized that both our Physics and Mathematical Sciences programs were further along in their curriculum revisions and had much clearer ideas about what they wanted their teaching and research spaces to look like.

Again the Science Executive Committee played a key role in the decision making process. Because they knew they were engaged in a common enterprise, they could think in a long-headed way about what would best serve the needs of the whole community. These two departments guided us all to the decision to apply our energies to a proposal for a Physics and Mathematic structure, while not losing sight of the fact that a major aspect of our next capital campaign would be to seek support for Chemistry.

We found out, however, that construction in the sciences is far from a "scientific" matter. Even though curriculum needs and the need to build a more active "science community" were clear and the marriage of these two disciplines seemed a natural one, there were other human factors to take into consideration. So the old "two cultures" rhetoric breaks right down when a dean asks scientists to begin to imagine how they could best do their work. Listen to one of our physicists speaking:

> I've always been in old science buildings--I began in the basement of Eliot Hall (1911) at Reed College, moved on to another turn of the century building, Dalton Hall at Bryn Mawr...with its drafts and floods...and have spent my teaching career in Tome Hall of Science at Dickinson, rumored to be the first "scientific" building constructed on a college campus. When I visit colleagues in new construction, I am struck by the cavernous cinderblock spaces which are not on human scale...I am threatened.
>
> On the other hand, when prospective students come to Dickinson and visit our antique building, they must think physics is a low priority at Dickinson.

Priscilla Laws was not alone in her reluctance to leave a building with the character of Tome Science Building, one that with a series of successful grants the faculty had managed to renovate to accommodate their new workshop physics approach. So what convinced them to listen to their colleagues, especially those in the Mathematics and Computer Science, and join forces in seeking support from a major foundation?

Intellectual excitement was the key, but the Math Department, housed in a "temporary" World War II structure that doesn't offer adequate space to create the laboratories that were essential to its workshop approach, was spurred by more immediate needs: most of its classroom spaces are windowless basement rooms. The math department knew they wanted to be part of the project. How did they convince their colleagues that the two departments could function well together? By showing them how closely the two faculties were in their pedagogy and demonstrating the natural links between mathematicS and physics? Well, eventually.

First some deals had to be struck: would the chain smoker in math cease and desist? The physicists were very clear about the environment in which they could work. Would physics laboratories shared with math and other people's experiments--which might look like "mess" to an outsider--be respected? Because every class could not fit into a structure that housed the combined disciplines, could the two departments work out an equitable agreement about what would be taught elsewhere?

Deans can only hover around the outside of such conversations and wait for the outcomes, certain, however, that unless the faculty are committed to the project, the many other groups in the college necessary to bring such a proposal to fruition can direct their energies elsewhere. After several tense weeks of negotiations, tours of one another's present facilities, comparisons of one another's "bubble drawings" of ideal spaces, and some midnight phone calls, the bargain was struck in the Science Executive Committee and the exciting work of jointly designing a space began. Working with these two departments has convinced me that all the delicate negotiations (and the not-so-delicate) are well worth the consulting fees, the time and the aggravation.

In reading the design program which has emerged from conversations between our faculty and the architects we selected for the project, you can get a picture of our pedagogy, our ideas about the role of research in undergraduate education, and our aspirations for creating a learning environment that extends well beyond the laboratory or classroom.

The first floor of the building will be dedicated to computer-based workshops for introductory courses in physics, computer science and mathematics. Students from all over the college will work in these spaces, seeing the parallels between the disciplines in methods and in issues. As students and faculty move to the second floor, they will reach the heart of the building for aspiring majors: a common area fitted with spaces for small groups to work over problems together and an adjoining reading room. The entire area will be opened up through windows in such a way that passing students and faculty are welcomed into both the spaces and the discussions. The third floor will be dominated by upper level research laboratories and student laboratories. Located on all floors, faculty offices in proximity to laboratory space and laboratory classrooms will dominate the building and spell out the centrality of research in our curriculum.

Our design grows out of our faculty's commitment to "doing" science. These teaching, working, learning spaces were born of the collaborative work of an entire division and promise that our dreams will become a reality for the next generation of Dickinson students.

THE CURRICULUM
The Organizing Principle in the Design of Science Facilities
Charles S. Weiss, Ph.D.

Architecture is the housing of social relationships... it holds considerable power on the way we chart our lives.
Dutton/Grant, Academe, *July-August 1991.*

Motivating faculty members and administrators to plan science facilities is a challenging, difficult task. A natural tension develops when planners reach for ideal scientific and pedagogical goals, yet face fiscal and other institutional, departmental and individual constraints. Confronting looming changes in the working environment and making hard decisions involving millions of dollars can lead faculty and administrators to engage in territorial behaviors that may reduce the science facility's long-range impact, impair the social interaction within it and diminish the overall utility of a structure which should be a source of joy and productivity.

But motivating faculty and administrators to plan together can be an exciting adventure. Project Kaleidoscope (PKAL) seeks to celebrate "what works," so I will focus on what I have discovered "works" from being involved in several successful science renovation and building projects at Holy Cross.

INSTRUMENTATION LEADS THE WAY TO CURRICULAR DEVELOPMENT

As a new faculty member in the mid-1970's, I entered a department (Psychology) whose laboratories had almost no equipment, and existed in a partitioned, initially unheated, garage. This, I thought, was no ivory tower. But it was a beginning and my colleagues and I had the opportunity to build a facility almost from scratch. However, *we* wanted the facility built *then*; its need was so obvious to us. We believed our work in the classroom and in research merited a new building. Why was the administration so reluctant to act? Why were there no immediate plans for new space? What could we do about it?

Nationally, this scenario has played hundreds of times, and in my discussions with scientists who have endured and overcome a similar plight, a consistent theme emerged--"instrumentation leads the way" (I first heard this particular phrasing at the PKAL National Colloquium from Oberlin College chemist Norman Craig). This was true for us, as well. First, our administration stated that it was willing to provide matching support for NSF equipment grants--a statement we took as confidence in the new faculty and our goals. We were now on first base but, having missed the post-Sputnik surge in federal grant awards, our needs seemed to be so limitless that NSF reviewers were reluctant to support our "too rudimentary" requests.

Rather than ending our progress, this rejection provided us with an incentive, and a lever to take to the administration and to begin the instrumentation-curriculum-facility development process that ultimately "worked." We eventually secured a series of awards from the NSF and from private sources for instrumentation, science outreach, student research, and for more comprehensive planning and development.

With each grant, the laboratory space provided by the administration continued to grow and diversify, and our curriculum began to evolve in ways that reflected these changes. But increasing square feet of laboratory space by a certain multiplier does not necessarily result in a functional increase in similar proportion. This is particularly true when new space is added over time in a non-integrated way. Eventually, the time comes when a new facility is needed, one that meets the needs of the emerging curriculum, of expanding faculty and student research efforts, and of new instrumentation. That time came for us in 1989.

Now here is where an aspect of human behavior can occur that initially seems counter-intuitive. In times of high demand for scarce resources, our faculty members shared equipment, supplies and space. There was a cramped camaraderie of doing science "together" in what I now think of as the "good old days." When the potential for what seemed to be unlimited possibilities developed, rather than share the wealth, there was a tendency for hoarding behaviors to appear, for the individual's requirements to take precedence over those of the whole. In other words, faculty members can move from a cooperative to an isolationist mode of behavior. This is certainly not good for the whole or the parts--curriculum, faculty and student morale. It became clear that, unless there was some overarching guide to the facility's planning, design and implementation, the final product would be simply bigger and not better.

THE CURRICULUM: THE ORGANIZING PRINCIPLE FOR WORKING TOGETHER

We all have seen departments in which there is a sense of team play, of cooperativeness and of faculty members identifying with the collective mission of the department while continuing to make their unique contributions to teaching, research and service. At least as often, unfortunately, we have seen divisive, competitive entities held together by only the department's name. If planning a new science facility and implementing change is difficult in the former kind of department, it can border on an impossible task in the latter. I am convinced, however, that there is at least one way to move beyond whatever level of cooperation exists within departments (the same rule applies between departments, as well) to achieve the outstanding science facility that supports the desired end--an enhanced educational experience for our students.

In those departments that have a real vitality and sense of the whole, there is almost always a cooperative project that has brought faculty from an individualistic perspective to a collective one. In recent years, in science departments on many campuses, such projects seems to have the goal of forging a lively, laboratory-based curriculum. One may argue that only in departments that are cooperative *a priori* can such developments easily occur. My experience, however, shows that the curriculum, more than any other aspect of academic life, is the locus where faculty of all dispositions will make real investments. Therefore, college-wide and departmental administrators should make curricular reform even more of an ongoing priority, not only to be pedagogically and scientifically contemporaneous, but because this may be the sole activity that leads to a cooperatively-based product.

It is the curriculum that lives. The science building is a shell for this life and, thus, should reflect and promote the life within.

I have been most impressed by the manner in which this principle has operated for the chemistry department at Holy Cross, a department known campus-wide for its sense of identity and productivity. Over the past decade, the curriculum of our chemistry department began a metamorphosis; it has now grown into a laboratory-based, process-oriented approach called Discovery Chemistry. The laboratory is "the driving force" behind the teaching of chemistry.

> ***Discovery Labs illustrate the scientific method. Each lab can have a component of data gathering, data analysis, hypothesis formation, and hypothesis testing (Ricci and Ditzler, 1991).***

There is a

> ***connection between a theory and the supporting empirical data. Each student contributes individually and cooperatively to the database, which...is then used by the students, with the help of their instructors, to develop models and theories (op. cit., p. 228).***

Both faculty and students enjoy this approach and the spirit of cooperation and social interaction that it generates. Tailored around this major curricular innovation is a teaching environment that the chemists call the "Discovery Complex." Each complex is a self-contained area for all aspects of Discovery Chemistry (a discussion area, a wet chemistry area, an instrumentation area) that responds to the curricular demands of general or specialty chemistry courses.

Our many successful interdepartmental projects (i.e., greatly expanded science complex; enhanced instrumentation for the science departments and psychology; development of a science endowment) also used the curriculum as the guiding principle. Moreover, our experience in receiving grants tells us that proposals seeking external support for renovation, building, and instrumentation projects have a higher rate of success when the focus is on the curriculum rather than on the edifice or the instrument.

At the PKAL National Colloquium, Richard Green, then Director of NSF's Research Facilities Office, briefly described a "reactor vessel" model of science education. In this model, students, faculty and administrators are combined with instrumentation, curriculum and physical plant to yield a product called *scientific discovery.* I wish to employ this model in thinking about the planning of science facilities and the importance of the curriculum. The reactor vessel is the science facility, its size and shape respond to the energy and contents available. Administrators, faculty, and students (AFS) provide the system's energy through tuition dollars, alumni contributions, successful grant writing efforts, and creativity.

AFS constitute not only the driving force to initially define the contours of the vessel, but must sustain the vessel by providing continuous fuel to the reaction. AFS, added to a complex of new and existing instrumentation, should yield full-blown curriculum development. It is the resulting curriculum that exerts the outward pressure against the walls of the vessel--the curriculum should shape the science facility.

PRACTICAL COROLLARIES TO THE PRINCIPLE

There are several practical corollaries that should be provided along with my contention that the curriculum should serve as the unifying principle in the building of science facilities.

- First, a long-standing faculty scientist, one who is broadly trained and perhaps has administrative experience, should head an interdepartmental team. Responsibilities of the team would include fostering the curricular foci of the new facility within and across departmental boundaries. This team leader can serve as an effective liaison between the administration and faculty. An architect, well-grounded in the design of science facilities and having a long-term affiliation with the institution (such as an in-house architect) should be part of the team and readily available for consultation with the faculty. Laboratory supervisors, technicians and data processing specialists should be represented and advised throughout the process.

- Second, administrators can help elicit cooperative behaviors by providing adequate compensation (via release time, summer salary, weighing participation heavily in tenure, promotion and salary decisions) for those faculty members who are central to planning science facilities. Further, the administration should recognize that the faculty should have prime responsibility for the vision of the new facility (within realistic fiscal and other constraints).

- Third, provision should be made for the long-term maintenance of the infrastructure by way of an endowment restricted for such a purpose, an ongoing plan to seek external gifts, or advanced planning for increases in operating budgets.

- Fourth, lines of communication should be kept open to inform and seek input from the faculty. Often, after being involved at the initial stages, the faculty find themselves removed from the process until too near the date of occupancy. At this point, major errors may have been made and it may be impossible or be costly in dollars and time to remedy them.

- Fifth, design a facility that can accommodate additional growth and new curricular directions. Planners should look beyond today, particularly beyond the present trough in science enrollments.

- Sixth, be prepared for problems with heating, ventilation and air conditioning that can make a beautiful and pedagogically functional environment one that has greatly diminished utility. This is particularly important for structures with atria and towering ceilings. Ensure, via early negotiations, that proper HVAC function will be established prior to occupancy.

Use the opportunity of designing new spaces for science and mathematics to make a clear statement about the integral role of these disciplines in the institution's liberal arts curriculum.

• Seventh, consolidate disparately housed science library collections to provide connections between disciplinary-based science and the science community beyond.

• Eighth, science education and academic life are fundamentally social processes. Let the building's design facilitate social activities among students, between faculty and students, and among faculty--the source of the energy that sustains the educational reaction.

• Ninth, use the opportunity of designing new spaces for science and mathematics to make a clear statement about the integral role of these disciplines in the institution's liberal arts curriculum.

And, finally, enjoy the educational fruits that a new science facility can help to grow.

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TURNING THE DREAM INTO REALITY: CHALLENGES

Daniel Guthrie, Ph.D.

I have approached this topic in a pragmatic manner, discussing several challenges which may arise during the planning and construction of a new science facility. I also give a few suggestions on how to deal with those challenges. Before I begin, however, I must emphasize that building a new facility--from concept to completion--is a big job. It is important that one person, not a committee, be assigned to be in charge. This person will be the contact for architects, administration, contractors, and faculty. He or she will have to attend the weekly or biweekly meetings during the planning and construction period; he or she will have to seek advice from and disseminate information to all concerned parties through both formal and informal channels. The person needs to be diplomatic--able to deal with and arbitrate the potential areas of conflict described below, thus be well aware of the various needs and operating styles of the faculty and administration. Considering the time demands and responsibilities of such a position, the person should have release time from some normal responsibilities.

How do you get faculty involved when they will plan only one building during their career?

CHALLENGE I. THE INITIAL PROCESS

WORKING WITH FACULTY. Beginning the planning for a new facility is easy, as it involves little conflict. Ask all faculty--individually and as a group--what they want! Faculty are very good at planning research and laboratory areas, offices, and even support areas such as shops, dark rooms, storage areas, etc.

However, challenges soon arise. Faculty are less adept at knowing how to plan and incorporate spaces to make the building livable for students. They are also not experienced in thinking ahead, anticipating facilities needs for new and emerging programs. The current anatomist may not need gas or vacuum lines in his laboratory, but in 20 years, who knows? Faculty need to think about how to plan for future flexibility, and how the placement of utilities affects that flexibility. They need to think about changing research priorities when retirements occur and new appointments are made. If the current ecologist, scheduled to retire in five years, wants a flowing artificial stream in his lab, can it be easily (cheaply) removed if his successor does not want it? They need to think about providing spaces for emeritii and for visiting professors. They need to think about how the science program is connected to and integrated with the total curricular program of the college.

You have to press the faculty to consider all these needs, and then to begin to translate those needs into square footage. Knowing the square footage of all the rooms you currently use--and the inadequacies of those spaces--will help.

How do we accommodate the "known unknown"--the unforseen changes in science, technology and pedagogy and the sciences--in buildings used for several decades?
-Kenneth Wittig, Siena College.

WORKING WITH THE ADMINISTRATION. It would be nice if all this planning could occur before the college administration agreed to the project. They then would have a clear picture of your needs and, hopefully, try to meet them. However, often the administration has made decisions prior to getting your input. The administration may have already determined where a building will go and the size of the plot available. They also may have very restrictive demands about the appearance of the building--that it fit in with existing architecture (not an unreasonable demand). If it is to be in the middle of the campus, they may have specific ideas about access from all sides, somewhat difficult for a building that often needs a loading dock and storage areas for field vehicles and boats. The administration may have donors in mind; our recent building was designed with two wings because originally two donors were being approached and we needed two naming possibilities. Finally, and perhaps most importantly, the administration may have a set cost for the project--one that is almost certainly lower than you will want.

CHALLENGE II. GETTING THE SIZE, SHAPE, AND SPACES RIGHT

Your first problem will be getting to the proper square footage. Architects can be very helpful in helping you understand how to calculate square footage needs and costs for a building. If you say you have $15 million for the project and need 75,000 square feet, they will demonstrate that you can "purchase" a $11.25 million building ($3.75 million for site preparation, architects fees, building permits, contingency funds, and equipment) that will give you a 75,000 square feet building ($150/square feet). Given that buildings have 60% useable space and 40 % other space--hallways, bathrooms, mechanical rooms for electrical panels, HVAC, etc., you have 45,000 square feet useable space. (You also have a problem!) The architects will also tell you that the site can accommodate a 25,000 square feet floor plan. In other words, you need three stories.

There are many questions to consider in dividing your needs among floors. Chemistry is cheapest on the top floor, due to the cost of fume hood vents. Does that work best for your program? Most of the mechanical rooms, shops, and storage will probably be on the lowest level. Is that the most efficient use of space? Do you wish to divide a department by functional units? Do you want students walking past your offices as they go to introductory labs? Do you want offices anywhere near the anatomy lab?

Of course the cheapest building (read most efficient) is a rectangle with no frills. Many college science buildings look this way. These buildings serve faculty fairly well; they have plenty of labs and research areas. However, your building is for students! Will it be a place where students enjoy working at 10 p.m.? Fight hard to save the "friendliness" of the building, i.e., places where students gather. Our four-hour laboratory sessions are made much more tolerable by the design of a place nearby to have a snack break.

I firmly believe in the importance of the floor plan in shaping what goes on in a building. We wanted faculty and students to interact with each other. Therefore, one of our prime considerations was clustering faculty offices around social areas where students would feel welcome. Getting the shape right means thinking carefully about how you wish people to interact, not simply about what will fit best into the available space. When we were faced with the need to downsize our plans, one of our big "economies" was to get rid of the 200-seat lecture hall. Although it would have been good to have one in the new building, on our campus there already are several lecture halls of the size that we needed, not being used during the hours that we needed them. Our administration agreed to remodel one of these (in an adjacent building) by adding a portable lab bench, thereby saving us 3000 square feet. Other savings can be made by having outside corridors, which cost less than interior corridors.

Laboratory furniture comes in modules of set lengths geared to standard students' space needs, building code requirements, and standard construction size units. You may find that the exterior design, when divided up into interior spaces, requires squarer labs that you desired, or leaves extra space on one floor and not enough on another. Again, lots of compromises may be needed. Some of our laboratories migrated to different floors during this period, and several areas changed size from our original desires.

By much compromise we were able to accommodate all faculty desires and meet our goal of maintaining the friendliness of the building. We did lose some space for expansion, but persuaded the administration to excavate more area in the basement and leave it as unfinished (and cheap) shell space for future expansion.

CHALLENGE III. DEALING WITH CODES

During the design period, you will learn the joy of dealing with building codes and city ordinances. For science/educational structures, there are requirements and codes for almost everything:

- number of windows relative to heating and insulation requirements
- number of doors per laboratory, and their position relative to laboratory shape
- corridor and aisle widths
- number of bathrooms
- number of parking spaces
- number of and widths of stairways and elevators
- animal rooms (federal requirements)
- access and signage for the disabled
- fire safety rules for construction, including fire walls and doors
- storage of volatile chemicals and toxic waste

Code review is extremely important! You may have a desire to design offices with doors open to a social area. The fire codes may demand closed doors. There are ways around this (e.g., automatic door closers tied to the fire alarm system) but they must be planned for in your design. (You will also learn that architects hate windows that open because they mess up the air conditioning and heating system.)

CHALLENGE IV. CONTINUED FACULTY INVOLVEMENT

Finally, you will be at the point when you must deal with the most difficult challenge: getting the faculty to review the construction documents. I cannot emphasize strongly enough the importance of this step. For it is this step, more than any other, that determines, finally, what you will have to live with in the future. Some faculty assume that they can tell you, or the laboratory design people, what they want and it will appear. However, all the regulations, codes and considerations for room placement and shape, plus the inscrutableness of faculty scribbles, lead to things not being that easy. Vigilance is required.

Faculty have to realize, moreover, that they must review documents carefully. Construction documents are divided into floor plans, furnishings, electrical, plumbing, mechanical, etc. They are replete with symbols that take time to understand. Faculty need to review all of them. A minor example of the kind of problem that can arise will illustrate this point.

Our introductory biology lab had three 12 foot tables. Each has three legs per side, and accommodates four students per side, spaced evenly. In our new building, it is possible to have 15 foot tables. We said, "make them like we have, only longer." Well and good, but, when they were constructed, they turned out to be 36 inches high, not 30 inches, and to have four legs per side, making it hard to seat four students spaced as before. The lab designer said that legs could not be more than seven feet apart, due to loading considerations.

There are at least three lessons here: one is that faculty must review the documents very carefully if they are to get what they want. The table changes had been clearly shown in the drawings, but in reviewing them, the faculty member did not know that the little squares on the top view of the table meant legs. He also never found the page of the plans that showed a side view detail, including the 36 inch height specification for all lab counters and tables where another height was not specified. The change order to correct this cost over $5000.

Another lesson is not to assume anything. If you want undercounter microscope cabinets to open away from the knee hole openings in the workbench, say so. Otherwise, you may find all doors opening in one direction, regardless of locations relative to knee openings.

Finally, faculty must realize that they must communicate their plans clearly--to the architect, and to their campus representative--at every stage of planning, design, and construction of the science building.

Once construction begins, there will be regular meetings, between the architect, the contractors, and the college representative. The departmental representatives must be there, or there must be a formal means to communicate back to the departments on an ongoing-basis.

Many issues will come up that are important to faculty, ranging from office furniture selection, to how to key the building, and whether you can live with a different kind of dishwasher (because they forgot to put in the floor drain).

And, as construction proceeds, faculty will start to wander into the building and discover that their space does not look the way they thought it would. It will be the responsibility of the institutional representative to explain to them why, to remind them about building codes, or to show them that their laboratory is being constructed exactly the way it is shown on the construction plans they failed to review a year ago. It will also be your responsibility to try to get change orders approved, when oversights or problems are found that you cannot live with.

Boston College Chemistry Building
Chestnut Hill, Massachusetts

Client: Boston College;
Professor David L. McFadden,
Chairperson, Chemistry Department

Firm: Ellenzweig Associates, Inc.,
Cambridge, Massachusetts

Size: 109,000 gross square feet

Construction Cost: $21,600,000

Net Square Feet:

Laboratories:	27,189
Office:	8,196
Lab Support:	10,380
Expansion Space/Other:	16,130
Total:	63,130

Completion: August 1991

The Boston College Chemistry Building. Entrances at the first floor and lower level are linked inside by a stepped lounge and outside by landscaped terraces.

Located on Boston College's Chestnut Hill campus, the new Chemistry Building provides state-of-the-art laboratory and classroom space to serve Boston College's expanding chemistry department. The building contains four floors of laboratory and laboratory support spaces, administration offices for the chemistry department, faculty offices, a 150-seat lecture hall with full audio-visual facilities, and two classrooms.

Exterior materials of the building are buff brick with a cast-stone base which is sympathetic with other campus buildings. The mechanical penthouse is enclosed by a sloping mansard-style slate roof, incorporating the complex mechanical requirements of this building type in a design compatible with both the Boston College campus and the adjoining residential neighborhood.

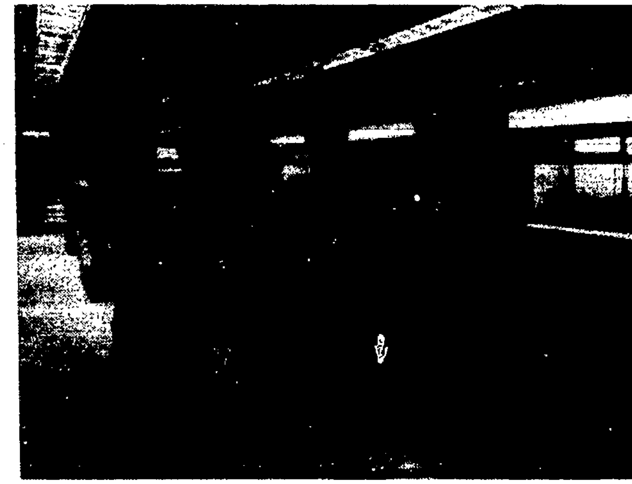
The Chemistry Building was designed to accommodate current laboratory practices and procedures while anticipating future needs of the chemistry department, both in the provision of expansion space and in the layout and design.

The process which the architect used to develop the program for the building components included a series of detailed discussions with the future occupants for the building. During the programming and laboratory design process, the architect scheduled multiple interviews with the faculty member leading each research group and with the faculty members responsible for the various teaching laboratories. As a result of this process, one of the prime goals established as a priority for the design of the research laboratories was to encourage interaction in order to enhance the research and teaching experience between faculty and students.

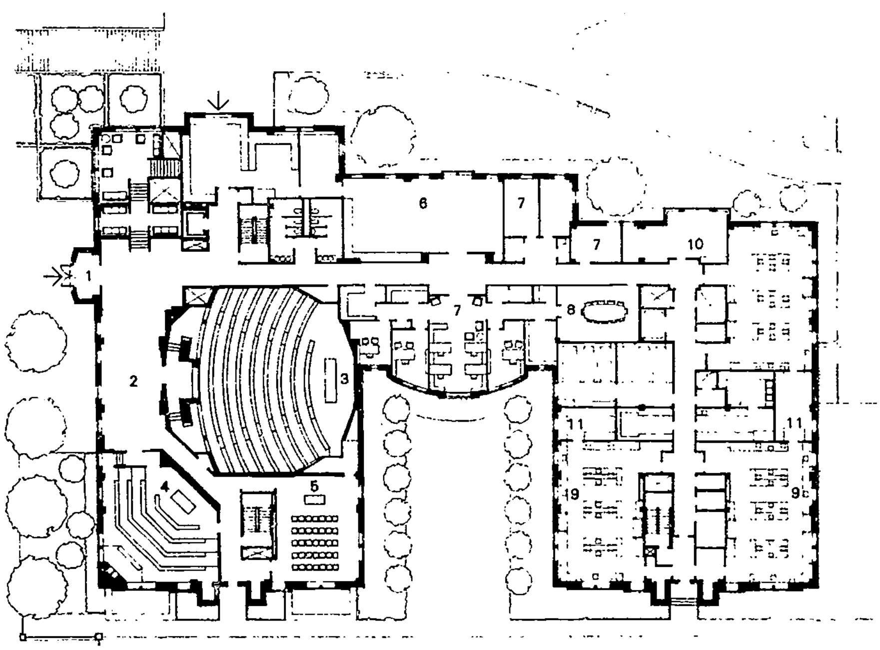
The resulting design of the Chemistry Building encourages interaction on every level, both inside and outside of the building. For example, each wing of the building is provided with a south-facing lounge space with kitchen facilities for the researchers to be able to eat lunch outside their laboratories or casually meet with their colleagues. In addition, a seminar room is located on the opposite end of each wing to provide ample space for meeting and discussion outside of the laboratory. Each of these lounges and seminar rooms is open to the corridor either by a glass door or screen to further encourage interaction and to maintain a connection between the corridor and the outside.

Faculty offices are grouped in clusters on the research floors adjacent to the lounges to encourage faculty communications. Every teaching laboratory, research laboratory, and faculty office above the lower level is provided with windows which help create an environment more conducive to the long hours usually associated with chemistry teaching and research. Teaching labs were shaped and equipped with audio-visual equipment to encourage interaction and discussion. The open space between the lower and first floor levels provides multi-level lounges connecting entries on both levels and mirrored by the adjacent landscaped stepped terraces outside. These interconnecting spaces form welcoming entries to the building and a natural meeting space for the chemistry community.

Organic Chemistry Research Laboratory

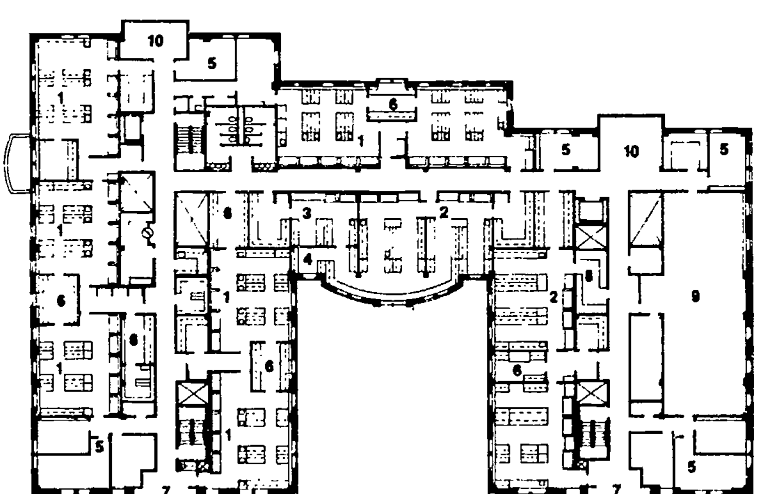


Advanced Teaching Laboratory



First floor plan

1 Main entrance
2 Lobby
3 Lecture hall
4 Classroom
5 Seminar room
6 Major scientific equipment
7 Office
8 Conference room
9 General chemistry laboratory
10 Lounge
11 Support space



Third floor plan

1 Organic laboratory
2 Inorganic laboratory
3 Radiochemistry laboratory
4 Radiochemistry student area
5 Faculty office
6 Support space
7 Lounge
8 Inorganic support
9 Future expansion
10 Seminar room

Canisius College

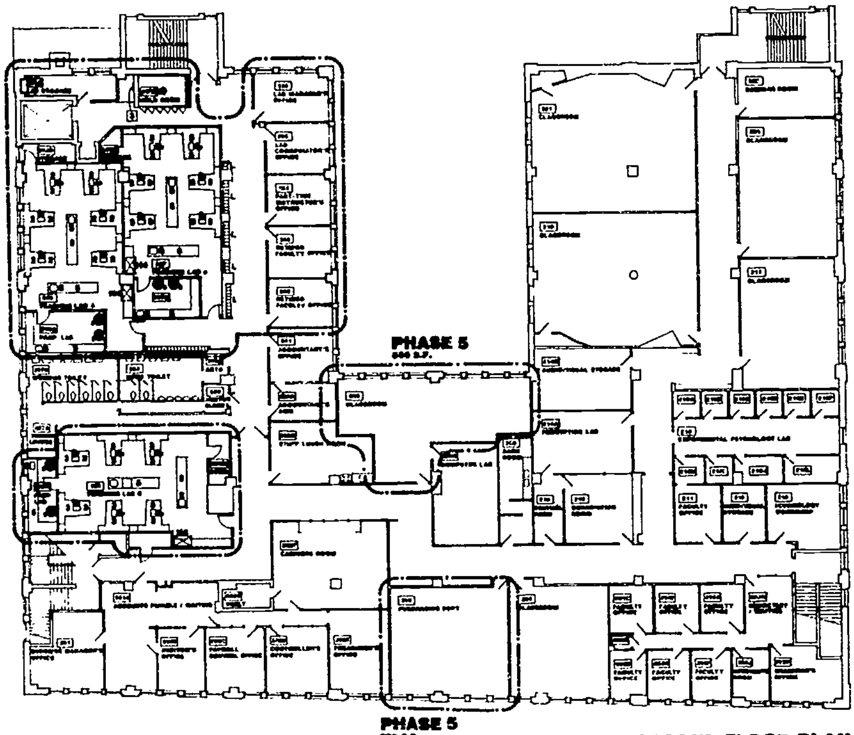
BIOLOGY DEPARTMENT REMODELING
BUFFALO, NEW YORK

Edward C. Kisailus, Ph.D.,
Assoc. Prof. Biology
Edmund G. Ryan, S.J.
Exec. V.P. Academic Affairs

Firm: *Trautman Associates Architects and Engineers*

Wallace J. Ochterski, P.E.
Principal-in-Charge;
Richard M. Gehring, AIA
Project Architect;
Raymond F. Johnson
Project Engineer, Mechanical;
Robert R. Turley, P.E.
Principal Engineer M & E;
Robert P. Stelianou, P.E.
Principal Engineer, Structural.

Construction Manager:	*Falgiano Const.*
Area:	*13,560 S.F.*
Total Cost:	*$1.6 M*
Cost/S.F.:	*$118*
Completion:	*November 1992*



SECOND FLOOR PLAN

A significant increase in the undergraduate research program at Canisius College required new biology research laboratory space. Constructing that type of facility in a multi-program building used both days and nights for teaching was an unenviable task facing the designers, educational staff, and contractors. Only a short three month summer recess period was available for unlimited work on the renovations.

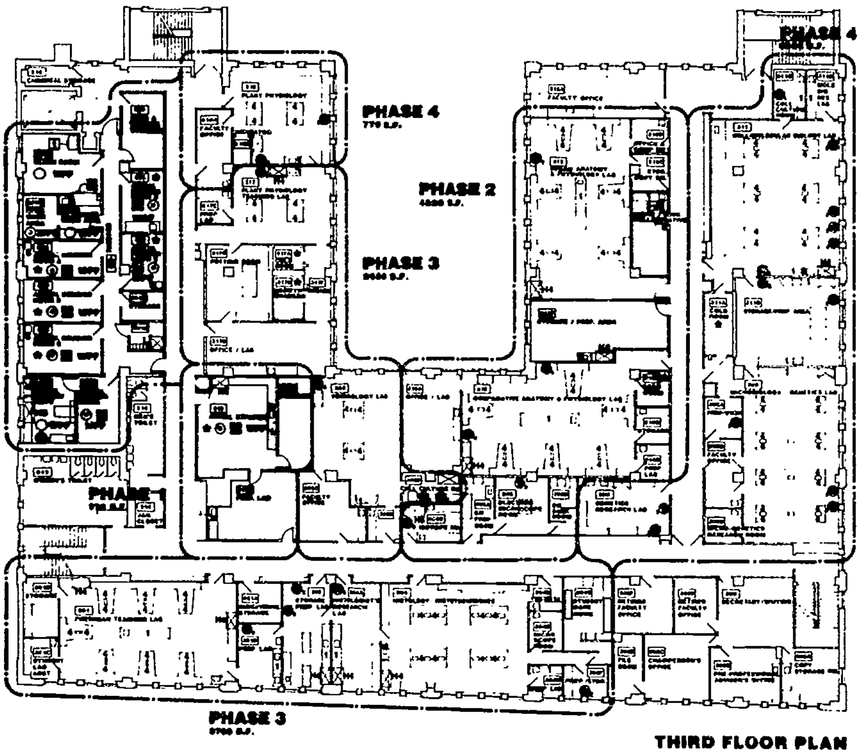
An innovated scheduling and construction method was introduced by the architect-engineer. With the programming assistance of the College, the construction was phased into five steps. By moving out the academic program in one area of the building at a time, disruptions would be minimized. The section designated by the reconstruction would be acoustically segregated from the other active classrooms and laboratories for a period of time.

After reconstruction was completed in one area, equipment, materials, and personnel would be shifted into that renovated space, freeing up another portion of the building for reworking. This hopscotching of construction, relocation, and protective barriers would be followed until the entire rebuilding program was completed. To start off this chain of events, the offices of the ROTC program were moved to another building.

To facilitate the contractors and subcontractors working on and off the job, Canisius College signed an agreement with a construction management firm. This firm will coordinate all construction bids and activities, allowing the College to benefit from small and multiple contracts for limited services.

Unique air handling configurations were necessary to provide independent outside air to animal holding rooms. The reuse of previously stored lab benches and cabinets required special design considerations for the layout of the laboratories and research areas. A new emergency electrical generator will be installed to provide backup for the animal holding rooms, research laboratories and necessary equipment.

The project is funded in part by a National Science Foundation Academic Research Facilities Modernization grant. That portion of



THIRD FLOOR PLAN

the construction which directly impacts undergraduate research and training was funded by NSF with at 50% cost share. Funds for teaching laboratory construction and renovation were provided by the College. These latter costs and the grant cost share are currently the focus of a special fund drive.

The NSF grant proposal addresses issues essential to improving the science and engineering infrastructure and to broadening the science base in the United States. These essential elements include upgrading and modernizing current science facilities to enhance and expand undergraduate research and research training opportunities; and to recognize the importance of faculty and student involvement in college-school collaboration.

Research training of undergraduates is an essential component in the study of biology; it is necessary to expand the student's knowledge base beyond that of didactic and teaching laboratory courses. Research training is used as part of the decision-making process for post-baccalaureate graduate studies, and as work experience for job applications. The resume and transcript of the student should reflect preparation in a modernized curriculum.

Thus, the focus of the Canisius College Department of Biology has changed during the past decade to reflect the new opportunities in biology. New courses, supplemented with research-based laboratory sessions have been implemented in the freshman year, and are planned for the sophomore year. Upper level elective courses are being upgraded annually. New faculty are being recruited with active research backgrounds and who are committed to work with our students in a research laboratory setting.

The goal is to not only strengthen existing research programs, but to plan for future expansions so that a student's interest in a career in biology is maintained during the four-year course of study. The faculty involved in research training have discovered that this is an effective means to not only stimulate interest in careers in biology, but also in educating future professionals and teachers of biology.

The proposed renovation and modernization will allow for 1) current research-training space to be used solely for research and research-training of students; 2) concrete plans to be made to expand the research initiatives within the department over the next five years as existing non-research oriented faculty retire, without being limited by the space constraints that currently exist; 3) the creation of effective teaching spaces so that research-based laboratory sessions can be integrated into courses which may aid in the recruitment of the so-called "second tier" students who may have an interest in science, but who don't respond to the existing methods of teaching science; and 4) the increased participation by the faculty and students in Canisius' college-school collaborative programs.

The Biology Department's goals center around undergraduate research and training and a unique college-school collaborative training program for elementary and secondary science teachers. This latter effort has direct impact on broadening and strengthening the nation's science and engineering research enrollments. Educators who participate in collaborative training can immediately transfer their skills and knowledge to a student population eager to absorb these abilities.

F. W. Olin Biological Sciences Building
DePauw University

View of Main Entrance

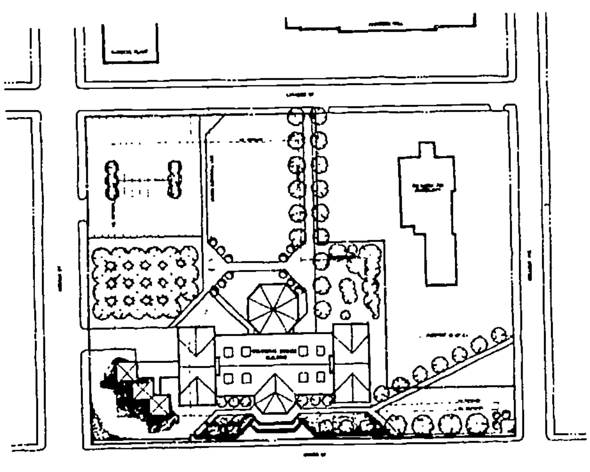
Client: *DePauw University*
Dr. Robert G. Bottoms, President
Ms. Margaret Catanese, VP Finance
Mr. James E. Daugherty, Dir. Bldgs. and Grounds

Firm: *JAMES Architects & Engineers, Inc.*

Design Team:
Philip L. Hodge, AIA, Principal Architect
J. Scott Winchester, AIA, Project Manager
C. Andrew McNeilly, AIA, Project Architect

Mechanical Engineer:	*Woodland W. Holm, P.E.*
Electrical Engineer:	*Phillip C. Gardner, P.E.*
Structural Engineer:	*Rudy G. Sanders, P.E.*

Capacity:	320 students
Area:	46,100 s.f.
Total Cost:	5,720,000
Cost/Sq. Ft.:	124.00
Completion:	June, 1993

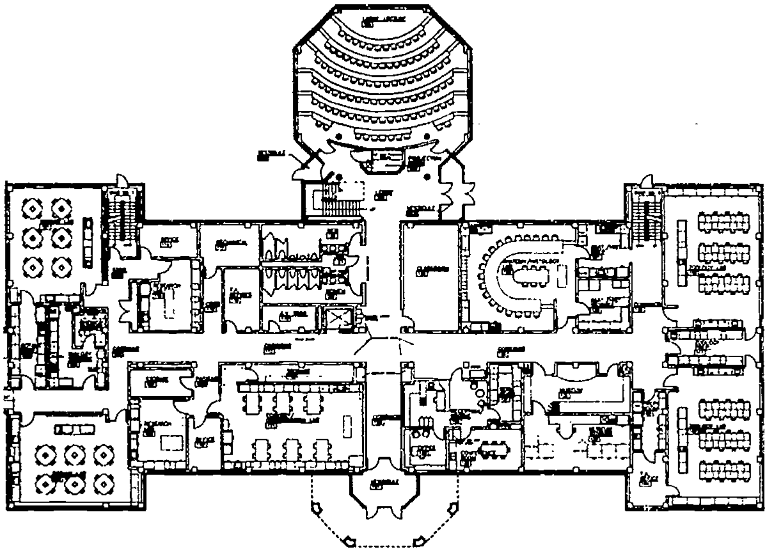


Site Plan

The design of the new F. W. Olin Biological Sciences Building presented a myriad of challenges. The faculty, administration, and architects were presented with the challenge of designing a new science facility that not only met the needs of today's students, but of tomorrow's. Instructors were asked to look beyond their initial reactions to design a facility that wouldn't be reactive to the inefficiencies of the existing facility, but would be an active approach to present and future classroom instruction and laboratory teaching. The result is a flexible design of multi-use classroom/lab spaces with common core-subject areas clustered together.

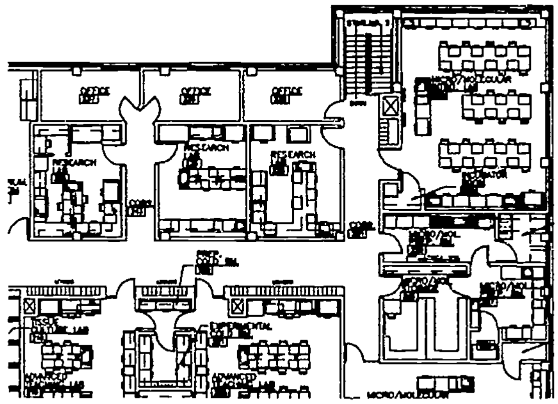
Movable instructional tables, ample equipment storage, and flexible arrangement of instructional areas enable future reorganization to accommodate technology, equipment and instructional techniques. Standardization of class size and related instruction spaces was instrumental in the development of the cluster arrangement. Each instructional cluster includes a classroom/lab for twenty-four students, a smaller advanced teaching lab for major work, and the instructor's personal research lab and office. During the design development phase, all of the spaces were "tested" for function. Each instructor was interviewed to ensure that the allocated spaces fit the needs of the specific subject matter.

A collaborative approach was undertaken to "imagineer" the needs of the future.

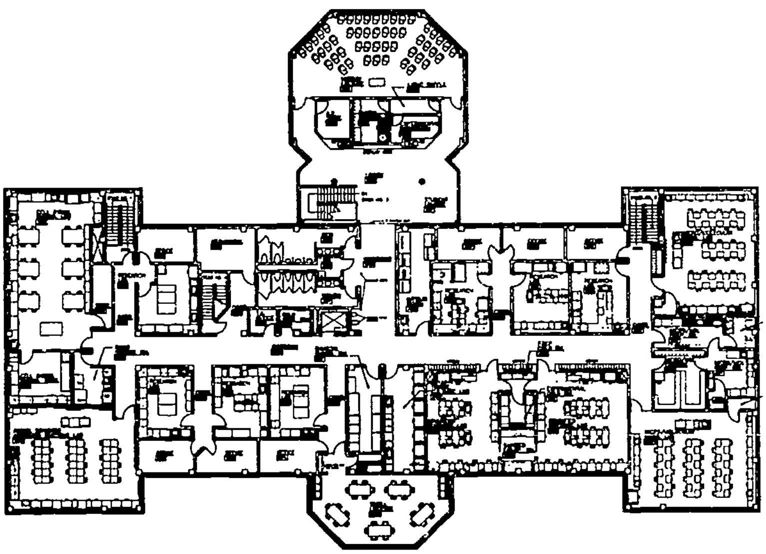


First Floor Plan

Model - View of Campus Relationship



Micromolecular Biology Cluster



Second Floor Plan

Model - Arboretum

View of Entrance to Lecture Hall

NATIONAL AWARD OF MERIT

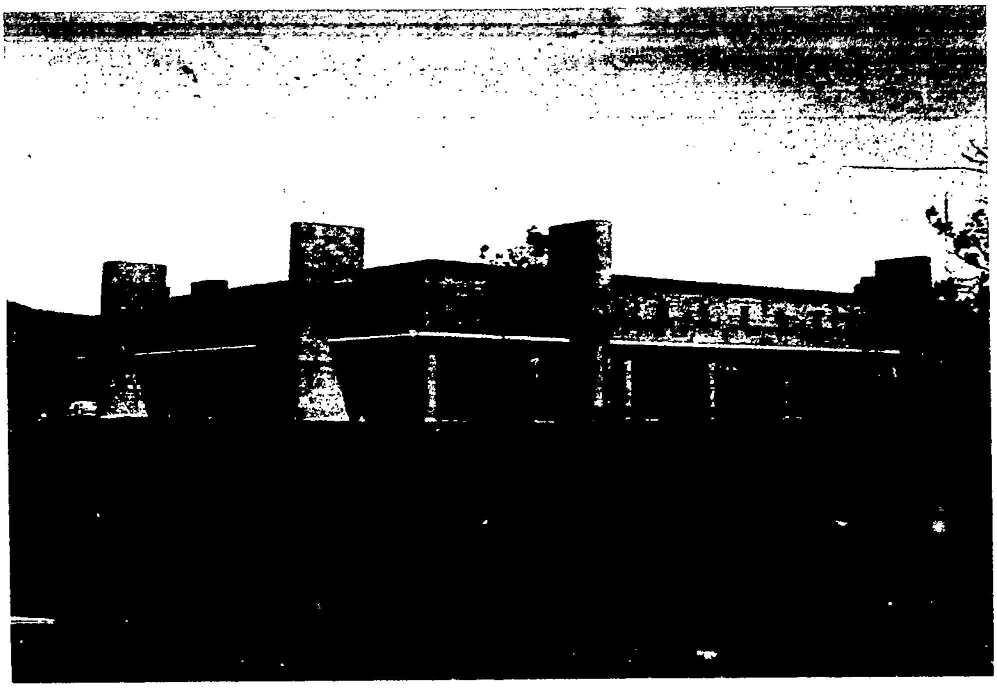
Hollins College Dana Science Building
Roanoke, Virginia

Client: Hollins College
Cyrus R. Osborn,
Board Chairman

Firms: Douglas Orr, deCossy, Winder & Associates (New Haven, Connecticut) Randolph Frantz & John Chappelear Architects (Roanoke, Virginia)

Design team:
Edwin W. deCossy, Architectural Design; John Chappelear, Architect; H.A. Lucas and Sons, Builders (Roanoke)

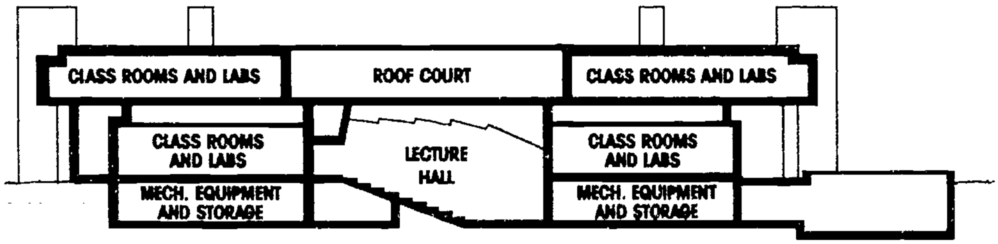
Capacity: 750
Space/Student: 115 sq. ft.
Area: 85,000 sq. ft.
Total cost: $3.1 million
Cost/square foot: $37
Completion:
October, 1967

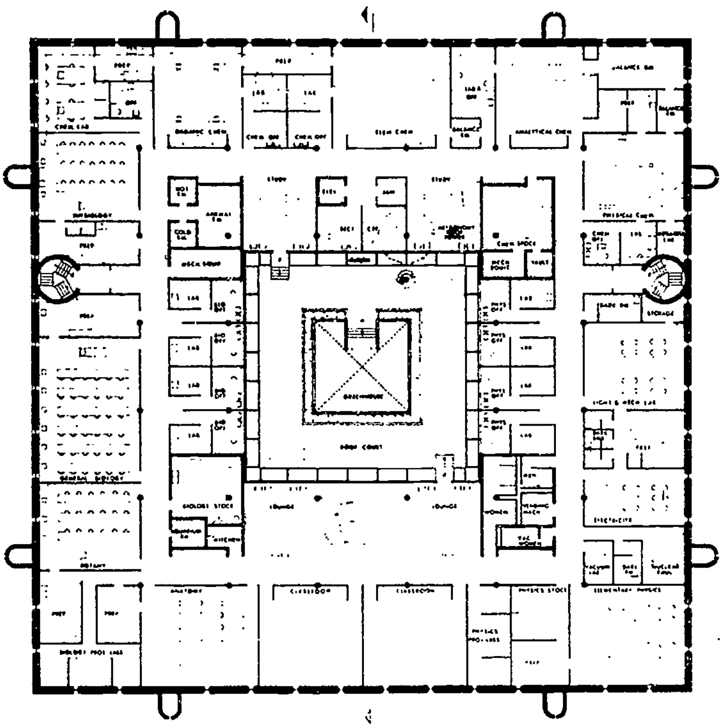


An innovative structure which does not aggressively assert its scientific purpose, but is gracious, humane, and inviting in a manner befitting the traditions of the college. Superb teaching and research facilities, matched by ɘnerous *lounges and a handsome entrance hall. Harmonious in scale; a pleasing oasis of learning.*

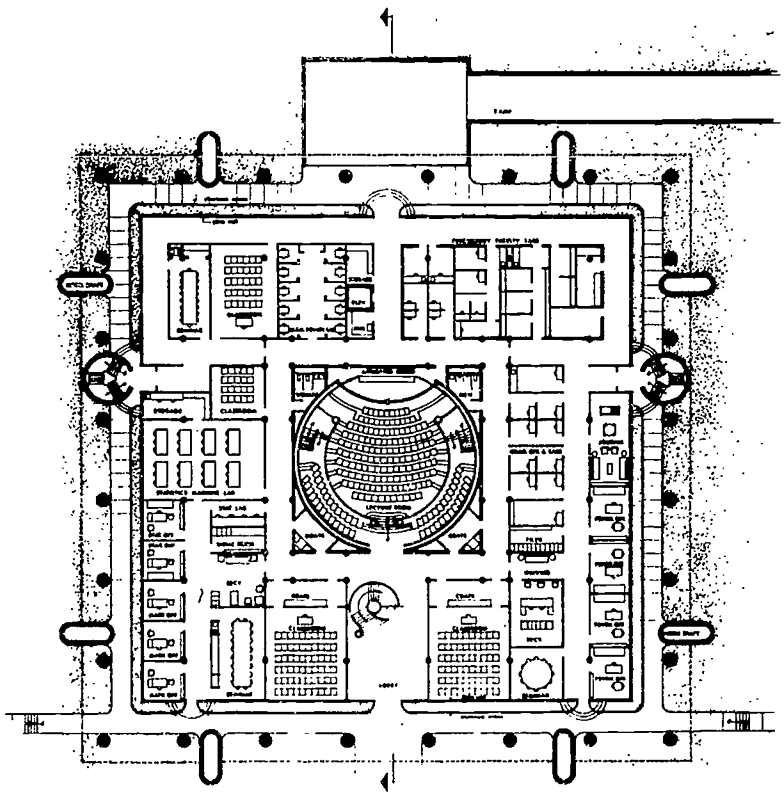
Twenty-five years ago, the Dana Science Building was designed to provide unified facilities for the teaching and research of the faculty and for the classroom, laboratory, and independent work of Hollins students. It increased six-fold the space devoted to science; for the first time at Hollins, the Departments of Biology, Chemistry, Computer Science, Mathematics and Statistics, Physics, and Psychology were housed under one roof.

Since then the bold, integrated, and flexible design has proven itself repeatedly, as its uses have evolved to meet the changing demands of the sciences at Hollins. The proximity and tight integration of faculty offices, research laboratories, classrooms, study rooms, and teaching laboratories – so apparent in the second-floor plan – are the primary reasons for the strong sense of community experienced by science faculty and students. The wonderfully human scale provides an environment for dealing





SECOND FLOOR PLAN



FIRST FLOOR PLAN

with intellectually-taxing material; some students even bring their sleeping bags to the communal space in the second-floor lounge, and stay the night when their experiments require 24-hour attention. The undergraduate instructional laboratories are so well designed for space, infrastructure, and equipment that they continue to be among the finest in the country.

General classrooms, seminar rooms, and lounge areas are used by all departments of the college, extending the sense of community campus-wide. The latter is most readily apparent in the Mary Reynolds Babcock Auditorium, an elegant amphitheater which seats 200 and has the latest audio-visual equipment.

Not only is Dana scientifically effective, but on a campus currently celebrating its sesqui-centennial (since 1842) the building is in harmony and scale with older structures. Its size is visually minimized by its low, brick profile and gently-curved outline. This is a design success looking forward to the challenges of the next 25 years.

Heim Science Building
Williamsport, Pennsylvania

Client: Dr. David A. Franz, Chemistry
Dr. Robert B. Angstadt, Biology

Firm: Hayes Large Architects
J. Richard Fruth, AIA

Area: 63,000 SF
Total NSF: 36,450 NSF
27 Laboratories: 18,290 NSF (50.3%)
13 Offices: 12,123 NSF (5.8%)
25 Lab Support: 17,152 NSF (19.6%)
19 Classrooms: 18,885 NSF (24.3%)
Building Efficiency: 58%
Capacity: 420 Science/300 General
Space / Student: 150 GSF/Science
87.5 GSF/Student
Construction Cost: $8,351,633
Cost / Sq. Ft.: $132.57/GSF
Completion Date: August 1990

A cost effective, lab intensive complex that promotes interaction between faculty and students. A small liberal arts college's approach to improving its science program.

An important addition to the Lycoming College campus, the new science building houses the departments of biology and chemistry. The building replaces a science facility that was a former bottling plant, which was upgraded in 1958 to house laboratories, The college was faced with a retrofitted 30-year old building and a critical shortage of classroom, lecture and laboratory space. The architects were challenged to provide a lab intensive environment supported by cost-effective engineering system, and to provide spaces for interaction between faculty and students—an important ingredient of a liberal arts education.

The college's project leader was Dr. David Franz, Chairman of the Chemistry Department. Acting as the liaison between the architect and user groups, Dr. Franz states that "science buildings work when a dedicated user group gets involved." This approach went beyond the labs themselves. "Rather than using up space, the building created usable space within an unused part of the campus," said Franz. "We created a handsome, no-nonsense building which met our needs."

Critical to the design of the structure was accommodation of a wide variety of classroom and laboratory sizes. Elaborate requirements for faculty office, research and preparation rooms, in order to provide flexible solutions to space constraints, allowed the college to offer a higher level of science education than before. These requirements were balanced with the need for regular structural bays and an orderly window arrangement.

Longitudinal: In order to achieve a wide variety of room sizes, a basic 8' planning module was used for all spaces. Office/research became 8' wide and laboratories were laid out in multiples of 8'. The structural bay was 24'.

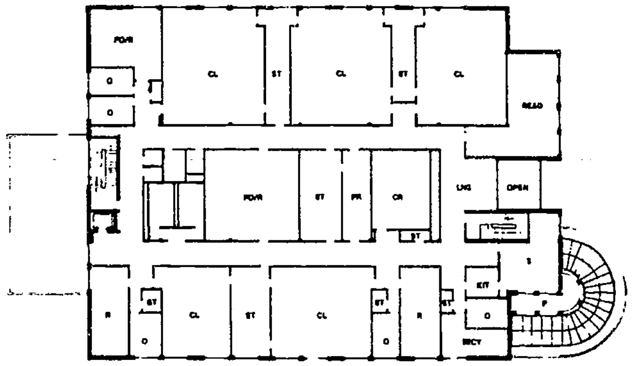
Latitudinal: A "racetrack" corridor scheme allowed efficient circulation. The core was purposely set off-center relative to the building's long axis to further vary the choice of laboratory size.

Learning in a University building takes place formally in classrooms. Also important to learning are the spaces provided for social interaction between faculty and students between classes. Also faculty need social spaces to interact among themselves.

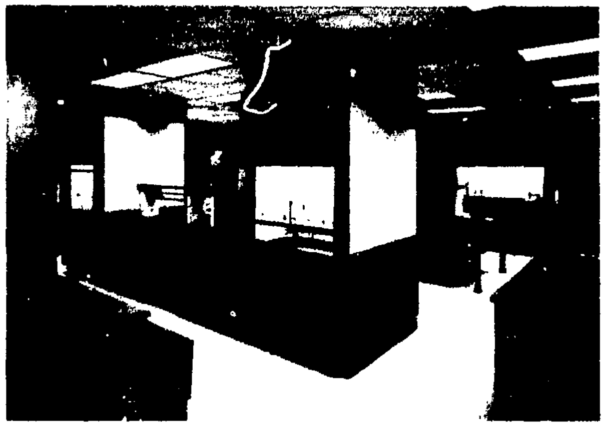
Social spaces provided:

- On the ground floor, a generous lobby leads into 2 large instruction spaces
- The second floor lounge overlooks a double-height front entrance lobby
- An outdoor second floor patio off the main seminar room overlooks the main quad.
- Landscaped entrance with broad steps and low walls invite informal gatherings

The best used social space turned out to be the stairs, seminar lounge, coke machine and kitchenette next to the science building's main secretary and office.



2nd floor-Chemistry



A major goal of the project was to provide a lab intensive environment supported by a cost effective engineering system. All but five special fume hoods and the general laboratory exhaust is dumped into one exhaust air plenum. Waste heat energy was captured in this plenum by using only two heat recovery coil banks. This system maintained individual control of fume hood exhaust fans without any operational devices (i.e. dampers) within the ducts which may corrode.

- 57 fume hoods tied to penthouse plenum
- Heat recovery using glycol loop
- Direct digital control
- Labs maintain negative pressure
- Labs use 100% outside makeup air
- Labs and lecture halls equipped with ventilation override control to purge fumes
- All exhaust fans in penthouse for ease of maintenance

A balance was sought to provide a building environment conducive to summer work by the professors without air conditioning the entire building in order to conserve scarce capital. The building was designed to allow selected rooms, such as research laboratories and faculty offices, to be air conditioned during the summer months with an option for all rooms to be air conditioned at a later date. After the first year's use, it was decided to start implementing the full air conditioning of the building.

◀ *View of the previous science building: Should the college renovate or build new?*

Previous teaching lab circa 1958 ▶

The facility's purpose was to enhance both the reputation of the College and its science program. It helped establish the credibility the college needed. In April, 1991 they gained American Chemical Society approval.

The facility has played an important part in attracting students to the college: Chemistry enrollment is up 70% and Biology is up 60%.

Because the college must spend its capital dollars carefully, the new facility provided overflow lecture and classroom space for the rest of the liberal arts college. The planned use of the facility's general lecture space has brought students and the community into the science environment and has helped the college's goal of building a stronger liberal arts institution.

Lycoming College sought to place science in a leading role on campus. Weighing the investment of capital against the pursuit of excellence in education, the college built a facility that will allow faculty and students to achieve their highest potential.

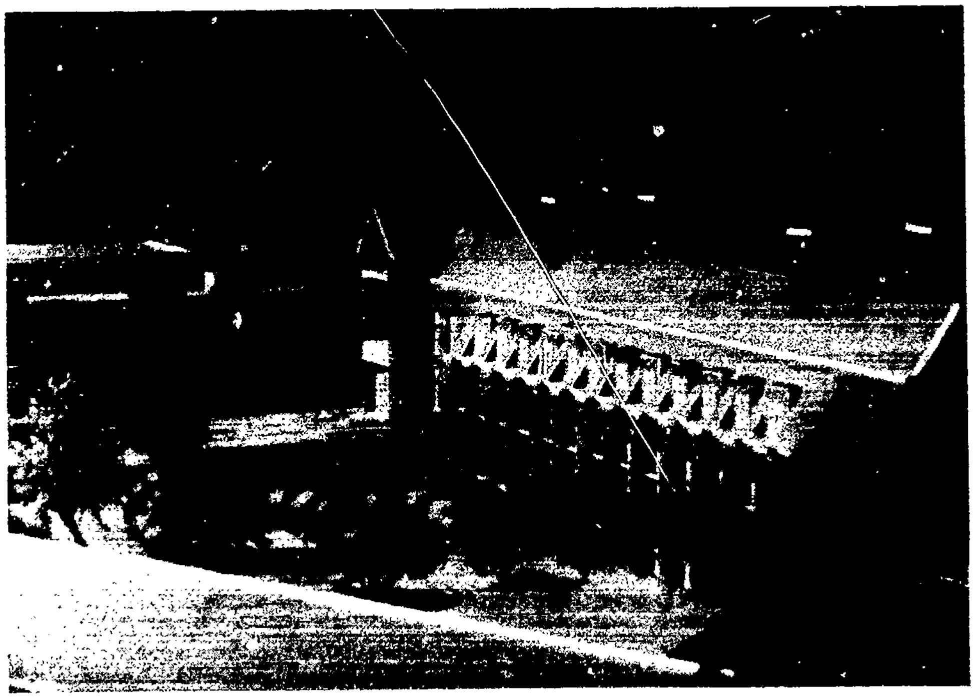
REED COLLEGE - CHEMISTRY BUILDING

Client: Reed College, Portland Oregon
Douglas C. Bennett, Provost

Firm: Zimmer Gunsul Frasca Partnership

Design Team:
Robert Frasca,
Partner-in-Charge/
Principal Designer;
Paul Engels,
Project Designer;
Lee Kerns,
Project Architect;
Jori Bourret,
Interior Designer;
McLellan & Copenhagen,
Lab Planning;
KPFF Consulting,
Structural Engineer;
Manfull Curtis,
Mechanical Engineer;
James Graham & Associates,
Electrical Engineer

Area: 59,724 square feet
Total cost: $8.2 million
Cost/Square foot: $138
Completion: July, 1992



Chemistry Building

Hauser Library

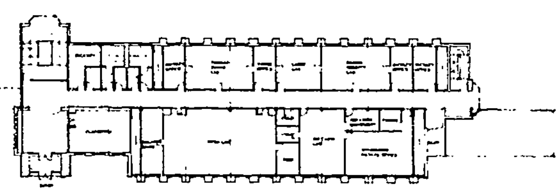
Reed College's new Chemistry building (to open Fall, 1992) and a reconstruction of the old building for use by Psychology are the centerpieces of an integrated renewal of the college's facilities for the laboratory sciences. The overall project, which also involves some renovation of facilities in the Biology-Physics building, was planned by a committee which included representatives of the four departments and was chaired by the Provost.

The project was planned around a curriculum which is laboratory-oriented from the introductory courses through a senior thesis that is required of all students. In the new Chemistry building, as elsewhere in the complex, faculty offices are adjacent to research-teaching labs in which faculty work on research projects with students. We have also made provision for shared offices for thesis students, additional laboratory space for student projects, and informal study space for students. Our goal has been to create several small, laboratory-centered communities of inquiry in comfortable proximity to one another. The two lower levels of the building (not shown here) have equipment and computer rooms, a stockroom and larger teaching laboratories.

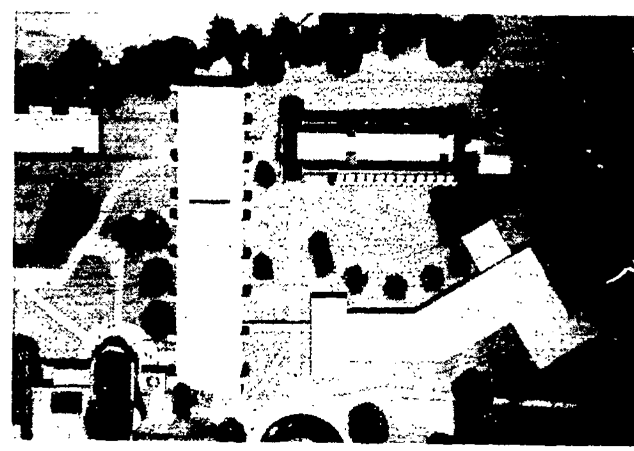
By having the four departments plan the renewal together, we had an opportunity to make common provision for facilities that could be shared among the four departments: storage, a small lecture hall with excellent AV capability, a set of classrooms tailored to the laboratory sciences (including two computer classrooms), office and laboratory space for emeritus faculty and visitors, shop facilities and an animal colony.

The three buildings which house the laboratory disciplines are close to the Hauser Library, into which the individual departmental Biology, Chemistry, Mathematics and Physics libraries were integrated through a recent addition and renovation (also designed by ZGF). A science reading room provides quick access to current journals, and we also added a science librarian to work with faculty and students in these departments to provide specialized reference, bibliographic instruction, collection development and online searching services.

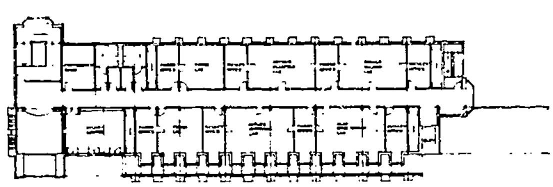
Campus Model Looking West



Plan, Level One

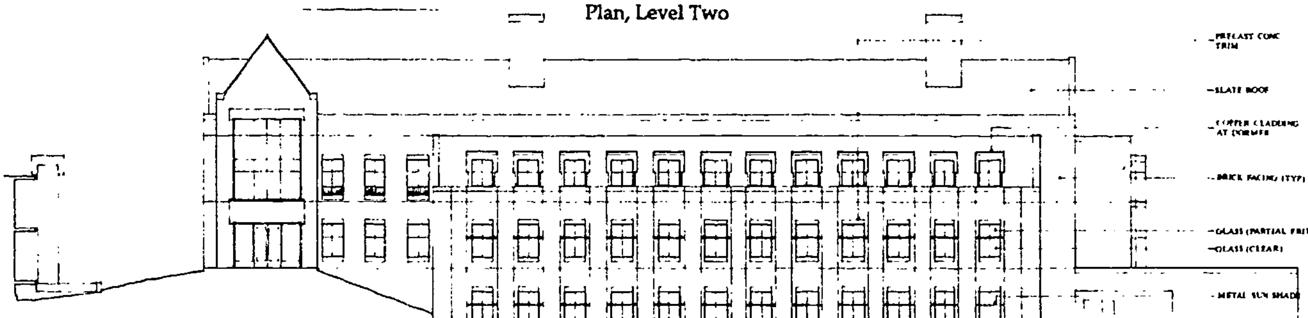


Site Plan



Our goal has been to create several small, laboratory-centered communities of inquiry in comfortable proximity to one another.

Plan, Level Two



South Elevevatic

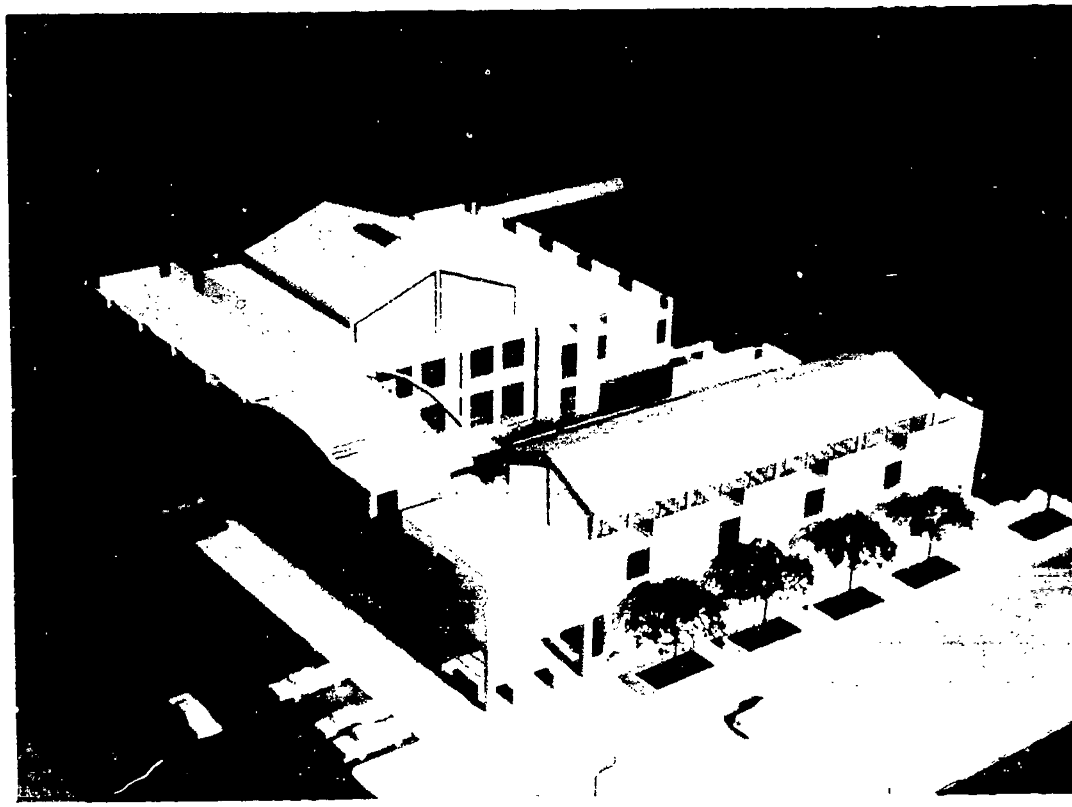
LABORATORY DESIGN PROMOTES TEACHER AND STUDENT INTERACTION

W.M. KECK FOUNDATION JOINT SCIENCE CENTER
CLAREMONT MCKENNA/PITZER/SCRIPPS COLLEGES
CLAREMONT, CALIFORNIA

CLIENT:
Claremont McKenna College
Scripps College
Ptizer College
Friitz Weis, Treasurer, Claremont McKenna College
James Manifold, Treasurer, Scripps College

ARCHITECTURAL FIRM:
Anshen+Allen Architects, Inc..
Peter Stazicker, Principal-in-Charge
David Rinehart, Design Principal
Scott Kelsey, Project Architect

DESIGN TEAM:
Research Facilities Design
Laboratory Design Consultants
Ove Arup & Partners
Structural, Mechanical, Electrical Engineers
Carmen Farnum Igonda
Interior Design Consultants
Burton and Spitz
Landscape Architects
Koll Construction
General Contractor



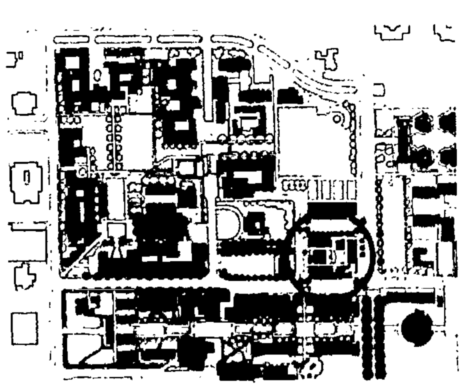
Area: 82,000 square feet
Total Cost: $11.4 Million
Completion Date: November, 1991

The planning for the new W.M. Keck Science Center involved the faculty of the Joint Science Department which serves Claremont McKenna, Pitzer and Scripps Colleges and also the administrations of these three colleges. Key issues were the site, scale and placement of the new facility, which needed to make a positive statement about the increased importance of science to each college's academic program. The site selected is at the intersection of the three campuses, convenient and visible to each. A significant architectural challenge was to avoid a "back" door. Thus creating a building with four attractive facades accessible from all directions.

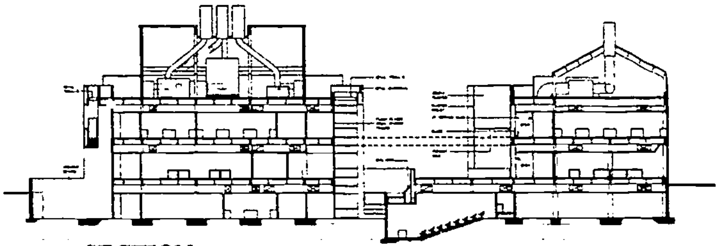
An important design criterion was the need to create space for interaction and informal conversation, among both faculty and students. The placement of faculty and administrative offices, with laboratories and the corridors between them, maximizes faculty and student contact. The central, open courtyard between the two wings also serves to encourage informal interaction. Open corridors on the east wing, the courtyard and landscaped light wells, possible in the benign climate of Southern California, create vistas across and within the facility. Students and faculty are readily visible as they move from one part of the building to another.

The dramatic use of large windows on all floors, including the basement through creative use of light wells, landscaping and interior color scheme all promote a "user friendly", attractive environment. This teaching facility is designed to attract students to science and reflects the faculty's commitment to making science exciting rather than forbidding.

The Joint Science Department encourages student as well as faculty research. Faculty offices are adjacent to research laboratories, a convenience for faculty which also allows students to work with faculty nearby. While the architects designed laboratories for specific disciplines and courses, they also built in flexibility for future curriculum revisions. To accommodate future growth in overall student population and in the percent of students taking science classes, a large basement area was left in shell form, to be finished when needed.



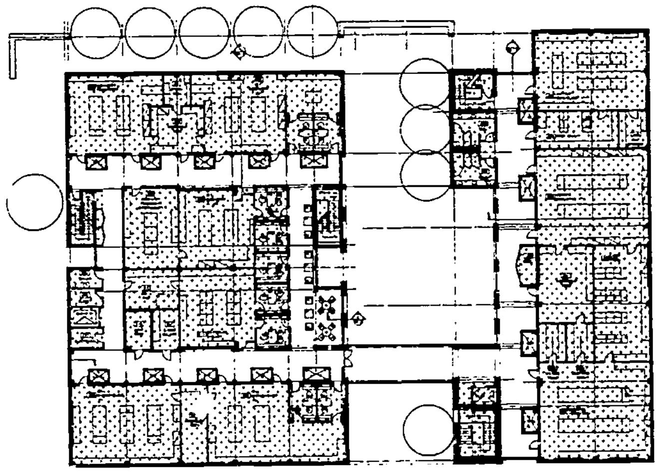
SITE PLAN



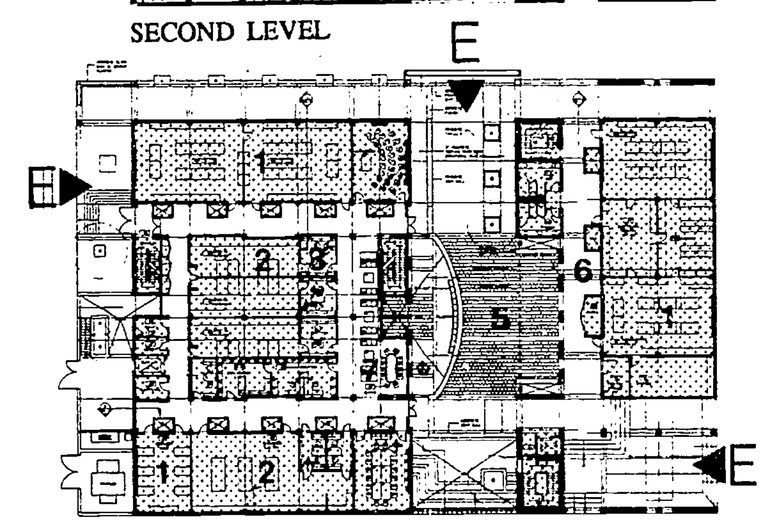
SECTION

LEGEND

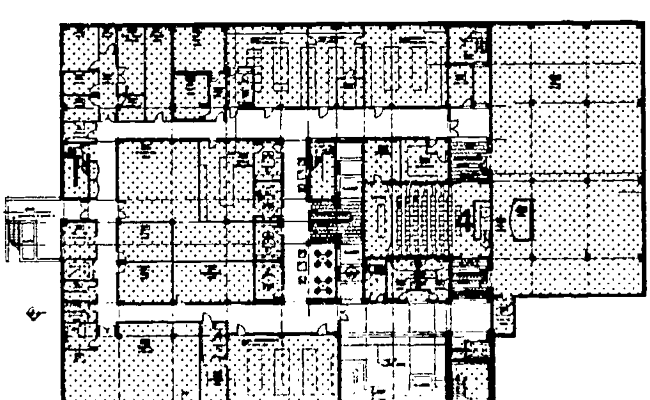
1. Teaching Laboratory
2. Research Laboratory
3. Faculty Offices
4. Lecture Room
5. Exterior Courtyard
6. Exterior Corridor
7. Faculty/Student Alcove



SECOND LEVEL



FIRST LEVEL



BASEMENT LEVEL

FINANCING AND MANAGING ACADEMIC RESEARCH FACILITIES

[Adapted from the Statement of a Workshop on "Facility Financing: University Policy Options." The workshop was convened by the Government-University-Industry Research Roundtable, a unit of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. Dr. Linda Wilson, President, Radcliffe College, chaired the meeting. Patricia Warren wrote the workshop statement.]

INTRODUCTION

Further study of the problem is not necessary. Now we need to move from ideas to action.

The deterioration and obsolescence of scientific research facilities on the nation's campuses are widely recognized. The facilities gap, and the many factors contributing to it, have been documented in a succession of studies dating from the early 1970's. Consensus now exists in government and industry, as well as academe, that the situation has reached a point where it threatens the strength of the nation's research enterprise and the quality of education of new scientists and engineers. Further study of the problem and its dimensions is not necessary. What is needed now is to move from ideas to action.

Recognizing this need, the Government-University-Industry Research Roundtable convened a meeting on November 6, 1989, of senior university officials and faculty. The purpose of the meeting was to work toward consensus on a statement of feasible and desirable changes in university policies and practices regarding the financing and managing of academic research facilities. That statement (and this adaptation of it) are in the form of options to stimulate discussion, not policy recommendations.

The focus of this paper is restricted to discussion of university policies and practices, as specified in the Roundtable charge to the group. To the extent that practices of other sectors create incentives or barriers for universities, we have acknowledged them, but the aim of this paper is to address matters that can be controlled by universities. It should be noted, however, that university policies are very sensitive to federal policies, particularly those dictated by OMB Circular A21 and tax laws which affect universities' abilities to solicit funding for equipment and facilities.

In addition, the focus of this paper is limited to facilities used for academic science and engineering research and does not include those used solely for undergraduate instruction. The tight coupling of education and research in colleges and universities, however, make strict separation difficult especially at the upper levels of undergraduate instruction.

Universities can take some actions that would enhance the financing, management, and use of research facilities. No single strategy, however, nor even the sum of all university strategies will suffice. As one participant put it, these suggestions are akin to "lighting a match in a hurricane." Given the multi-billion-dollar magnitude of the facilities deficit, universities acting alone can meet only a small fraction of the need.

The overall problem is so large and steadily growing that it cannot be properly addressed without actions in partnership with federal and state governments and the private sector.

OPTIONS

The universities' abilities to finance and manage research facilities efficiently are affected by their individual circumstances, their traditional decentralized authority, the individual project-award system that funds much of research, and state and federal regulations. Moreover, if forced to choose, universities will generally use available funds to retain faculty infrastructure. This attitude is in keeping with the dual mission of the university--education and research--which emphasizes human capital and requires the long view.

Within this context, we have identified a number of management practices that are being effectively implemented in many universities and that warrant more widespread use. We have also identified some changes in the system that would facilitate and improve universities' abilities to finance and manage their physical resources effectively. These practices and suggested changes form the basis of the options that follow. Unless otherwise noted, they apply to both public and private institutions.

Taken as a whole, these options imply a need for universities individually to consider a more centralized approach than is now the general practice in their management of research facilities. We note that other developments, mainly the result of financial pressures, point in the same direction. They include the universities' growing interest in debt financing and in developmental efforts involving close cooperation with state governments and industry. Centralization has consequences beyond the management of facilities, however, and the trade-offs must be carefully considered.

Some options for universities are:

1. To plan more systematically their allocation of resources to favor research and facilities in areas that are central to their mission of education and research or that offer the best opportunities to achieve distinction.

> The costs and complexities of financing and managing first-rate academic research facilities are some of the several pressures, mainly financial, that appear to be moving universities toward campus-wide strategic planning.

Such planning leads to increased selectivity in the allocation of resources to work in disciplines that offer the university the best opportunities to achieve distinction.

Sound strategic planning must involve extensive faculty participation and clearly requires better internal communication between faculty and administrators than is now the case on many campuses.

Such increased selectivity, however, leaves excellent work in other areas unsupported and therefore represents lost opportunities in science and technology and lost benefits from them. Unless resources are made available for facilities renewal, we believe that more and more hard decisions of this kind will have to be made.

2. *To build long-term financial planning and funding mechanisms for plant renewal and adaption into the on-going financial operations of the institution, as recommended in a recent report by SCUP, NACUBO, APPA, and Coopers & Lybrand,* Financial Planning Guidelines for Facility Renewal and Adaption.

Steps in this direction include:

A. Adopting board-level or system-level plant asset protection formulas similar to endowment spending policies. Such formulas might require allocating from reserves sufficient:

- plant renewal funds on an ongoing basis to keep the plant in good condition for its present use (e.g., 1.5%-2.5% of current plant replacement cost);
- plant adaption funds on an on-going basis to alter the physical plant for changes in use and changes in codes and standards (e.g., .5%-1.5% of current plant replacement cost); and
- catchup maintenance funds over a short-term period to bring the plant into reliable operating condition, based on a plant audit.

B. Taking advantage of a wide range of tactics to assure an adequate flow of funds to those reserves, including:

- raising private funds to pay for specific plant renewal and adaption projects and, wherever possible, to endow continuing upkeep;
- planning adequately for building upkeep costs for new or renovated buildings;
- assuring that auxiliary and other facilities that generate revenue cover their own renewal and adaption costs through user fees;
- building plant asset protection formulas into loan covenants;
- borrowing, if necessary and financially prudent, to cope with catch-up maintenance; and
- assuring that the balance of the funding needed is provided from unrestricted operating budgets.

Given the magnitude of the sums needed, the SCUP report recommends phasing in these changes over several years so as to avoid unduly prejudicing other goals.

3. To review the roles and lines of authority within the institution and recognize the need for discipline, continuity, and assigned responsibility with respect to financing and managing facilities.

The traditional decentralized organization and shared governance of academia complicate orderly business practices in institutional planning, budgeting, and facility development.

There is no substitute for the clear assignment of responsibility for the care of plant assets, and for a consistent, long-term disciplined approach. Within this overall assignment, however, universities may find it helpful to hold the finance division clearly responsible for assuring over time the adequate provision of financial reserves and the plant division clearly responsible for long-range facility planning and project management.

4. To reduce cost and achieve better use of existing and potential facilities by improving facility design, construction, and space management and incorporating the best current practices.

There is little communication among universities about good design and construction methods. Modernizing university research facilities on a national scale will require universities to adopt more efficient management practices, including state-of-the-art design and building methods. Improvements in these and other aspects of facility management, such as planning, allocation, operations, and financing, would help ensure that invested funds go as far as possible.

5. To collect systematically information on the use of space on their own campuses and consider space reallocation to maximize its efficiency.

Construction of new space involves not only initial capital costs, but also a long-term commitment to maintenance, utilities, and building staff. Therefore, before constructing new space, universities should be certain that existing facilities are fully used and that pressing needs cannot be met by reallocation or renovation of existing space. Space utilization studies by inhouse staff or by outside consulting firms are often cost effective by identifying actions that can be taken to reduce the need for construction of new space.

Institutions that have made significant progress in renewing facilities and adapting them to changing needs can usually trace their success to the persistent efforts of a senior administrator or trustee who acts as the champion for facilities needs.

6. To explore greater use of debt financing as a means of financing research facilities, but with careful regard for the long-term consequences.

Universities that have not done so should develop expertise on debt financing. This expertise should include the ability to determine and communicate the true costs of debt financing and should be readily accessible to research administrators and faculty. The complexity of tax-exempt debt financing, the many participants, the necessary legal opinions, and the various political and corporate entities involved make it essential that universities fully understand the marketplace.

Universities vary widely in their use of debt financing, but a universal concern is the need for a reliable stream of income to make the debt payments. Universities that are active in debt financing generally require a fallback source of income, such as college or departmental resources, to pay the principal and interest on the debt if necessary. A noteworthy aspect of debt financing is that it imposes risk on the university as a whole, not just on the unit benefiting from the facility. This implies a shift from decentralized toward centralized authority. The necessary commitment of institutional resources can also reduce the university's flexibility to pursue promising new opportunities as they arise.

There is no formula to determine how much debt a university can sustain. The appropriate level depends on many variables, including the institution's philosophical approach to financial management and its credit rating. Several factors that have been identified as measures of debt capacity, different forms of debt financing, and their pros and cons as they related to financing academic research equipment are discussed in a 1985 report of AAU, NASULGC, and COGR, *Financing and Managing University Research Equipment*.

7. To explore opportunities for collaboration, sharing, and use of new information technologies within and among institutions and with industry.

The degree of sharing that is feasible varies greatly among fields of research. Important determinants include the cost and nature of the facility and the characteristics of academic science. Sharing by many users has long been characteristic of facilities in high-energy and nuclear physics and in optical and radio astronomy. Sharing is very effective when the research requires limited and routine use of commercially available service-type equipment such as electron microscopes or high-field nuclear magnetic resonance spectrometers. Computing equipment is widely used by remote access. The increasing power and decreasing cost of small computers, however, will probably act to reduce the number of use who might share a machine and limit sharing of computers to those who require the power of supercomputers. Because research equipment is increasingly operated under computer control, it may be possible to share it by means of remote access.

Modernization cannot be a one-time effort. Continuing investment will be required.

Academic scientists can gain access to state-of-the-art facilities in industry through collaboration with industrial investigators in pursuit of common interests. Normally, however, industrial laboratories are not set up to service outside users. Barriers to academic use include considerations of safety, liability, and proprietary information. Industry also provides facilities for academe in other ways such as industrial affiliate programs, research centers, and consortia.

While collaborative approaches have increased and are improving in some areas, emphasis on individual creativity and scholarship should remain a major driving force for such collaborations in the university.

CONCLUSION

The health of the academic research enterprise rests on several factors that are mutually dependent and reinforcing. State-of-the-art facilities and equipment influence what research will be done and how productive it will be. And the environment in which scientists work is critical to recruiting new faculty and retaining them, thus ensuring the availability of sufficient numbers of future scientists and engineers. Inadequate facilities, when combined with other pressures on investigators, such as increased difficulty in finding support for their research, are discouraging many young people from beginning careers in science and engineering. This failure to meet the nation's need for highly trained people will have potentially disastrous consequences for the U.S. economy and national security. The nation simply cannot continue to allow the academic infrastructure to erode. It is inextricably linked to our most precious resource--human capital.

January 10, 1990

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THE NATIONAL PICTURE:

A NEW PERSPECTIVE ON DATA

Carol H. Fuller

SECTION II

THE NATIONAL PICTURE: PART I
SUMMARY AND DISCUSSION

INTRODUCTION

Project Kaleidoscope began its research agenda with two objectives:

- To identify undergraduate programs that have been successful in attracting and sustaining student interest in science and mathematics, documented by the numbers and proportions of baccalaureate degrees in these fields, and by the numbers and proportions of their graduates who received doctorates in these fields.

- To provide data describing the productivity of all institutions granting baccalaureate degrees in science and mathematics, disaggregated by field, by race/ethnicity, by gender, and by institution.

These objectives relate to the larger goal of Project Kaleidoscope to develop a plan of action to strengthen undergraduate science and mathematics and to join in the national effort to address problems in science and mathematics education at all levels.

As we began to gather and analyze data, it became clear that we needed to engage in a third activity:

- To identify areas that must be improved in the collection, analysis, and utilization of data at the institutional, the state, and the national level.

OBJECTIVE 1. Identifying successful undergraduate programs in these disciplines is the necessary first step in developing models for reform which can inform and guide the formulation of federal, state, and institutional policies.

There are colleges and universities, of all types and sizes, in all regions, that have thriving undergraduate mathematics and science programs. This variety of successful institutions suggests that, while there may be central principles for successful programs, there may be a variety of specific models for their implementation with different adaptations to fit the needs of different institutions. Many of these successful programs encourage and enable individuals from under-represented groups, particularly women and minorities, to pursue and to complete baccalaureate degrees and to go on to complete doctoral degrees in mathematics and science.

The productivity and diversity of undergraduate institutions must be recognized as data are collected, analyzed, and used to set national policies.

OBJECTIVE 2. A detailed description--disaggregated by field, race, gender, and institution--of the current productivity of undergraduate mathematics and science education provides information that is obscured when the data are combined. We know Blacks, Hispanics, and Native Americans are under-represented among college graduates in general, and in mathematics and science fields. But they are not evenly underrepresented across fields. In some fields, for certain groups, their participation in mathematics and science is equal to their rate of participation in all fields. Participation in mathematics and science has been declining for some groups and in some fields, but there has not been a decline for every group, in every field, and definitely not at every institution. Detailed information on where we now are is necessary to provide baseline data in order to know whether reform efforts put in place during the next decade make a difference. (Data on trends in baccalaureate degrees, disaggregated by gender, race/ethnicity, field, and institution, and data on the baccalaureate origins of Ph.D.'s and faculty are presented in Part II.)

OBJECTIVE 3: Certain important data are not currently available for several reasons:

- the data have not been collected systematically,
- some important elements are difficult to measure, and
- there has not been sufficient attention to the question of what information is needed in order to address the problems in mathematics and science education.

In some areas there is need for refinement or more detail, such as the need for data on subgroups within the Asian and Hispanic populations. In other areas, there is a total lack of data.

For example, although the Task Force on Women, Minorities, and the Handicapped in Science and Technology concluded, "at 10.5 percent of the postsecondary education students, people with disabilities represent a large untapped pool of talent for science and engineering,"[1] there are no data collected on degrees earned by people with disabilities.

WHAT WORKS

This research was undertaken as a part of Project Kaleidoscope, an effort to outline a national plan of action for strengthening undergraduate science and mathematics. The working committees of Project Kaleidoscope identified these guiding principles for "what works" in undergraduate science and mathematics education:

> *The optimal setting for science and mathematics education provides a community of learners, where groups of manageable size enhance collaborative learning, and where faculty are deeply committed to teaching, devoted to student learning and success, and confident that all students can learn. Learning should be active rather than passive; it should be hands-on, experiential, and research-based--all this from the very first introductory courses to the completion of students' science and mathematics education. And it should involve activity that is meaningful to students and faculty in a highly personal way; it must be connected to historical context, other fields of inquiry, and practical applications of interest to students--to the reality students experience. Finally, there must be multiple entry points to the science and mathematics curriculum and multiple pathways through that curriculum; faculty must meet students where they are and support them as they work to learn; science and mathematics education must be a pump, not a filter--it must focus on "cultivating" rather than "weeding."*

WHAT WORKS: THE INSTITUTIONAL CONTEXT

While successful undergraduate mathematics and science programs are found in all types of institutions, the data presented here show that many of the most successful institutions are liberal arts colleges--the sector of the undergraduate community that has been the focus of Project Kaleidoscope.[2]

From an historical viewpoint the success of the liberal arts colleges in mathematics and science education should come as no surprise. Features that consistently have been found to be important for successful undergraduate education are inherent in the traditions of the liberal arts colleges: emphasis on teaching, small class size, frequent contact with faculty in the classroom and laboratory and in a variety of campus settings, and concern for the individual student.

And the diagnoses of the problems in undergraduate education cite conditions and practices that are alien to the culture of the liberal arts colleges: over-emphasis of faculty research to the detriment of teaching, lack of support for undergraduate teaching, over-departmentalization or specialization--sacrificing breadth and context, over-emphasis on subject matter rather than student development, and impersonal and bureaucratic structures.

If the fields of study being examined were in the humanities, perhaps the success of the liberal arts colleges would be assumed without question. But it may come as a surprise to some who are not familiar with the liberal arts colleges that mathematics and science are as important as the humanities in the liberal arts college curriculum.

A cursory look at the number of mathematics and science graduates from the liberal arts colleges can be misleading. Since these colleges have relatively small enrollments they cannot be expected to have enormous numbers of graduates in any field. However, it should be noted that several of them have numbers of graduates in these fields that exceed the number for institutions of much greater size. For example, between 1987 and 1989, among all the institutions in the nation **of any size**,

- only 31 institutions had more mathematics graduates than Saint Olaf College,
- only 39 institutions had more physics graduates than Reed College,
- only 7 institutions had more women graduates in chemistry than Xavier University of Louisiana,
- only 2 institutions had more women graduates in physics than Bryn Mawr College, and
- only 3 institutions had more women graduates in geology than Carleton College.

The liberal arts colleges graduate students who go on to scientific careers in numbers that are very high in proportion to the size of their enrollment.

Of course, the features of undergraduate education that lead to such high productivity are found in institutions of all types and sizes, and the liberal arts colleges themselves vary in how close they come to achieving their traditional objectives. For instance, small classes can and do occur in large institutions; conversely, some smaller institutions have occasional classes that are larger than might be expected for a small college.

Many faculty at institutions of all types are dedicated to undergraduate education and are doing an excellent job.

However, certain organizational features make some outcomes **more likely**. If the institution serves only undergraduates there is no problem of conflict for the faculty in dividing their time and attention between undergraduate and graduate students. There is no question whether undergraduates at the liberal arts colleges will be taught by senior faculty in the classroom and the laboratory. In conducting their research, the liberal arts college faculty turn to the undergraduate students for their assistants and work with them as colleagues. On these campuses the undergraduates do not have to compete with graduate students for access to equipment or for faculty time and attention. While major universities are expected to have an excellent research faculty, an extensive curriculum, and more equipment than many liberal arts colleges, these features do not provide an advantage to an undergraduate student who has little or no access to them.[3]

Of greatest importance is an institutional value statement made through our formal curriculum: scientific illiteracy is a form of ignorance which cannot be tolerated.... students are expected to be active, not passive, learners. The lecture/demonstration approach to instruction has been largely replaced by a "hands-on" involvement in the various sciences. The final ingredient...is a faculty who are themselves professionally active in their fields. Research keeps faculty current with their fields; and science as a career comes alive as a serious option for students.

-Gresham Riley, President
The Colorado College

WHAT WORKS: EFFECTIVE PRACTICES FOR ALL STUDENTS

There have been a great many reports detailing the status of women and minorities in mathematics and science, and providing analyses of the underlying factors leading to differences in participation among various groups.[4] Institutions of all types, struggling to provide a successful environment for all their students, need information about what works.

A great deal of attention has been given to the pre-college factors that affect students' opportunities to pursue majors in undergraduate mathematics and science. Recent discussions on the under-representation of women and minorities in science and engineering highlighted the lower pre-college mathematics and science achievement among women and under-represented minorities, and lower levels of expressed interest in mathematics and science among women. Pre-college factors are relevant to any student's undergraduate performance--but these factors need not be seen as insurmountable barriers. It is important to note that some institutions have been able to take students with poor academic preparation--due to whatever set of causes--and turn them into fully trained mathematics and science graduates. The success of these institutions indicates that the obstacles can be overcome.

A critical message has emerged from these successful programs: the effective education practices that work best for special groups are identified as those that are the most effective for all students. While women and underrepresented minorities may need special intervention programs to cope with existing conditions in certain undergraduate mathematics and science programs, the objective should be to provide the undergraduate education practices known to be effective for all students in order to improve undergraduate education for all. Marsha Matyas and Shirley Malcom concluded from their review of programs for minorities, women and students with disabilities,

> *A coherent, coordinated, articulated structural approach to enabling students from under-represented groups to succeed in science, mathematics, and engineering programs has yet to be achieved. Within the special project structure, which is the most common intervention strategy, we find that these models support enhanced learning for all students, not only for the underrepresented students for whom they may have been originally designed. Perhaps programs for women, minorities, and students with disabilities can once again point the way toward structured reform within science, mathematics, and engineering programs that can provide excellent education for everyone.*[5]

A critical message has emerged: the effective education practices that work best for women and minorities are those that are the most effective for all students.

We need to go beyond the mystique that seems to surround the well-known success of the women's colleges and the Historically Black Colleges and Universities (HBCUs) as significant sources of women and Black scientists. Since most women and most minority students will be enrolled at other types of institutions, it is vital to understand what can be transferred from the women's colleges and the predominantly minority institutions to improve environments for these students at coeducational and majority institutions. We also know that there are coeducational institutions that provide environments in which women succeed, and there are "majority" institutions that have relatively high success rates for their minority students. We need to understand what they have in common with the women's colleges and the HBCUs that leads to their ability to provide an environment in which these students can succeed.

The success of the women's colleges and the HBCUs can be attributed to their "talent development" approach to undergraduate education.[6] According to Astin, the "talent development view...would regard as excellent any teacher who is capable of producing significant improvements in the performance of students, whatever their performance level at college entry."[7]

ENVIRONMENT. The primary facilitating feature of the HBCUs is the hospitable, accepting, and challenging environment provided to their students. The expectation of success is frequently mentioned as fundamental. This positive environment can be provided at majority institutions, and is being realized to varying degrees. Jacqueline Fleming[8] pointed out that the factors necessary for success are the same for all students, but certain students are more likely to find them in particular environments. "What works" for White men will work for other students as well if it is provided to them.

At the women's colleges there is no question of whether women will receive equity in faculty attention, or in opportunities to participate, or in encouragement to succeed. Similarly, at the HBCUs, the features that encourage and support students as they attempt to complete mathematics and science majors, without question will be available to the Black students. One concern remaining, however, is the status of Black women. The HBCUs that are also women's colleges could be expected to provide an optimal learning environment for this group. Since there are only two such colleges (Spelman College and Bennett College), the status of Black women within the coeducational HBCUs and the majority women's colleges, as well as within the coeducational majority institutions, is a subject that needs more attention.[9]

STUDENT/FACULTY INTERACTION. The research on the achievement of minorities in higher education points again and again to the preeminence of the relationship between the student and the faculty in determining the student's academic success.[10] While general institutional support and social integration are vital to the success of all students, each faculty member must examine the quality of the interaction between himself or herself and each student. The value of undergraduate research experiences in motivating students and promoting their undergraduate education has been recognized for a long time.[11] Shirley Malcom[12] suggests that one of the fundamental reasons for the effectiveness of undergraduate research may be that it requires an especially beneficial kind of relationship between students and faculty.

ROLE MODELS. Much attention has been given to the topic of same-sex and same-race mentors as a factor in the success of the women's colleges and the HBCUs. Some have concluded that it is the single most important factor. At some point the individual must begin to think of himself or herself in the role of scientist, and that perception needs to be supported. When women students have the opportunity to interact with women scientists it may be easier to overcome much of the negative sex stereotyping prevalent in our culture[13]--and that interaction is much more likely to occur at the women's colleges.

However, these analyses have not considered the role of men faculty at the women's colleges, or the faculty of other races at the HBCUs. Indeed, what does not seem to be well-known is that the faculty of the women's colleges include many men, and the faculty of the HBCUs include persons of all races. There is more to explaining the success of the HBCUs and the women's colleges than just same-sex or same-race role models. As Etta Falconer, Director of Science Programs and Policy at Spelman College, has said,

> *Majority faculty [at majority institutions] should be willing to serve as mentors, and should not expect the few minority faculty at the institution to take care of all minority students. They too can be role models. If white faculty at HBCUs can serve as role models for Black students, why can't white faculty at majority institutions? The science department must become the same home for minority students as it is for majority students.*[14]

"CRITICAL MASS." Another feature that has been mentioned frequently in studies of women and minorities is "critical mass," the number of individuals within a group who share particular characteristics. The objective is clear: each student should feel comfortable in the classroom, lab or other college setting as an individual on an equal basis with every other student. If students feel isolated or alienated, their academic work will suffer.

But, what constitutes "critical mass"? Is it an absolute value, or proportional, or both? One of the problems of critical mass is that the dimensions involved are idiosyncratic and probably change from setting to setting depending on which characteristics seem relevant. As an individual student reacts to the larger group, certain factors can be expected to play an important role in determining which personal characteristics are focussed on.

The nature of the activity can be expected to make some attributes more salient. For example, in activities in male-dominated fields, women probably will feel isolated by gender. Uri Treisman has provided a model for dealing with problems of isolation,[15] but we need a better understanding of the topic of critical mass.

In looking at total enrollments at several large universities, Richard Richardson, Howard Simon, & Alfredo de los Santos[16] observed that enrollment for a specific minority group needed to approach 20% for the students to cease being a "special" group and become incorporated into the mainstream of the institutional culture. There have been suggestions that it is not that simple for women. Because our society traditionally has been male-dominated, there appear to be different group dynamics between groups that are 100% women compared to those that include men.

The experiences at Wheaton College (MA), as they admitted men, indicate that there are critical differences in classroom dynamics between classes with only women and coeducational classes. Even when women are in the majority in coeducational classes, they receive less attention from faculty and participate at lower levels.[17] Elizabeth Tidball[18] reported that the academic achievements of men at formerly men's colleges was not diminished when they became coeducational, but the academic achievement of women at formerly women's colleges was shown to decline following the shift to admitting men. It is no doubt possible that any debilitating effects on women's performance in coeducational settings can at least be lessened, but we need to understand what works for women in coeducational settings.[19]

For this purpose we seek to identify coeducational and predominantly majority schools which are most productive in graduating women and minorities, so that further studies can focus on the dynamics of successful education in these environments.

REVIEWING THE DATA

Data are available from the U.S. Department of Education on the numbers of baccalaureate degrees conferred by each institution in mathematics and science fields, and from the National Academy of Science on the baccalaureate institution of each individual who receives a doctorate from a U.S. university. Even though there are such outcome measures available that can be used as a first step in identifying the institutions that have programs that work, there are no national data that directly assess the effectiveness of undergraduate science education.

The great diversity in U.S. higher education is apparent in a number of dimensions, including contributions to the science pipeline. To make comparisons among institutions, it is necessary to take into account differences in breadth of curriculum, as well as size.

In reviewing the available data, the great diversity in U.S. higher education is apparent in a number of dimensions, including contributions to the science pipeline. In order to make comparisons among institutions, it is necessary to take into account differences in breadth of curriculum, as well as size.

There are specialized institutions with no mathematics or science instruction and others that offer instruction only in these fields. Most undergraduate mathematics and science students are enrolled in institutions with general education curricula that offer instruction in mathematics and science as well as a number of other fields. These institutions vary widely in the number and the proportion of the baccalaureate degrees they award in mathematics and natural science, and the number and proportion of their undergraduates who go on to complete Ph.D.'s.

BACCALAUREATE DEGREES IN MATHEMATICS AND NATURAL SCIENCE

Of course, the largest number of mathematics and science graduates are produced by the universities with the highest enrollments. However, inspection of the data for individual institutions reveals surprising results: many smaller institutions have a high number of baccalaureates in these fields (often higher than the number for much larger institutions), while several larger institutions have a much lower number than might be predicted on the basis of their size. This is especially true for the numbers of baccalaureates earned in these fields by women.

SECTOR PRODUCTIVITY. Looking at absolute numbers of degrees granted is useful in gauging the status of the "pipeline," but evaluating the productivity of an institution requires adjusting for the size of the student body. Mathematics and science baccalaureates are granted by institutions large and small: with undergraduate enrollments ranging from fewer than 300 to more than 30,000. This variation in size can be controlled by reporting mathematics and science degrees as a proportion of the total number of degrees conferred in all fields by each institution.

The institutions with the highest proportion of their undergraduates earning degrees in mathematics or natural science fields are, as would be expected, the specialized institutions. Other highly productive institutions include representatives of each of the various sectors: public and independent; predominantly undergraduate and doctoral level; liberal arts colleges, comprehensive colleges and universities, research universities, and other doctorate-granting universities. However, within each of these sectors there is a great deal of variation in productivity.

While each sector has highly productive institutions, the Liberal Arts Colleges and the Research Universities (1987 Carnegie Foundation Classification) are the most productive groups. These groups each have a larger share of the mathematics and natural science baccalaureates than their share of the baccalaureates in all fields. The Liberal Arts Colleges confer 5% of all baccalaureates, but confer 11% of the mathematics and natural science baccalaureates; and the Liberal Arts Colleges confer 6% of the baccalaureates earned in all fields by women, but 12% of the mathematics and natural science baccalaureates earned by women. The Research Universities confer 30% of all baccalaureates, and 35% of the mathematics and natural science baccalaureates; and they confer 27% of the baccalaureates earned by women in all fields, compared to 33% of the mathematics and natural science baccalaureates earned by women.[20]

These findings confirm the conclusions of the Office of Technology Assessment 1988 report[21] and the Oberlin reports [22] that the liberal arts colleges are an especially productive group of institutions, and these findings demonstrate the variety and number of colleges making a significant contribution to undergraduate mathematics and science education.

Because of the continuing decline in the college-age population, the proportion of students receiving bachelor's degrees in science and engineering would have to increase dramatically just to maintain the current annual supply. Can such an increase be accomplished? The historical data are not encouraging. Between 1960 and 1980, the fraction of 22-year olds receiving baccalaureate degrees in the natural sciences and engineering hovered between 4 and 5 percent. Recent data indicate that the conferral rate this year [1989] will be 4.5 percent, at best. That rate would have to increase to over 6 percent by the turn of the century to maintain the current supply of scientists and engineers...Can the conferral rate be increased sufficiently to maintain supply? Only with ingenuity and considerable luck!
-Richard Atkinson, Chancellor, University of California, San Diego, 1990.

The most productive groups of institutions for women mathematics and science graduates are the coeducational liberal arts colleges and the women's liberal arts colleges. The comprehensive women's colleges are more productive than the coeducational comprehensive institutions.[23]

The number of institutions conferring baccalaureate degrees in mathematics or natural science fields to Black, Hispanic or Native American graduates is disturbingly small. As would be predicted from enrollment patterns, a very high percentage of the mathematics and science degrees earned by minority graduates are conferred by the Historically Black Colleges and Universities and other predominantly minority institutions. However, there are variations in productivity among the predominantly minority institutions as there are among the majority institutions.[24] The most productive group of institutions for Black mathematics and natural science graduates are the liberal arts colleges among the HBCUs. The majority liberal arts colleges graduate a high proportion of their Hispanic and Black graduates in the fields of mathematics and science. These colleges do not have large numbers of minority mathematics and science graduates, because they do not have large enrollments of minority students.

ATTRITION/PERSISTENCE. Of course, simply knowing either the number or the proportion of the degrees an institution awards in any field does not provide direct information about the effectiveness of the program. The fundamental piece of information needed (but not generally available) would be how many of the students who enter the program successfully complete it. What are the attrition/persistence rates? If an institution enrolls a sufficiently high number of potential majors, it is possible for them to have a large number of mathematics or science graduates even with a program that discourages many potential majors. Assessment measures of what students have learned or gained must be considered in relation to retention rates. An institution that "weeds out" large numbers of prospective majors might well show high levels of achievement for the few survivors, compared to an institution that "cultivates" a larger number of majors with a concomitant greater range of mastery.

The best programs could be defined as those that not only retain a high proportion of their entering students but attract and enable others as well--majors and non-majors alike. These institutions are those that provide multiple entry points into majors with flexible curricula and that provide support for students who arrive at college at various levels of development and preparation.

An institution that "weeds out" large numbers of prospective majors might well show high levels of achievement for the few survivors, compared to an institution that "cultivates" a larger number of majors with a concomitant greater range of mastery.

The best programs not only retain a high proportion of entering students but attract and enable others as well--majors and non-majors alike.

BACCALAUREATE ORIGINS OF NATURAL SCIENCE DOCTORATES

The diversity in mission and programs among postsecondary institutions is reflected in their contributions to the Ph.D. portion of the science pipeline. As in the case of the baccalaureate degrees conferred in mathematics and natural science, the number of doctorates subsequently earned by the baccalaureate recipients of many institutions differs from what would be expected on the basis of institutional size. Several relatively small colleges and universities have high numbers of their graduates who have earned natural science doctorates, while many larger institutions have relatively low numbers of their graduates who go on to complete Ph.D.'s. The institutions with the largest number of baccalaureates who earned natural science Ph.D.'s include several small colleges and universities.[25]

The most productive institutions as baccalaureate sources of Ph.D.'s, defined by the number or by the proportion of their graduates who go on to complete doctorates, include representatives of each sector: independent and public; predominantly undergraduate and doctoral level; liberal arts colleges, comprehensive colleges and universities, research universities, and other doctorate-granting universities.

However, the highest productivity rates are found among the independent institutions, particularly the private Liberal Arts I Colleges and the private Research I Universities. These results are consistent for all doctorates, and for doctorates earned by women. It is important to note also, that, while the liberal arts colleges among the women's colleges as a group were not more productive of women baccalaureates in the sciences than were the coeducational liberal arts colleges, the women's liberal arts colleges were distinctly more productive of women graduates who subsequently earned a doctorate in these fields.[26]

The undergraduate experiences women have in women's colleges may be particularly important in providing women with the confidence and the motivation to persevere through graduate training in fields that are male-dominated.

The number of natural science doctorates earned by Hispanic and Black graduates continues to be intolerably low. The HBCUs continue to be a significant baccalaureate source for natural science Ph.D.'s earned by Blacks. Predominantly minority institutions and other institutions in the Southwestern U.S., Florida, California and Puerto Rico were the baccalaureate source for one-half of the Hispanic doctorates.[27]

The undergraduate experiences women have in women's colleges may be particularly important in providing women with the confidence and the motivation to persevere through graduate training in fields that are male-dominated.

BACCALAUREATE ORIGINS OF NATURAL SCIENCE FACULTY

Analysis of data obtained for Project Kaleidoscope from a recent sample of natural science faculty suggest that the various types of undergraduate institutions contribute to the current faculty at about the same levels as they contribute to doctorates. However, definitive data on this topic are not available. Although faculty surveys frequently include a question on baccalaureate origins, usually the data have not been recorded or analyzed. The undergraduate experiences of postsecondary as well as K-12 mathematics and science teachers is an area that needs much more attention.

SUMMARY

Looking at the data currently available can provide helpful information by identifying institutions that are unusually productive in these fields. Examination of the different as well as the common features of these institutions and their undergraduate programs can provide insight into what works, and can provide information about the resources necessary to develop and sustain effective undergraduate mathematics and science programs.

Numbers are only indicators of where to look for quality. But the data summarized above and presented in detail in Part II provide a first step in addressing the predicted crisis in the scientific pipeline and the problems in science education.

THE DATA LEAD TO NEW QUESTIONS

The data used for this research are presented in detail in Part II of this section. Of particular importance are the data for women and under-represented minorities. These data are useful for several purposes. They provide some direct information and they provide the basis for further questions and investigations in attempts to better understand what works for these groups, and how and why it works.

Knowing which are the institutions that have higher rates of success in mathematics and science for their women and/or minority students makes it possible to identify models for effective programs. In addition to several of the women's colleges, there are coeducational colleges and universities that are highly productive for women, both at the baccalaureate level and as sources of Ph.D.'s. What are the essential elements of these programs that account for this success? Which institutions recruit and retain larger numbers of students who major in these fields? What is required to "cultivate" rather than "weed"?

The list of leading institutions in the percentage and number of women graduates receiving baccalaureate degrees in these fields (p. 73) includes several predominantly minority institutions. This phenomenon requires more scrutiny. Especially important is the unanswered question of what happens to these students after they receive the baccalaureate degree. These same institutions are not found on the list of leading institutions in the percentage and number of women baccalaureates earning Ph.D.'s (p. 74). How many enter baccalaureate or master's level careers? How many enter professional programs? How many leave the science pipeline for other fields?

Looking at the frequency distributions of the number of institutions granting mathematics degrees earned by Black and by Hispanic graduates (p. 72) and the distribution of mathematics and science degrees by sector (p. 74), reveals the very small number of institutions that grant degrees in mathematics to Hispanic or Black graduates, and the concentration of these students in predominantly minority institutions. This raises questions at several levels. For an institution to provide an effective undergraduate mathematics or science educational experience for these students requires effective recruitment and support programs. Each institution must examine its own record for retention in general and for retention in mathematics and science.

Dr. Walter Massey, Director of the National Science Foundation, proposed a simple formula (2N+1) for each institution to apply to its graduation rate for increasing the number of minority scientists. It is clear that momentous change can (and must) occur from applying the +1 factor at those institutions with no Black or Hispanic mathematics or science graduates. Several of the predominantly minority institutions are making a major contribution to producing minority scientists. They cannot be expected to make the entire contribution. Other institutions must also make the commitment to educating minority scientists and mathematicians.

LEADING INSTITUTIONS IN PROPORTION AND NUMBER OF GRADUATES RECEIVING BACCALAUREATES IN MATHEMATICS AND THE BIOLOGICAL AND PHYSICAL SCIENCES DATA FOR WOMEN GRADUATES AVERAGED 1987-1989

MATH & SCIENCE AS % OF ALL FIELDS	AVERAGE NUMBER MATH & SCIENCE	INSTITUTION / STATE	CLASSIFICATION
32.2	93	University of Puerto Rico-Cayey U. C. PR	COMPI PM
28.3	85	Massachusetts Institute of Technology MA	RESI
26.3	73	Johns Hopkins University MD	RESI
26.2	45	Xavier University of Louisiana LA	COMPII PM HB
24.4	91	Saint Olaf College MN	LAI
24.1	70	University of Chicago IL	RESI
23.5	264	University of California-Irvine CA	RESI
22.9	51	Carleton College MN	LAI
22.5	370	University of California-Davis CA	RESI
22.3	231	University of California-San Diego CA	RESI
21.3	56	Bryn Mawr College PA	LAI W
21.1	44	Union College NY	LAI
20.9	88	University of California-Riverside CA	DOCI
20.8	44	Rensselaer Polytechnic Institute NY	RESII
18.5	55	Spelman College GA	LAII PM HB W
18.5	71	SUNY-College at Potsdam NY	COMPI
17.6	68	Bucknell University PA	LAI
17.6	90	Mount Holyoke College MA	LAI W
16.5	181	SUNY-Stony Brook NY	RESI
16.4	76	Inter American U. of PR-San German PR	COMPI PM
15.9	55	College of the Holy Cross MA	LAI
15.7	56	Wake Forest University NC	COMPI
15.7	74	University of Rochester NY	RESI
15.5	112	University of California-Santa Cruz CA	DOCI
14.6	50	Gustavus Adolphus College MN	LAI
14.5	61	Princeton University NJ	RESI
14.4	114	Duke University NC	RESI
14.3	44	Carnegie-Mellon University PA	RESI
14.2	101	Brown University RI	RESII
13.8	355	University of California-Berkeley CA	RESI

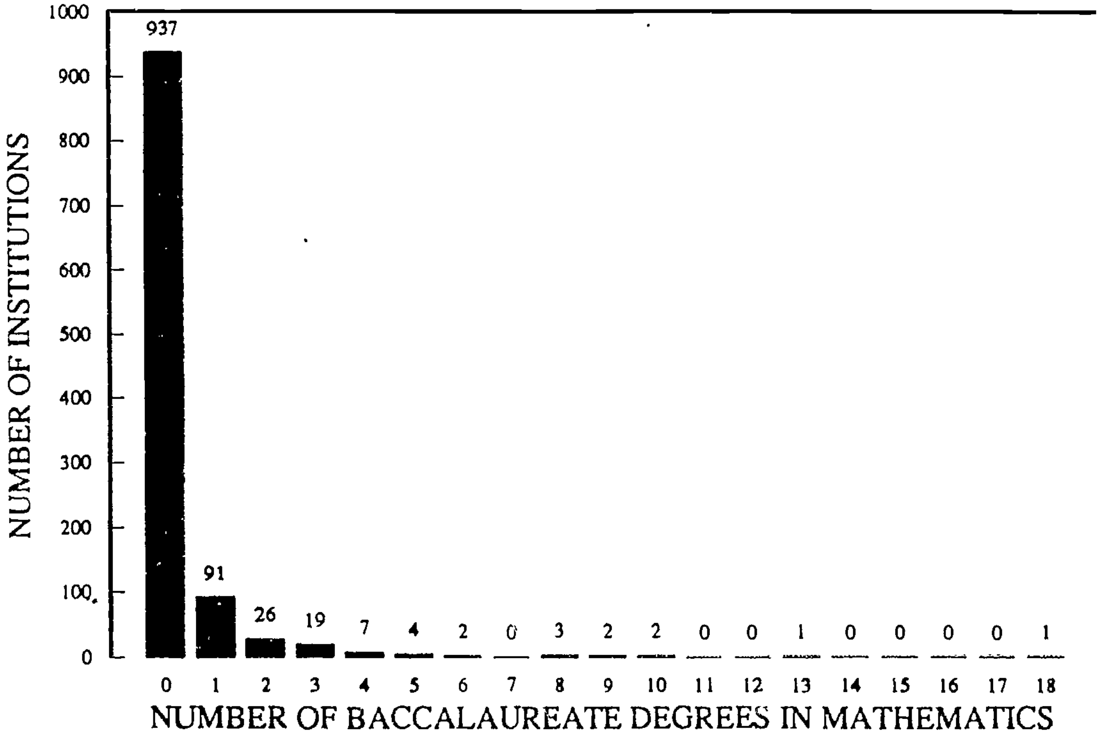
* Classification: Carnegie category, Predominantly Minority (PM), Historically Black Colleges and Universities (HB), and Women's Colleges (W) (see Appendix B). For complete data, see Appendix C, Table 16

LEADING INSTITUTIONS IN PROPORTION AND NUMBER OF WOMEN 1970-1982 BACCALAUREATES EARNING NATURAL SCIENCE DOCTORATES

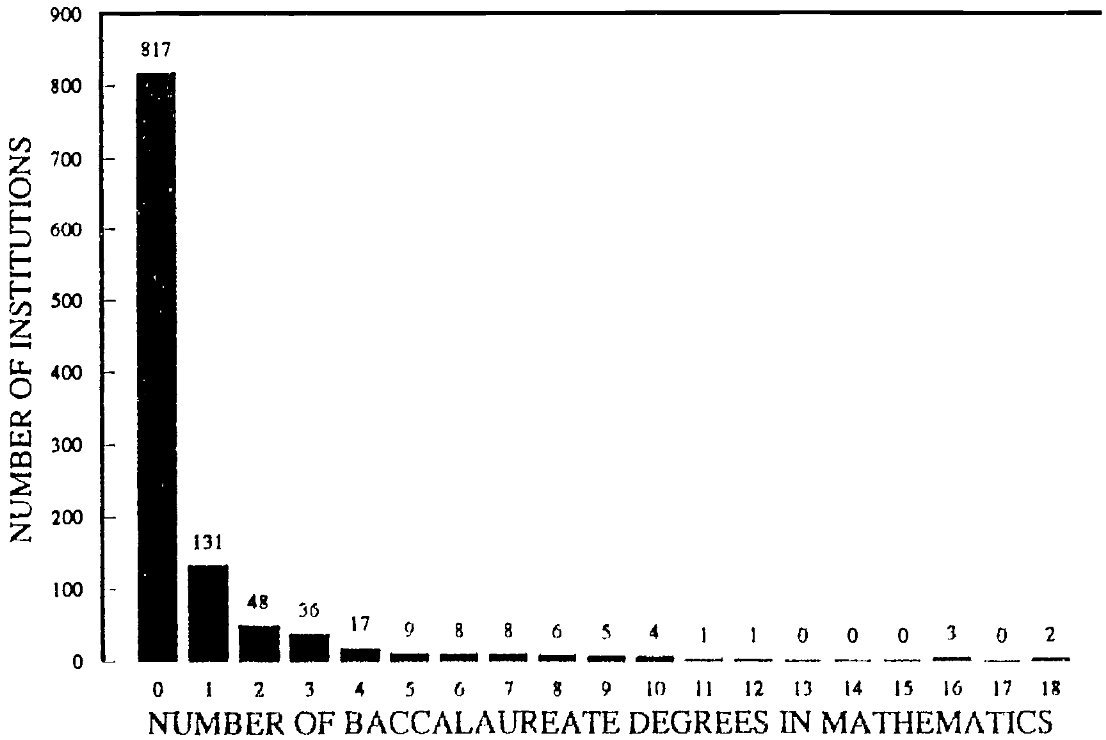
PH.D.'S AS % OF BACC. DEGREES	AVERAGE NUMBER	INSTITUTION / STATE	CLASSIFICATION
14.8	29	California Institute of Technology CA	RESI
7.2	119	Massachusetts Institute of Technology MA	RESI
4.1	47	Rensselaer Polytechnic Institute NY	RESII
3.6	89	University of Chicago IL	RESI
2.7	30	Reed College OR	LAI
2.6	59	Rice University TX	DOCI
2.4	41	Swarthmore College PA	LAI
2.4	51	Carleton College MN	LAI
2.2	41	Pomona College CA	LAI
2.1	123	Harvard-Radcliffe MA	RESI
2.1	58	Bryn Mawr College PA	LAI W
2.0	273	Cornell University NY	RESI
2.0	32	Grinnell College IA	LAI
1.9	106	University of Calif.-San Diego	RESI
1.8	28	Kalamazoo College MI	LAI
1.8	34	Johns Hopkins University MD	RESI
1.7	141	Stanford University CA	RESI
1.7	102	Mount Holyoke College MA	LAI W
1.6	63	Oberlin College OH	LAI
1.6	67	Yale University CT	RESI
1.6	124	Smith College MA	LAI W
1.5	89	Brown University RI	RESII
1.5	59	Brandeis University MA	RESII
1.5	33	Occidental College CA	LAI
1.5	46	Princeton University NJ	RESI
1.4	90	Wellesley College MA	LAI W
1.4	84	University of Rochester NY	RESI
1.3	62	Vassar College NY	LAI
1.3	24	Muhlenberg College PA	LAI
1.3	24	Dartmouth College NH	DOCII
1.2	78	Barnard College NY	LAI W
1.2	42	Bucknell University PA	LAI
1.2	31	Middlebury College VT	LAI
1.1	32	Goucher College MD	LAI W
1.1	23	Randolph-Macon Woman's College VA	LAI W

* Classification: Carnegie category, Predominantly Minority (PM), Historically Black Colleges and Universities (HB), and Women's Colleges (W) (see Appendix B). For complete data, see Appendix C, Table 51

MATHEMATICS DEGREES EARNED BY HISPANIC GRADUATES IN 1988-89

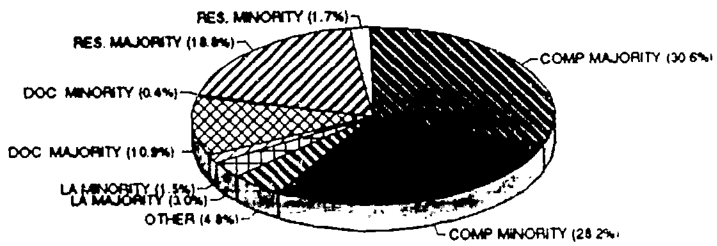


MATHEMATICS DEGREES EARNED BY BLACK GRADUATES IN 1988-89

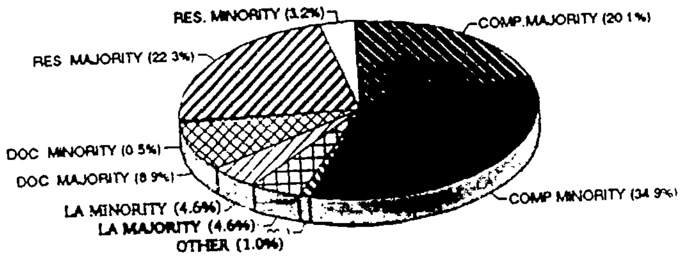


* For complete data, see Appendix C, Tables 7-9.

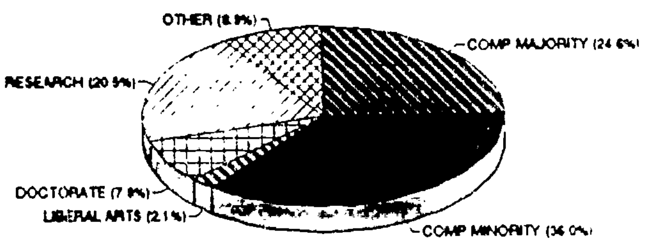
BACCALAUREATES IN ALL FIELDS BLACK GRADUATES BY SECTOR



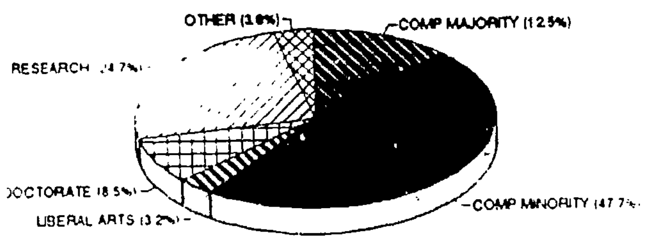
BACCALAUREATES IN MATH & NATURAL SCIENCE BLACK GRADUATES BY SECTOR



BACCALAUREATES IN ALL FIELDS HISPANIC GRADUATES BY SECTOR



BACCALAUREATES IN MATH & NATURAL SCIENCE HISPANIC GRADUATES BY SECTOR



* For complete data, see Appendix C, Tables 39-42

WHAT DISAGGREGATION REVEALS: TRENDS BY FIELD, GENDER, AND RACE

The second objective in the Project Kaleidoscope research agenda is to provide a detailed description--disaggregated by field, by race, by gender--of current outcomes to serve as a baseline for the evaluation of current and future reform efforts.

Trends in baccalaureate degree production between 1976 and 1989 have not been consistent across natural science fields, within population groups, or among institutions. These differences should be considered as policies are being defined. Reform efforts must be based on clear perceptions of the dimensions of the current situation in undergraduate science education.

TRENDS BY FIELD

While the numbers of baccalaureate degrees conferred have declined for biology, geology and chemistry, there has been an increase in physics and a recovery in the numbers for mathematics (although the number of baccalaureate degrees earned in mathematics and in physics was lower in 1989 than in 1966).

TRENDS BY FIELD AND GENDER

In mathematics, physics and geology, the trends in baccalaureate degree production have been parallel for men and for women. The number of biology and chemistry degrees declined for men, while the number of biology degrees earned by women has remained relatively constant and the number of chemistry degrees earned by women has increased. While it is encouraging to see improvement in some fields for women, the pipeline is severely threatened by a drop in the numbers for men who traditionally have constituted the majority of the science majors.

TRENDS BY FIELD, GENDER, AND RACE

In order to assess trends in mathematics and science fields for various population groups, it is necessary first to consider their varying rates for participation generally in higher education. By comparing the trends in science degrees to trends for other fields we can learn more than just what are the absolute numbers in the science pipeline. One measure of the attractiveness and accessibility of degrees in mathematics and science fields is provided by comparing the rate at which degrees in these fields are obtained relative to other fields.

- The proportion of all the baccalaureate degrees earned by Black men and Black women that were earned in mathematics has increased.
- The proporcion of all the baccalaureate degrees earned by Black women that were earned in the physical sciences has increased.
- There has been a decline in the proportion of all the baccalaureate degrees earned by Hispanic men and women that were earned in mathematics and the natural sciences.
- The number of degrees in science and mathematics earned by Asian men and women has tripled. However, the degrees in these fields earned by Asian men and women was the same fraction or less of all the baccalaureate degrees earned by members of this group in 1989 as in 1977.
- While the fraction of all the baccalaureate degrees earned by White men and women that were earned in mathematics has been level, in the physical and biological sciences there has been a decline.

RACIAL/ETHNIC/GENDER REPRESENTATION IN SCIENCE. Assessment of changes in the degree to which certain groups are under-represented in mathematics and science requires evaluation of changes for **all groups**. For example, the number of degrees earned in biology by women has remained nearly constant, while the proportion of the biology degrees that were earned by women has jumped from one-third to one-half--due entirely to the precipitous decline in the number of degrees earned by men. The fact that women now earn 50% of the degrees in biology has been interpreted to indicate that participation by women in this field does not require further attention. However, the number of women earning degrees in biology has not kept pace with the significant increase in the number of women earning baccalaureate degrees in all fields. Similarly, changes in the proportions of the degrees earned by particular racial/ethnic groups have been affected by changes occurring among other groups. It is not sufficient to know what proportion of the degrees are obtained by members of a group, without reference to what has occurred among the other groups.

The under-representation of Native Americans, Hispanics and Blacks in higher education compared to the general population has been well-documented. Comparing the proportion of the mathematics and natural science degrees earned by members of these groups to their over-all status in higher education can reveal areas of particular concern. Native American graduates earn mathematics and natural science baccalaureate degrees in about the same proportion as they earn baccalaureate degrees in all fields. Asians earn a higher proportion of the baccalaureate degrees in these fields than of baccalaureate degrees in all fields. Whites earn a smaller fraction of the baccalaureate degrees in biological science than in all fields, while their numbers of degrees in mathematics and in physical science is proportional to their over-all status. Hispanics earn a higher proportion of the biological science baccalaureate degrees than their proportion of the degrees in all fields, but a smaller proportion of the degrees in physical science and especially in mathematics. Black women earn baccalaureate degrees in physical science and biological science at about the same rate as all fields, but a smaller proportion of the degrees in mathematics. The pattern is different for Black men: their proportion of the mathematics degrees is about the same as for all fields, but they earn a smaller proportion of the degrees in physical and biological science.

Comparing the share of the mathematics and natural science degrees earned by Native Americans, Hispanics, and Blacks to their overall status in higher education can reveal areas of particular concern.

It will be important to determine whether certain racial/ethnic groups are under-represented in mathematics and natural science due to greater attrition from these fields, or due to their greater attrition rates from postsecondary institutions in general. Contradictory conclusions have been drawn from research investigating these issues.

The responsible reaction, of course, is to establish coherent and coordinated intervention and supportive programs at both levels[28], while additional research and analyses are conducted to clarify this. We need to keep students in college and make it easier for students to pursue majors in mathematics and science.

A FUTURE RESEARCH AGENDA: WHAT WE NEED TO KNOW

Much can be learned from the information that is currently available. But we need to look carefully at the goals and objectives of efforts to reform science and mathematics education, at all levels, to determine what additional information is needed.

While we have a large quantity of data about postsecondary institutions, there are several areas where adequate national data are not available. In some cases this is because it is not clear what should be measured, and in others because of difficulties in collecting certain kinds of information.

For example, many institutions have developed programs to address areas of concern such as scientific literacy, K-12 teacher preparation and development, pre-college outreach, and programs to serve minorities, women and students with physical disabilities, but information about these programs may go no further than the originating campus. A national information network is needed to make it possible for institutions to share information on what has been tried, what works, and what efforts were not beneficial. We need national indicators to assess progress in these areas.

In addition, current data collecting and reporting have some deficiencies that require attention (see Appendix B). In some areas there is need for refinement or more detail. In others there is a total lack of data, such as the absence of degree data for persons with disabilities. We need those data--data that are carefully edited and provided in more detail.[29]

For example, we need data collected for the different subgroups within the Asian and Hispanic populations --with uniform definitions across agencies. Many science degrees currently are not being counted in the NCES surveys. The number of science degrees that currently are not being counted (interdisciplinary and unique majors or multiple majors) must at least be estimated. Although many students have two or more majors, only one is recorded--with no guidelines for deciding which one. (See Appendix B.)

The information needed falls into three broad categories:

- information about students,
- information about institutions,
- investigations of the assumptions and hypotheses about the causal factors operating in undergraduate mathematics and science education.

Needs for data collection should be evaluated from the perspective of the individual institution, as well as from the national perspective. We need to see where these perspectives converge. Ideally, information collected by federal agencies from each institution would provide feedback useful to the institutions.

Attempts to learn more about the state of undergraduate science education must not be unduly constrained by rigid assumptions about measurement. Of course, some data must be collected in a standardized format that provides directly comparable information for all reporting institutions. However, information also must be collected on many topics in a format that allows for and reflects the diversity of programs and outcomes, and

We should assess what we think is important, not settle for what we can measure.
-National Center for Education Statistics, Education Counts: An Indicator System to Monitor the Nation's Educational Health, *1991.*

allows the possibility of identifying new or unusual instances that may be instructive for others attempting to find models for improvement. We need to know what is typical, but we also need to know something about the distribution across institutions. When everyone has to answer exactly the same questions, in a standard format, many important questions cannot even be asked, and much of the information obtained is not very helpful. Sometimes different questions have to be asked in order to obtain the same information from institutions of different types.

For example, a recent standardized assessment of research facilities could not adequately depict the status of the research facilities at undergraduate colleges, since the survey asked about facilities used only for research. However, typically, the facilities at liberal arts colleges are used for education, research, and, especially for undergraduate research as education.

Sometimes different questions have to be asked to obtain the same information from institutions of different types.

A recent NCES special study panel concluded that the characteristics of "good undergraduate education" are well known:

> *good undergraduate education is characterized by high and clearly communicated expectations, by capstone experiences that require students to integrate and synthesize what they have learned, by opportunities to exercise and demonstrate skills, by frequent assessment and feedback to the student, by collaborative learning, and by frequent student-faculty contact outside the classroom setting.*[30]

What is not known, however, is "the incidence of good educational practices and...the prevalence of conditions that encourage these practices (small class sizes/human scale, instruction by full-time rather than part-time faculty, and tenure policies that encourage teaching)" (p. 80). The NCES panel also noted the need for more information about the adequacy of the resources (libraries, computers, physical plant, and research facilities and instrumentation) necessary to provide quality undergraduate instruction and research.

Efforts have been made to provide pieces of this information. The Carnegie Foundation for the Advancement of Teaching has provided data from its faculty surveys on faculty attitudes and perceptions. The U.S. Department of Education has conducted a survey of higher education faculty (which provides information on science faculty and on faculty at undergraduate institutions, but, unfortunately, not on science faculty at undergraduate institutions). The National Science Foundation conducts surveys on research facilities, scientific personnel, and recent graduates.

The Council for Undergraduate Research (CUR) collects information from its member institutions on several dimensions of departments of chemistry, physics, biology, and astronomy.[31] CUR surveys member departments on information about students, faculty and departmental resources--including a listing of major instrumentation. In contrast to many surveys that are designed for research universities, these surveys are designed for undergraduate institutions, so they accurately reflect the conditions at these institutions.

What is missing, however, in most data collection efforts is the link to effectiveness. These surveys typically provide an inventory of personnel or facilities. We need to be able to see how information about current resources translates into information about what is necessary or desirable for effective undergraduate mathematics and science education. One way to do this is to examine the institutions that have effective programs. Where have they found resources? How have they developed their programs? What worked? What did not work?

ASSESSMENT DATA BASED ON RETENTION-AND-ACHIEVEMENT[32]

Evaluation of the effectiveness of undergraduate mathematics or science programs would require information that is not available on a national basis, although many institutions have made an effort to examine their own programs.

Effectiveness can be assessed when an institution evaluates all of the entering students for their interests, skills, knowledge and aptitudes. It is then necessary to track these students to see how they fare in a given program, and to evaluate those students who complete the program to see what they have gained.[33]

Regardless of specific instruments used, achievement data must be considered in relation to retention rates. We need to know who persists and who drops out of mathematics and science--and why. The "High School and Beyond" study conducted by the Department of Education has provided valuable information.[34] Recent studies[35] have examined the factors at a few institutions related to persistence in undergraduate mathematics and science. The Cooperative Institutional Research Program (CIRP) conducted by the American Council on Education and the University of California at Los Angeles, has begun 2-year and 4-year follow-ups of the Freshman Survey, which can provide information on changes in students' aspirations and perceptions regarding science careers. Through the extensive student questionnaire used by the College Board, we know a lot about the entering characteristics of the students who take the SAT. However, this information is obtained for fewer than half of high school seniors.[36] It would be helpful to have the same information about the entire college-going population.

At the national level, data on attrition/persistence are necessary to monitor the state of the pipeline. At the institutional level, these data are necessary to monitor efforts to improve retention and recruitment.

It is especially important to watch for varying trends for different populations, defined by background as well as gender, race, socioeconomic status, disabilities, or age (e.g., what happens to students who are interested in, but not quite prepared for, a math major when they enter?). Do the introductory courses serve as filters or as pumps?

There are groups nationally-defined as underrepresented in mathematics and science. However, this identification of special populations needs to be made at both the national and the institutional level. As institutions follow the progress of the nationally-identified groups, they also need to focus on who may be "special" for an institution.

For example, Black women would be defined as a relevant group for monitoring at all institutions except Spelman College and Bennett College. Women, as a group, would not be a special population for the women's colleges. Each institution needs to examine its own data to determine whether there are particular groups of students who are less likely to persist in mathematics and science. In addition to such factors as race, sex, and disability, attention needs to be given to socioeconomic status, urban-rural background, high-school preparation, and age. It is important to follow all students.

A recent study by Nancy Hewitt and Elaine Seymour[37] found no

The educational effectiveness of a college should be measured in terms of its success in facilitating student learning and growth in accordance with the stated mission of the college. Unhappily, measures based on only this definition of excellence require knowledge of specific outcomes of the educational process and of the status of the student at the time of entry into the program with regard to these same variables.

-Peter Armacost, President Eckerd College.

differences in the characteristics of students who chose to stay in science majors and those who chose to leave, and the "switchers" did not differ from the "nonswitchers" in the problems they reported they encountered in their science courses. What did differentiate the "switchers" from the "nonswitchers" was whether they found ways to cope with the difficulties, such as study groups. As each institution attempts to learn what the difficulties are for students in their programs, and attempts to solve these problems, they also need to be alert to what coping mechanisms can be provided for all their students.

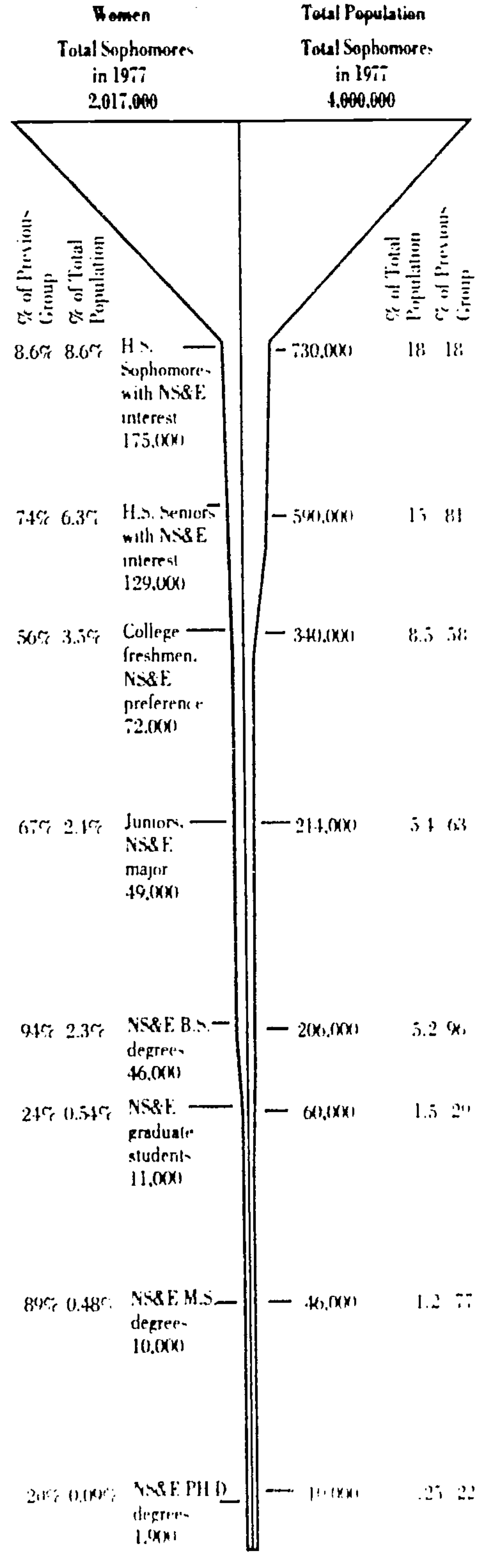
In the absence of carefully developed assessments and evaluations, it will be tempting to use whatever information is "at hand." Extreme caution must be used when doing so. For example, the Scholastic Aptitude Test (SAT) and the Graduate Record Examination (GRE) frequently are used to assess students' abilities when they enter (SAT) and leave (GRE) undergraduate programs.

This practice has some validity, since even tests designed for predictive purposes are based on measures of achievement. These tests provide valuable information, but the results of these tests--as currently administered--cannot provide the kind of information needed to assess the effectiveness of undergraduate programs.[30] The validity and utility of these tests for assessment purposes are limited by three factors in the construction and administration of these tests:

- First, they were constructed as predictive instruments. The criterion for selection of items and for scoring was predicting performance in undergraduate work (SAT) or graduate school (GRE).
- Second, the content of the tests is not uniformly relevant to the content of the curriculum of each institution (although innovation in many programs has been constrained in order to make sure students cover enough material to score well on the GRE).
- Third, only a subset of undergraduates take the SAT, an even more limited number take the GRE, and these overlapping, but not identical, subsets of students vary in uncontrolled ways over time, between populations, and across institutions.

Considering the limitations and problems that have been discussed with use of these tests for the purpose for which they were designed, it is particularly risky to use them for other purposes.

Interest and Participation in Natural Science & Engineering



Two organizations, the American Council on Education and the National Association of Independent Colleges and Universities, recently have published "handbooks" for institutions attempting to improve their recruitment and retention of minority students.[39] It appears that many institutions may need guidance in developing data on persistence/attrition. In their study of student recruitment and retention efforts to increase services for women, minorities and the disabled in science and engineering, Marsha Matyas and Shirley Malcom reported that many of the institutions they surveyed could not provide information on attrition rates--and sought guidance on how they could provide such information.[40]

ASSESSMENT OF DIFFERENT "TRACKS"

The effectiveness of undergraduate mathematics and science programs needs to be measured both for the students who major in mathematics and science and for those who major in other disciplines. It is important, however, not to over-emphasize the differences between these groups of students.

Assessment of student achievement in undergraduate science and mathematics must address the needs of all students. Many institutions are developing programs to provide scientific literacy for all their students. Again, it would be helpful if we had national indicators for identifying and evaluating these programs.

K-12 teacher preparation programs have been recognized as an essential part of reforms in mathematics and science education. It is unfortunate and frustrating that data collected in numerous surveys on the undergraduate origins of K-12 science teachers and undergraduate faculty have not been analyzed. As efforts are made to encourage more undergraduates to consider careers in these fields, it would be instructive to know the nature of the undergraduate programs that have been particularly successful in facilitating such career choices. The National Science Teachers Association has a database that could include such information, but currently does not have the resources to collect and analyze this information.

It is difficult to determine the number of mathematics and natural science majors at the liberal arts colleges who go on to careers in teaching at the secondary level. It is not possible to identify on a national basis which graduates are certified for teaching. The only students planning careers in teaching who can be identified from national data are those who major in education. Many of the students at liberal arts colleges who are planning careers as science and mathematics secondary teachers cannot be identified by the baccalaureate degree they earn--since typically they earn the same baccalaureate degree as the other majors in mathematics and science (rather than degrees in secondary education). Since having teachers earn degrees in disciplinary majors is one of the primary reforms being advocated to strengthen K-12 teacher preparation, it is unfortunate that there is no way to learn about these future teachers from the national degree data as they now are collected.

To meet the science needs that all students have in common, we must blur the distinctions between the introductory courses for majors and non-majors. Historical, philosophical, sociological, and political insights should be part of all science courses, offering all students the deep perspective on science which comes from understanding in context. Likewise all students should be introduced to the content and method of science, including laboratory work involving the design of experiments and the analysis of data.
-Project Kaleidoscope, What Works, *Volume I, 1991.*

Institutions of higher learning should take steps to improve the quality of mathematics and science teachers, including the establishment of higher admission, curriculum and graduation standards for such future teachers.

The process of change is already underway in a number of colleges and universities and other institutions of higher education are urged to follow. Substantial improvement will be realized if the following steps are taken:

- ***Liberal arts colleges need to assume a much greater role in training elementary and secondary mathematics and science teachers.***
- ***Basic education courses required of prospective teachers should be thoroughly reviewed and revised to incorporate the findings of recent research in behavioral and social sciences.***
- ***Elementary mathematics and science teachers should be required to have a strong liberal arts background, including college courses in mathematics and the biological and physical sciences. Student teaching, which acquaints the teaching candidate with children and classroom procedures, and proven methods courses should be emphasized.***
- ***College courses for prospective elementary school mathematics teachers should provide sufficient background for an understanding of the relationships between algebra and geometry, functions, elementary probability and statistics.***
- ***Secondary school mathematics and science teachers should have a full major in college mathematics or science, an appropriate number of effective education courses, and teaching experience under a highly qualified teacher.***
- ***Future elementary and secondary teachers should be computer literate; teachers must be familiar with computers to promote literacy among their students. Teacher training should incorporate the use of calculators and computers in mathematics and science instruction.***

-National Science Board Commission on Precollege Education in Mathematics, Science and Technology, Educating Americans for the 21st Century, *1983.*

OUTREACH

Some of the discussions about assessment of undergraduate education reflect a disconnected picture of the educational continuum. Efforts to increase the rate of participation for all students, and especially for under-represented groups need to have a clear focus on the entire educational continuum from kindergarten to graduate school.[41] The importance of a role for postsecondary institutions in improving college enrollment patterns and K-12 achievement in mathematics and science has been recognized. However, this role needs to be carefully articulated and we need information about the degree to which such efforts are succeeding. Institutions of higher education are doing a lot in this area--we need to know what kinds of efforts have been initiated and what has been learned from those efforts.

For example, the exceptional productivity of Xavier University of Louisiana is based on outreach programs to pre-college students, as well as carefully designed introductory courses, with study groups and individual attention from faculty. The experience of Xavier University is also important in demonstrating that such outreach efforts must be carefully developed and sustained over a long period of time in order to show significant effects.[42] Richardson, Simons, and de los Santos examined several large universities which have had success in graduating minority students. They noted: "Increasingly, these universities believe that early outreach extending into the junior high schools is the most important equity action in which they engage."[43]

INTERESTS AND CHOICE

In utilizing data from such sources as the CIRP Freshman Survey and the College Board student questionnaire, it is important to focus on what students are indicating when they express an "interest" in majoring in mathematics or science. It especially would be valuable to investigate the relationship between women's stated "interests" and their preparation.[44] Since moving forward in mathematics and science traditionally has been determined by prior opportunities and experiences, at any given point students may feel constrained by their backgrounds. We need to consider students' perceptions of their options, in addition to their stated "interests." We need to explor., for example, how much women's lack of interest determines their lack of preparation, or whether, given inadequate preparation, they are inclined to perceive their opportunities to be limited. In addition to efforts to retain the students who enter college expressing an interest in majors in these fields, institutions should consider the possibilities for recruitment. Counseling and the adequacy of introductory courses are essential features of these efforts.[45]

INSTITUTIONS SERVING HISPANIC AND NATIVE AMERICAN UNDERGRADUATES

While there have been a number of studies that have focused on the women's colleges and the HBCUs, there have been few attempts to focus on the Native American institutions[46] and those serving Hispanics. Studies focussed on these institutions could provide additional information on the common and the diverse factors necessary to provide more effective undergraduate education programs for each of these groups--and their sub-groups. From the studies that have looked at these different populations, we know that language and cultural factors are significant.[47]

For example, the relationship between these students and their families can be expected to play a role in their college careers that is different from that seen for other populations. Unfortunately, there has been insufficient attention to how these various findings should be applied to minority women.[48]

The Hispanic-serving institutions may prove to be particularly useful as models, since typically they were not founded especially to serve Hispanic students, but have adapted over time to demographic changes that have caused significant shifts in their enrollments. As other "majority" institutions attempt to devise programs for more diverse student bodies, they may find the experiences of these institutions to be helpful in identifying what in their experience was not helpful, and in identifying what works.

Ideally, faculty [should] work to add members of underrepresented groups to their faculties and bring professionals from these groups as role models to campus for as much contact with students as possible. However, all faculty, regardless of race or sex, can and should serve as mentors to these students. Perhaps most important is the repeated reinforcement of the message to these students that they are pioneers who, by forging professional identities that fit their unique cultural heritages, will become models for increasing numbers from their group who follow them.

-National Advisory Group of Sigma Xi, An Exploration of the Nature and Quality of Undergraduate Education in Science, Mathematics and Engineering, *1989.*

1. Task Force on Women, Minorities, and the Handicapped in Science and Technology. Changing America: The New Face of Science and Engineering. Final Report, December 1989, page 26

2. See What Works: Building Natural Science Communities. A Plan for Strengthening Undergraduate Science and Mathematics. Washington, D.C.: Project Kaleidoscope, 1991. The features of science and mathematics programs at liberal arts colleges that lead to their high productivity were described also in the Oberlin reports (David Davis-Van Atta et. al., Educating America's Scientists: The Role of the Research Colleges. Oberlin, Ohio: Oberlin College, May 1985; Sam C. Carrier & David Davis-Van Atta, Maintaining America's Scientific Productivity: The Necessity of Liberal Arts Colleges. Oberlin, Ohio, Oberlin College, March 1987) and the OTA report, Educating Scientists and Engineers: Grade School to Grad School, U.S. Congress, Office of Technology Assessment. Washington, D.C.: U.S. Government Printing Office, June 1988.

3. See A.W. Astin, Four Critical Years, San Francisco: Jossey-Bass, 1977; and U.S. Congress, Office of Technology Assessment, Scientific Equipment for Undergraduates, Washington, D.C.: U.S. Government Printing Office, Sept. 1985, for discussion of these issues.

4. L.S. Dix (Ed.), Minorities: Their Underrepresentation and Career Differentials in Science and Engineering, and Women: Their Underrepresentation and Career Differentials in Science and Engineering. Washington, D.C.: National Academy Press, 1987; S.G. Brush, Women in Science and Engineering. American Scientist, Sept/Oct, 1991, Vol. 79, pp. 404-419.

5. M.L. Matyas & S.M. Malcom, Investing in Human Potential: Science and Engineering at the Crossroads. Washington, D.C.: American Association for the Advancement of Science, 1991, p. 9.

6. A.W. Astin, Achieving Educational Excellence. San Francisco: Jossey-Bass, 1985; E.T. Pascarella & P.T. Terenzini, How College Affects Students. San Francisco: Jossey-Bass, 1991.

7. Astin, 1985, ibid., p. 104.

8. J. Fleming, Blacks in College. San Francisco: Jossey-Bass, 1984.

9. See Fleming, ibid.

10. M.T. Nettles, Toward Black Undergraduate Student Equality in Higher Education. New York: Greenwood Press, 1988.

11. Astin, 1977, op cit.

12. Address to the Council On Undergraduate Research Conference, San Antonio, July 1990.

13. W.K. LeBold. Women in Engineering and Science: An Undergraduate Research Perspective in Dix (Ed.), op cit., pp. 49-98.

14. Etta Falconer, Director of Science Programs and Policy at Spelman College, is a member of the Project Kaleidoscope Advisory Action Committee. See also J.E. Blackwell, Mentoring: An Action Strategy for Increasing Minority Faculty, Academe, September/October, 1989, Vol. 75, No. 5, pp. 8-14.

15. The Mathematics Workshop Project in U.S. Congress, Office of Technology Assessment, Higher Education for Science and Engineering. Washington, D.C.: U.S. Government Printing Office, 1989.

16. R.C. Richardson, H. Simons, & A.G. de los Santos, Graduating Minority Students. Change, 1987, Vol. 19, pp. 20-27.

17. E.B. Fiske, Lessons. New York Times, Wednesday, April 11, 1990.

18. M.E.Tidball, Baccalaureate Origins of Entrants into American Medical Schools. Journal of Higher Education, 1985, Vol. 56, pp. 385-401.

19. A.L. Gardner, C.L. Mason, & M. L. Matyas, Equity, Excellence & Just Plain Good Teaching, The American Biology Teacher, 1989, Vol. 51, pp. 72-77.

20. See Appendix C, Tables 45-46.

21. U.S. Congress, Office of Technology Assessment, 1988, op cit.

22. Davis-Van Atta, et al, 1985; and Carrier, et al. 1987, op cit.

23. See Appendix C, Table 47.

24. See Appendix C, Tables 7-9 and Table 35.

25. See Appendix C, Tables 50-55

26. See Appendix C, Table 47.

27. See Appendix C, Tables 56-57.

28. Matyas & Malcom, 1991, op cit.

29. National Science Foundation, Women and Minorities in Science and Engineering. Washington, D.C.: National Science Foundation, 1990, (NSF 90-301) p. 57.

30. National Center for Education Statistics, Education Counts: An Indicator System to Monitor the Nation's Educational Health. Washington, D.C.: U.S. Department of Education, 1991, p. 80.

31. John Mateja, A Statistical Overview of the Second Edition of the CUR Physics and Astronomy Directory. Council on Undergraduate Research Newsletter, Sept. 1990, Vol. XI, No. 1, pp. 37-49.

32. There are a number of initiatives in the area of assessment. For a review see Hutchings & Marchesi (1990), Watching Assessment--Questions, Stories, Prospects. Change, Sept/Oct, 1990, pp. 12-38.

33. To truly know the value of the program, of course, one would need to compare these gains to those for persons who did not complete the program. This dimension, however, usually would be beyond the resources of an institution.

34. C. Ottinger, College Going. Persistence, and Completion Patterns in Higher Education. What Do We Know. ACE Research Brief. Washington, DC: American Council on Education, 1991.

35. B.F. Manis, N.G. Thomas, B.F. Sloat, C.S. Davis. An Analysis of Factors Affecting Choices of Majors in Science, Mathematics and Engineering at the University of Michigan. Ann Arbor: The U. of M. Center for the Continuing Education of Women, CEW Research Report #23, 1989; L.S. McDade, Knowing the 'Right Stuff': Attrition, Gender and Scientific Literacy. Anthropology & Education Quarterly, 1988, Vol. 19, pp. 93-114; Nancy Hewitt and Elaine Seymour. Factors Contributing to High Attrition Rates Among Science, Mathematics, and Engineering Undergraduate Majors. A Report to the Alfred P. Sloan Foundation. Boulder, Colorado, April 26, 1991.

36. H. Hodgkinson. Schools are Awful--Aren't They? Education Week, October 30, 1991, p. 32.

37. Hewitt and Seymour, 1991, op. cit.

38. See C. Adelman, Signs & Traces: Model Indicators of College Student Learning in the Disciplines. Washington, D.C.: National Center for Education Statistics, 1989, for a discussion of efforts to develop indicators of undergraduate learning and the utility of the GRE tests.

39. M.F. Green, Minorities on Campus: A Handbook for Enhancing Diversity. Washington, D.C.: American Council on Education, 1989; National Association of Independent Colleges and Universities. Minorities on Campus: Understanding Campus Climate; Pluralism in the Professoriate; Thank You for Asking!; Independent Institutions in Partnership; Independent Minority Colleges and Universities. Washington, D.C., 1991.

40. Matyas & Malcom, 1991, op cit.

41. Shirley M. McBay, Improving Education for Minorities. Issues in Science and Technology, Summer 1989, Vol. V, No. 4, pp. 41-47.

42. S. Chira. Tiny Black College Takes High Road in Science. New York Times, March 28, 1990.

43. Richardson, et al., op cit., p. 22.

44. Dix, 1987, op cit.

45. Sheila Tobias (They're Not Dumb, They're Different, Tucson: Research Corporation, 1990) has provided information about the factors in introductory science classes at a large university that lead students in the "second tier" to reject science majors.

46 E.M. O'Brien. The Demise of Native American Education. Part III. Tribal Colleges Thrive Amid Hardship. Black Issues, April 12, 1990, Vol. 7, No. 3, pp. 33-36; and Paul Boyer, Tribal Colleges, Princeton, New Jersey: Carnegie Foundation for the Advancement of Teaching, 1989.

47. Dix, 1987, op cit.

48. See D. Carter, C. Pearson, & D. Shavlik. Double Jeopardy: Women of Color in Higher Education. Educational Record, 1988, pp. 98-103; Y.T. Moses, Black Women in Academe, Washington, D.C.: Association of American Colleges, 1989; S. Nieves-Squires, Hispanic Women: Making Their Presence on Campus Less Tenuous, Washington, D.C.: Association of American Colleges, 1991.

THE NATIONAL PICTURE: PART II
ANALYSIS, DATA, AND TRENDS

This report describes the trends between 1976 and 1989 for baccalaureates earned in mathematics, and the biological and physical sciences.[1] Current data for all four-year institutions were analyzed by field, by gender, by race, by sector, and by institution.[2] The baccalaureate sources of recent Ph.D.'s earned in these fields are described for all graduates, and separately for natural science doctorates earned by women, and by Hispanic and Black graduates.[3]

Project Kaleidoscope began with two objectives for the research agenda:

- To identify undergraduate programs that have been successful in attracting and sustaining student interest in science and mathematics, documented by the numbers and proportions of baccalaureate degrees in these fields, and by the numbers and proportions of their graduates who received doctorates in these fields.

- To provide data describing the current productivity of all institutions granting baccalaureate degrees in science and mathematics, disaggregated by field, by race/ethnicity, by gender, and by institution.

These objectives relate to the larger goal of Project Kaleidoscope to develop a plan of action to strengthen undergraduate science and mathematics and to join in the national effort to address problems in science and mathematics education at all levels. Identifying successful undergraduate programs in these disciplines is the necessary first step in developing models for reform which can inform and guide the formulation of federal, state, and institutional policies. In addition, it is essential to have a clear and complete picture of the current productivity of our nation's colleges and universities in science and mathematics to provide baseline data to be used in evaluating the effects of current and future reform efforts.

As the number of 22-year olds declines through 1998, the number of science graduates is projected to drop to a critically low level (Atkinson, 1990; Bowen & Sosa, 1989). The under-representation of women, Hispanics, Native Americans, and Blacks in mathematics and natural science also continues to be a major problem. In order to achieve equity and to avoid the potential crisis in the number of people trained for careers in science, it will be necessary to increase the rates of participation for all population groups.

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[1]Sources for the baccalaureate data were: National Science Foundation, CASPAR database; Department of Education (DoED); National Center for Education Statistics (NCES); and Office of Civil Rights (OCR). (Engineering was not included since few liberal arts colleges grant degrees in engineering [although they have many students in 3-2 programs with schools of engineering]. Computer science, a newer and evolving field at the interface between mathematics and engineering, was not included primarily because it lacks consistent definition across institutions.)

[2]The population groups defined by DoED include: Black, non-Hispanic; Hispanic; Asian or Pacific Islander; White, non-Hispanic; American Indian or Alaskan Native; and Non-resident Aliens (DoEd does not collect racial/ethnic information for non-resident aliens). Note: this definition for Hispanic is not consistent with that used by other agencies that permit the White Hispanic, and Black categories to overlap.

[3]The data on baccalaureate sources of Ph.D.'s were collected by the National Research Council through the Survey of Earned Doctorates.

While there has been much debate, and some skepticism (Greenberg, 1991), about the projected shortages, there have been clear data on: 1) the decline in the numbers of entering students indicating an interest in pursuing majors in these fields (Astin, et al., 1989); and 2) the attrition from these majors.

> ***Every fall tens of thousands of academically-able students enter college planning to pursue science majors. Yet more than half these students change their intended major for other, non-science fields....Indeed, the sciences have the highest defection rates and lowest 'recruitment' rates of any undergraduate fields. Sigma Xi, 1989.***

Even if there were no projected shortage, there are clear signs of problems in undergraduate science education. These fields are not equally accessible to all groups. There are different circumstances leading to students' departures from science majors. Many students leave science majors because they find other fields more attractive and they discover other career options. Unfortunately, many students are pushed out. In thinking and talking about the national goals in "plugging the leaks in the pipeline" we need to recognize that these "leaks" are people. We need to be cognizant of and sensitive to the personal tragedies and losses that may occur in the lives of individual students whose ambitions for a career in science are not realized. Margaret MacVicar (1989) pointed out that we need to see the objective of science education to be the empowerment of individuals. Failure to meet that objective results in personal loss as well as a loss of talent to the nation.

Recent reports describing the experiences of students in undergraduate science courses at three universities bring home the personal dimension of the problems in many classrooms (Tobias, 1990; Sloat, 1990; Manis, et al., 1989; McDade, 1988). Information of this type suggests what reforms need to be made. But formulating effective intervention strategies and setting appropriate policies for reform will require accurate assessments of the dimensions of the problem. Careful interpretation of the science degree production data will be necessary for two purposes. First, accurate dimensions of the pipeline problem can be described and suggestions for possible causes and remedies can be sought. Second, identification of cases of success (or at least relative success) can provide models for reform.

Data on the outcomes of undergraduate mathematics and science education need to be analyzed and reported in greater detail than is sometimes done, in order to see the different trends occurring across fields, groups, and institutions. Disaggregation provides information that is obscured when the data are combined. While generally the rates of science participation have been lower for women than for men, and particularly low for minority students, the rates vary by field across minority groups. Insufficient attention has been given to varying patterns by race among women, or, conversely, by gender within racial/ethnic groups. In certain fields, overall trends mask opposite trends for specific groups. The number of degrees earned has been increasing for some fields, decreasing for others, and remaining level for some. When data are added across fields, as they have been for some reports, these different patterns are obscured.

Data summarized over all postsecondary institutions mask the tremendous diversity among U.S. postsecondary institutions in the numbers and the proportions of their graduates who earn degrees in natural science and mathematics fields. Identifying those institutions that have been the most successful in producing graduates with baccalaureate degrees in mathematics or science, and whose graduates go on to pursue advanced degrees, can provide insight into which kinds of programs and undergraduate environments will be effective in increasing the numbers of individuals choosing to pursue degrees in these fields. Identifying successful programs provides models for reform efforts and can guide policy makers in setting priorities to provide support for the successful programs and provide incentives and opportunities for reform throughout higher education.

BACCALAUREATE DEGREES

TRENDS BY FIELD.

The trends in baccalaureate degree completion have varied across the biological and physical science and mathematics fields (Table 1; figures 1, 2).[4] Between 1976 and 1989, the total number of baccalaureate degrees earned in the biological sciences and geology has declined by one-third, and the number earned in chemistry has declined by 20%. However, the number for mathematics, after a decline between 1976 and 1981, increased by 1987 to nearly the same number as in 1976, and then declined slightly between 1987 and 1989. The number for physics increased nearly one-fourth between 1976 and 1989.

TRENDS BY FIELD AND GENDER.

The trends for mathematics, physics, and earth science were similar for men and for women (Tables 2-3; figures 3-5). These parallel trends result in only slight changes in the proportion of the degrees awarded to women in these fields. Women's share of the mathematics degrees increased from 41% to 46%; women earned 11% of the physics degrees in 1976 and 15% in 1989; 20% of the geology degrees awarded in 1976 were earned by women, compared to 26% in 1989.

The patterns for men and for women differed for chemistry and biology (Tables 2-3; figures 6-7). In 1989 women earned one-half of the biology degrees, compared to one-third in 1976. However, this apparent improvement in the status of women has occurred entirely due to the precipitous decline in the number of degrees earned by men. The number of biology degrees earned by women has remained at the same level throughout. Women's share of the chemistry degrees has increased from 22% in 1976 to 39% in 1989, due both to an increase by one-third in the number of degrees earned by women and to the decline by one-third in the number of degrees earned by men.

TRENDS BY FIELD, GENDER, AND RACE.

Identification of trends for non-White population groups cannot be conclusive in most cases due to the small numbers involved (Tables 4-6; figures 8-13). For example, the number of mathematics degrees earned by Native Americans in 1989 can be described as nearly double the number in 1977--but the numbers were only 26 and 49. Interpretation of the data by race are limited also by the incompleteness of the data. These data have been collected by the Department of Education only since 1975 and are available for only 6 of the years between 1975 and 1989. Only broad field groupings are presented so it is not possible to include break-outs for the separate physical science fields.

The logical, although not necessarily obvious, correlate of the small numbers of mathematics and natural science degrees earned by Native American, Hispanic, and Black graduates is that there are a small number of institutions granting these degrees. Tables 7-9 display the distribution of the biological and physical science and mathematics degrees awarded to Black, to Hispanic, and to Native American graduates.

Biological Science. The number of biological science degrees declined for all men between 1976 and 1989 (Table 2). This was observed for White, Black, and non-resident alien men (Table 4). The number has been level for Hispanic men and increasing for Asian men. The total numbers for women have been stable (Table 3). This stability results from the combination of a decline for White women, no change for Black and Native American women, and an increase for Hispanic, Asian, and non-resident alien women (Table 4).

[4]The baccalaureate degrees in the biological sciences include anatomy, bacteriology, biochemistry, biology, botany, entomology, physiology, and zoology. The physical sciences include astronomy, chemistry, physics, meteorology, and geology. (See Appendix B.)

Figures 1 and 2

FIGURE 1

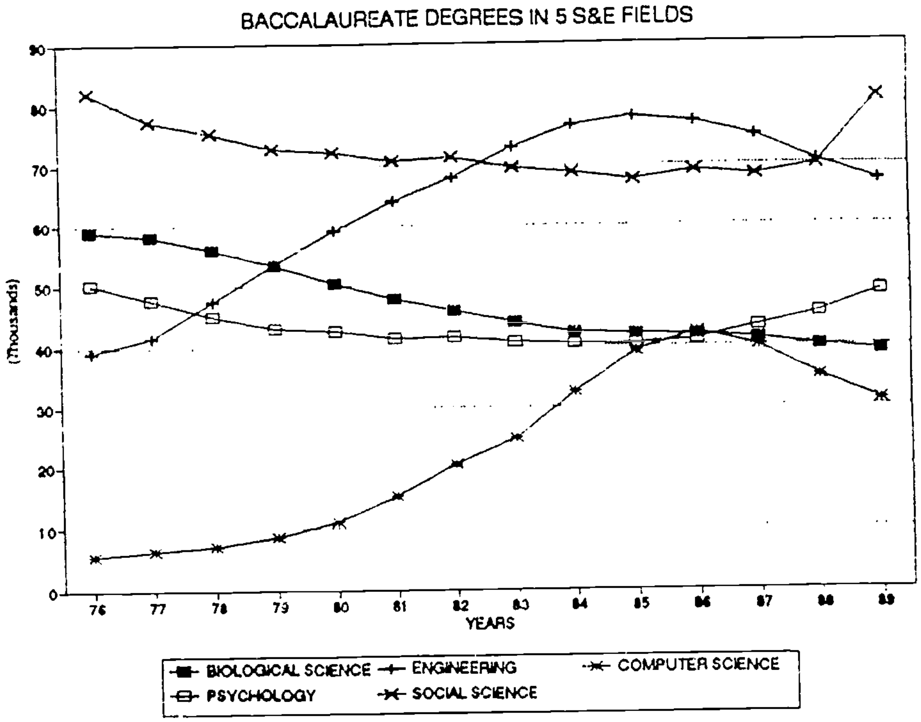
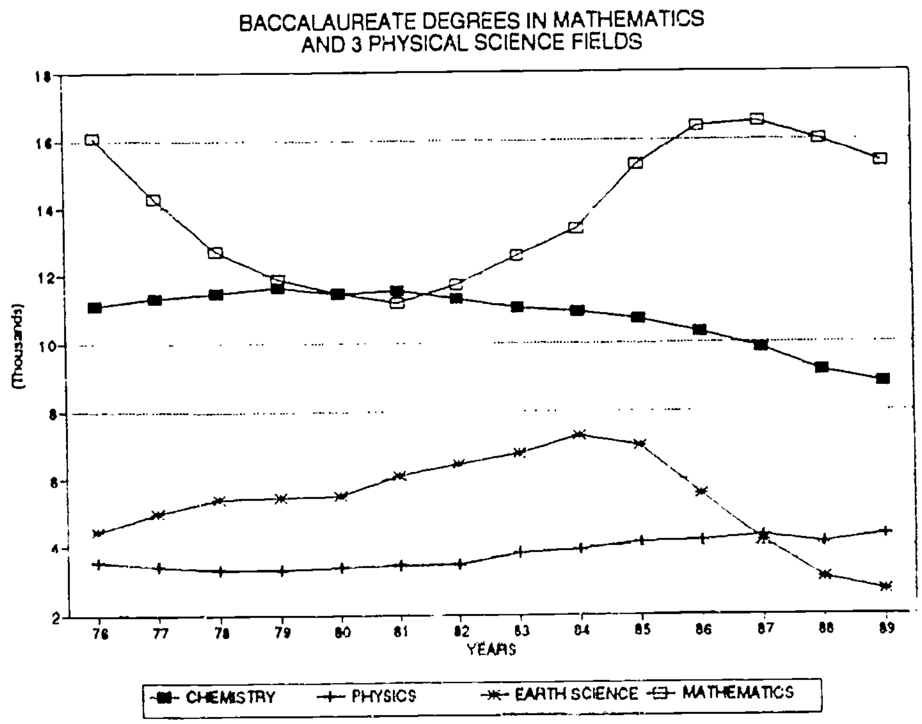


FIGURE 2



Figures 3-7

FIGURE 3

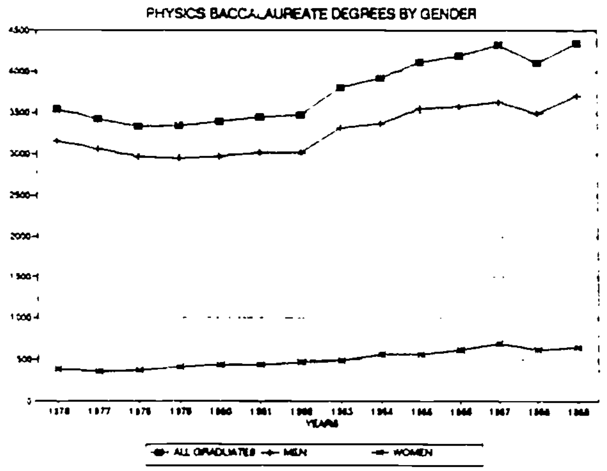


FIGURE 4

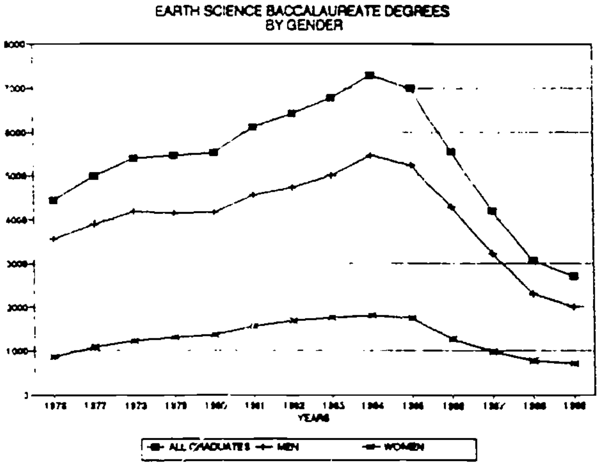


FIGURE 5

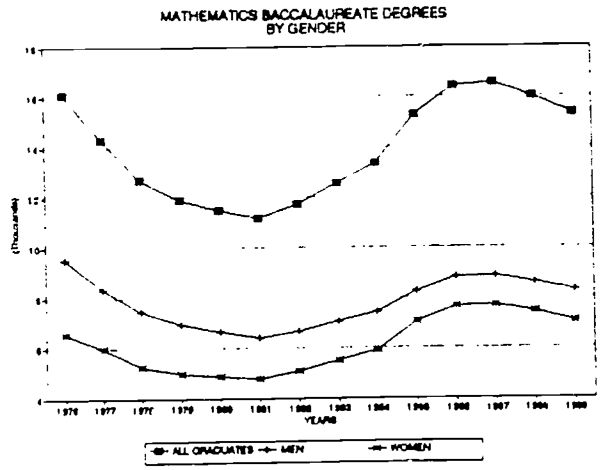


FIGURE 6

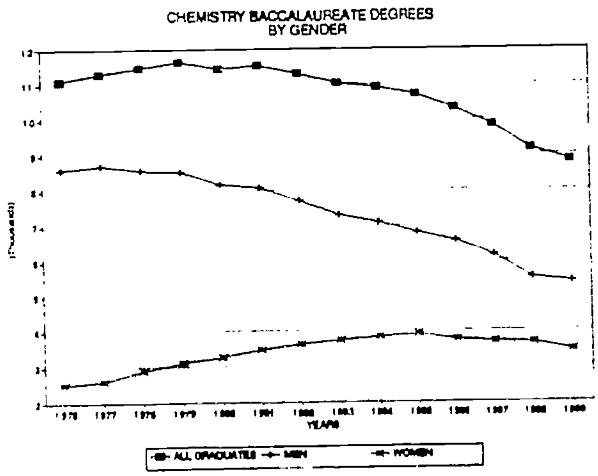
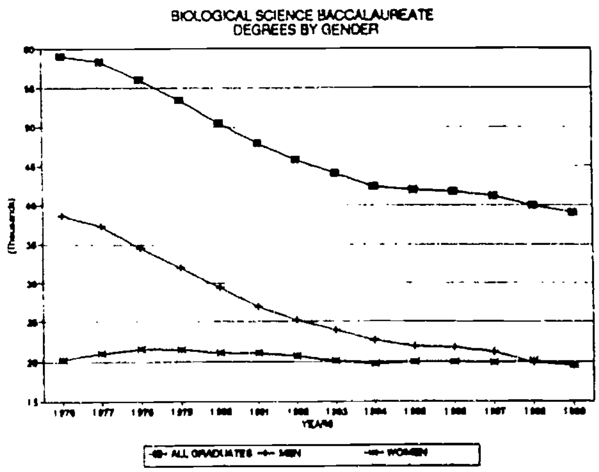


FIGURE 7



Figures 8-13

FIGURE 8

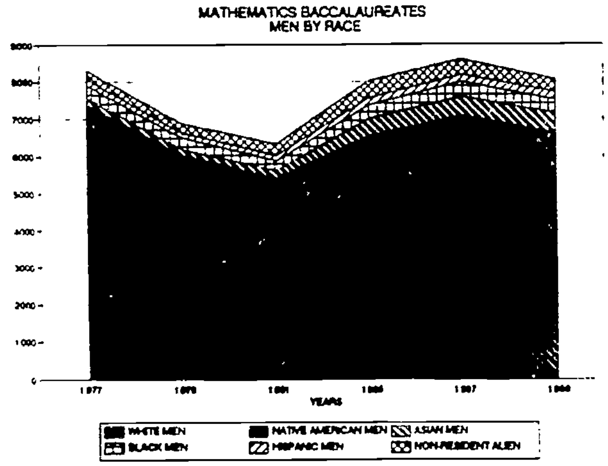


FIGURE 9

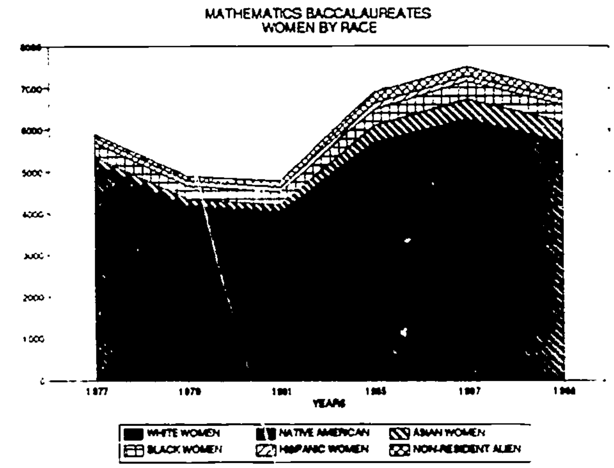


FIGURE 10

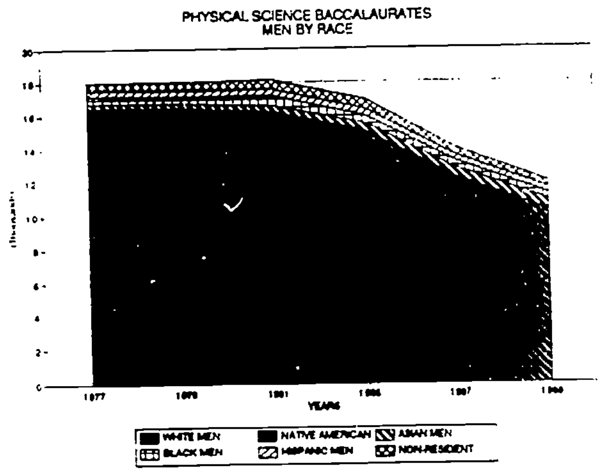


FIGURE 11

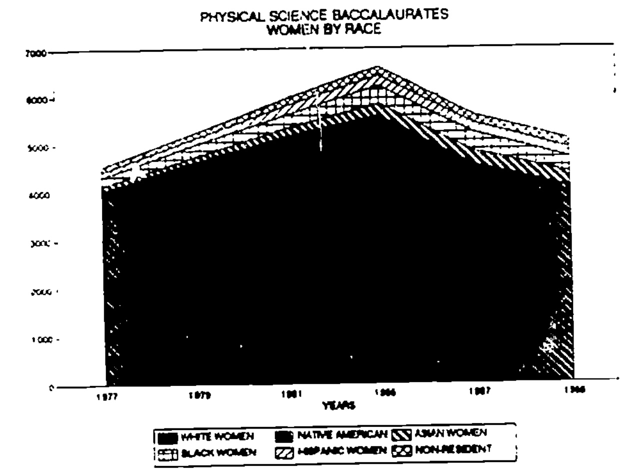


FIGURE 12

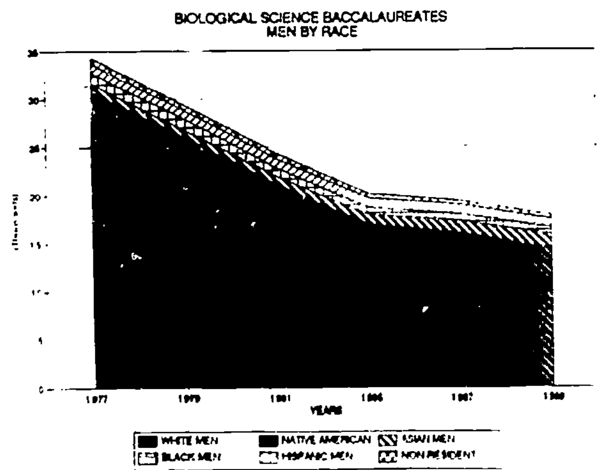
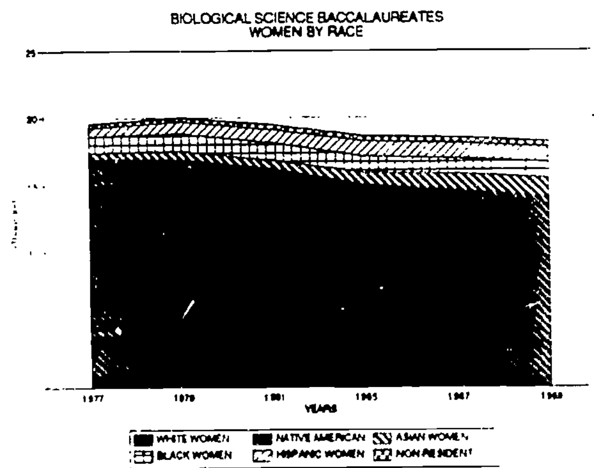


FIGURE 13



Figures 14 and 15

FIGURE 14

BACCALAUREATES IN ALL FIELDS
WOMEN BY RACE

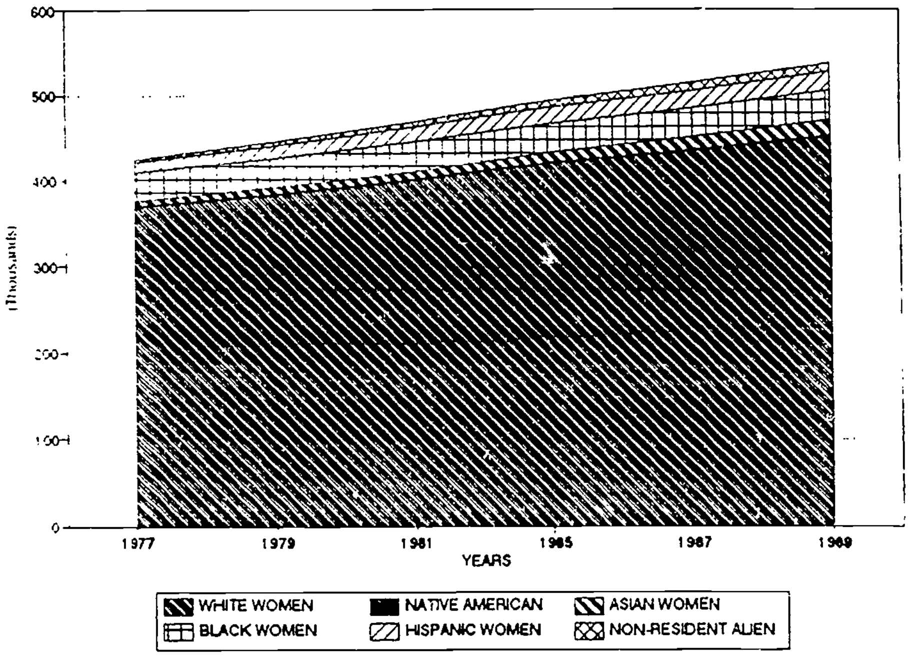
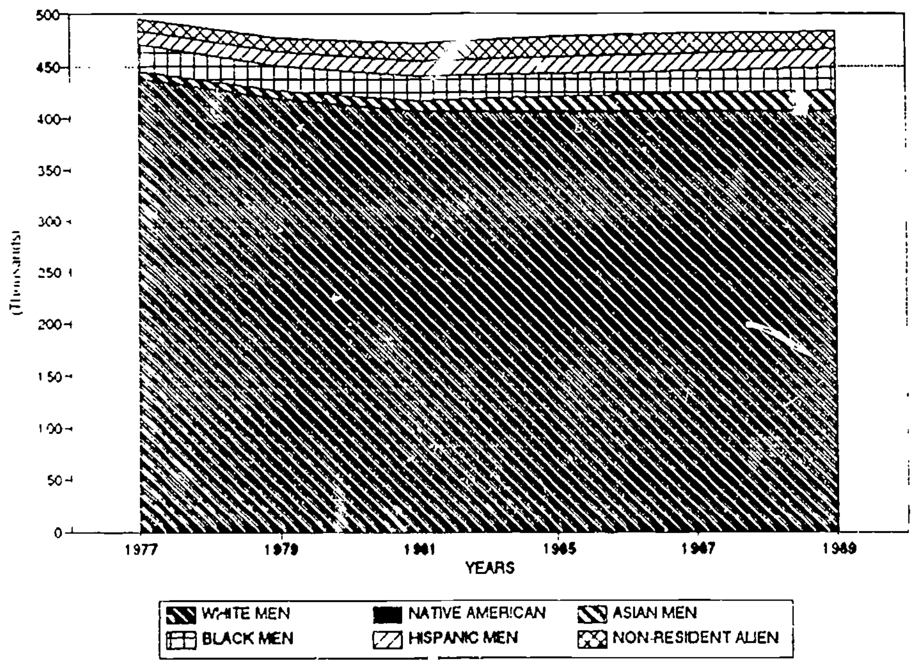


FIGURE 15

BACCALAUREATES IN ALL FIELDS
MEN BY RACE



Mathematics. The number of mathematics degrees earned by men declined between 1976 and 1981, increased through 1987, and then declined again in 1989 (Table 2). This pattern was observed for Black, Hispanic, and White men (Table 5). The number increased for Asians, Native Americans, and non-resident aliens. The trend for the total number of mathematics degrees earned by women was similar to that observed for men (Table 3). The changes in the total numbers for women primarily reflect the fluctuations in the degrees earned by White women (Table 5). The number increased for Asian and non-resident alien women, and was essentially stable for Black, Hispanic, and Native American women.

Physical Science. Since there are distinctly different trends in the number of degrees earned in chemistry, physics, and geology, it is unfortunate that these separate field data are not available by race. Merging them results in a steady number for men from 1976 to 1982, with a decline between 1982 and 1989 (Table 2). For Hispanic, Native American, and non-resident alien men there was not much change in the numbers of physical science degrees earned between 1976 and 1989 (Table 6). The number declined for White men by 35%. Asian men earned more than two times as many physical science degrees in 1989 as in 1976. The number increased for Black men between 1977 and 1981, but has declined since. The total number of physical science degrees earned by women increased between 1976 and 1985, and declined between 1987 and 1989 (Table 3). The number of physical science degrees increased between 1977 and 1985 for women in each racial/ethnic group, although the numbers declined between 1985 and 1989 for White and Native American women (Table 6). The number of physical science degrees increased through 1987 for Black women but declined in 1989.

SCIENCE DEGREES RELATIVE TO OTHER FIELDS. By comparing the trends in science degrees to trends in other fields we can learn more than just the absolute number of students in the science pipeline. One measure of the attractiveness and accessibility of degrees in a particular field can be provided by comparing the number of degrees earned in that particular field to the number of degrees obtained in all fields. We need to know the degree to which variations in the number of baccalaureates earned in mathematics and natural science reflect changes for those fields, rather than merely changes in the total number of baccalaureate degrees earned (figures 14-25).

Baccalaureates Awarded to Hispanic Men and Women. The total number of baccalaureate degrees awarded to Hispanic men and women has increased steadily between 1977 and 1989. Although there was an increase in the number of baccalaureate degrees in biology and mathematics earned by Hispanic men, these increases were less than the increase in the total number of baccalaureates earned by this group. The number of biological and physical science degrees earned by Hispanic women has increased since 1977 at about the same rate as the total number of baccalaureate degrees in all fields earned by this group.

Baccalaureates Awarded to Native American Men and Women. The numbers for Native Americans are too small (and unreliable) to draw firm conclusions about trends.

Baccalaureates Awarded to Black Men and Women. The total number of baccalaureates earned by Black men and women has declined. The number of degrees they have earned in mathematics has increased slightly, thus a higher proportion of all the baccalaureate degrees earned by Black men and women were earned in mathematics. The number of biological and physical science degrees has declined for Black men, much more than their total number of degrees. The proportion of the baccalaureate degrees earned by Black women that were earned in biological science has declined slightly. Black women earned an increasing number of physical science degrees between 1977 and 1987. Although the number of physical science degrees earned by Black women declined in 1989, this number still was more than 50% greater than the number in 1977. Since the total number of baccalaureates earned by Black women has declined since 1981, this results in an increase in the proportion of all baccalaureates that Black women have earned in the physical sciences.

Figures 16-21

FIGURE 16

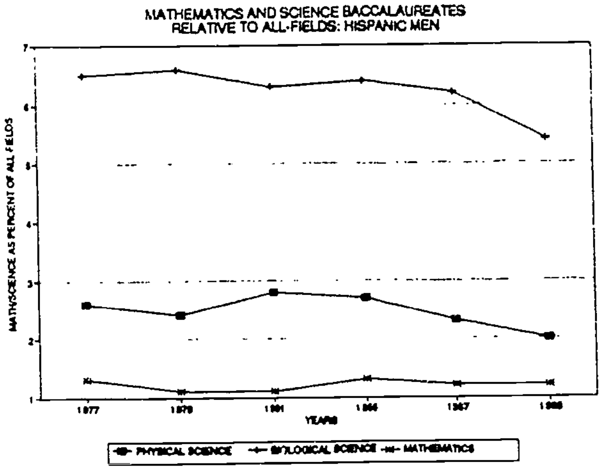


FIGURE 17

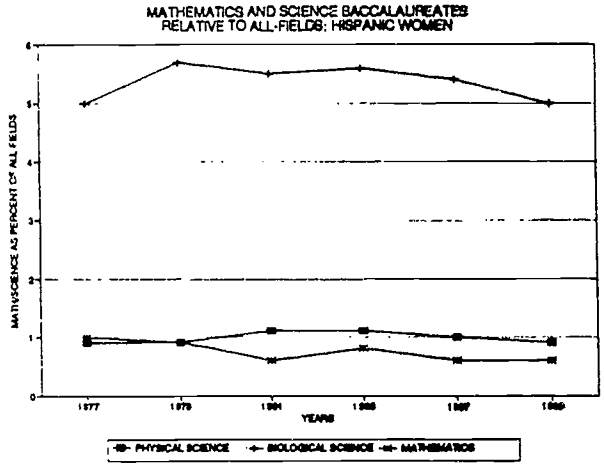


FIGURE 18

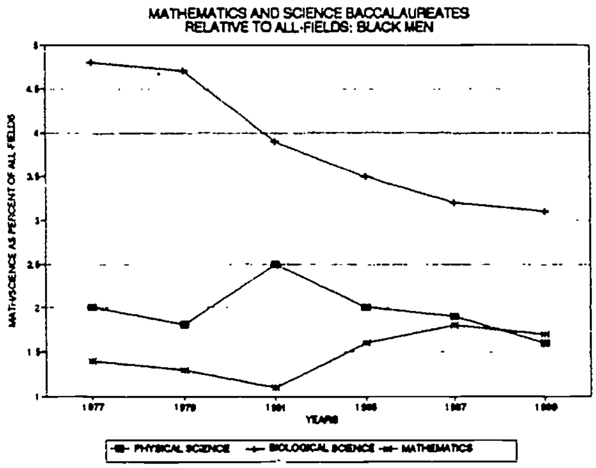


FIGURE 19

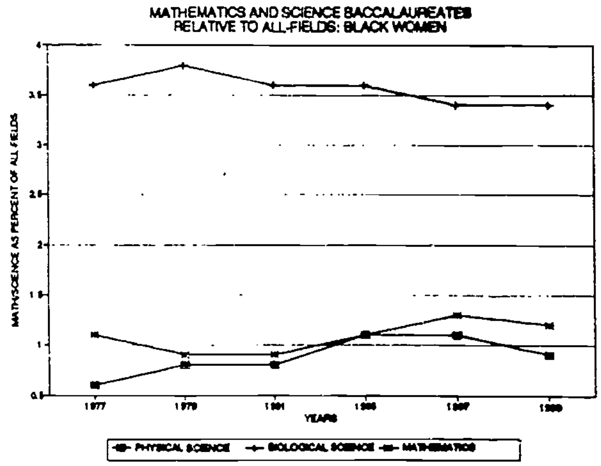


FIGURE 20

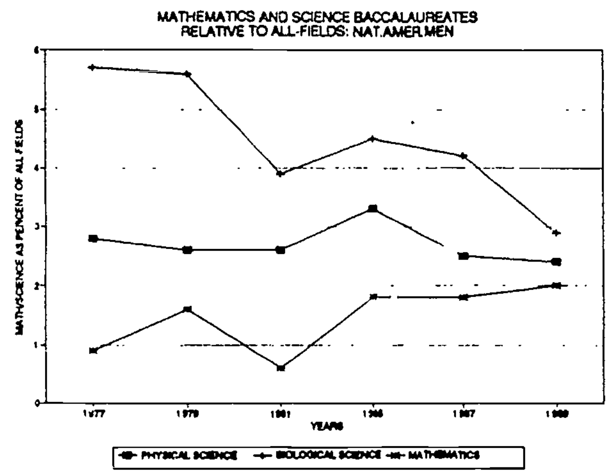
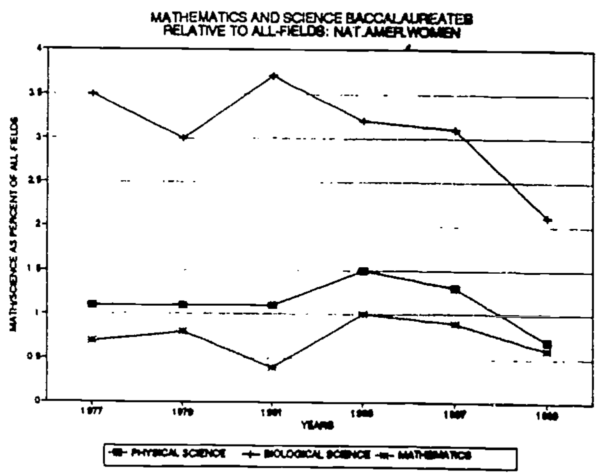


FIGURE 21



Figures 22-25

FIGURE 22

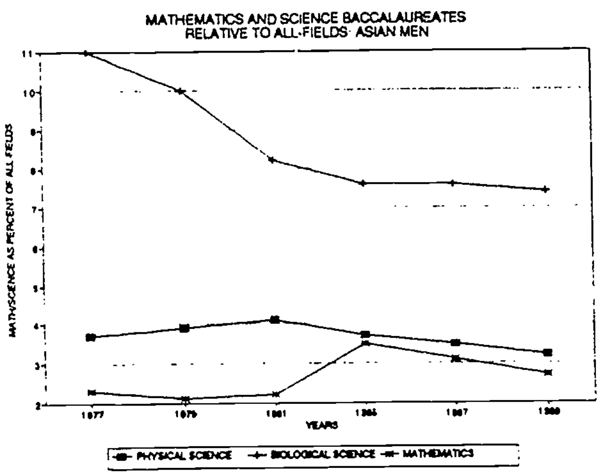


FIGURE 23

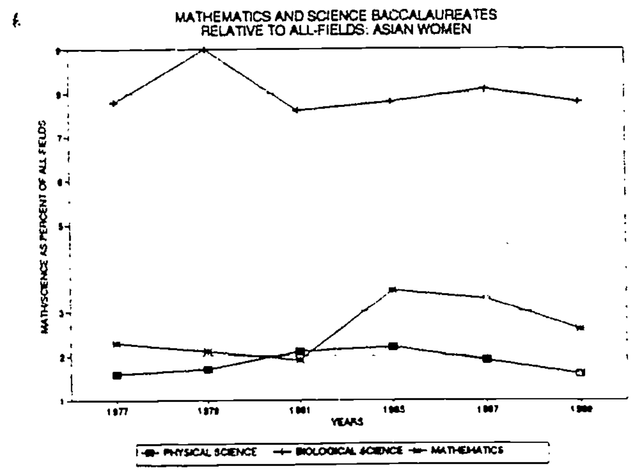


FIGURE 24

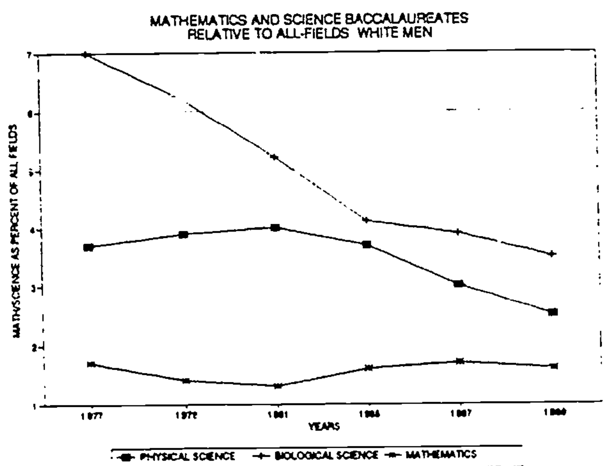
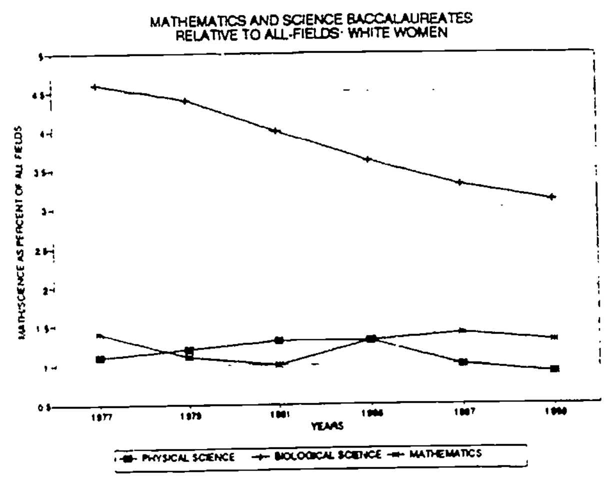


FIGURE 25



Baccalaureates Awarded to Asian Men and Women. The total number of baccalaureates earned by Asians tripled between 1977 and 1989. The number of mathematics degrees earned by Asians was slightly greater than the increase in the total number of baccalaureate degrees earned by this group, as indicated by an increase in the proportion of the baccalaureate degrees earned by Asian men and women that were earned in mathematics. The number of biological science degrees earned by Asian men has increased at a slower rate than the increase in the total number of baccalaureate degrees. The number of biological science degrees earned by Asian women has increased since 1977, but at about the same rate as the increase in the total number of baccalaureate degrees earned by this group. The number of physical science degrees earned by Asian women tripled between 1977 and 1989, just keeping pace with the increase in the total number of baccalaureates awarded to Asian women, while the increase in the number of physical science degrees earned by Asian men was less than the increase in the total number of degrees earned by this group.

Baccalaureates Awarded to White American Men and Women. In 1987, the proportion of all the degrees earned by White men and women that were earned in mathematics was the same as in 1977. Women earned a higher number of degrees in mathematics in 1987, but the increase was parallel to the greater total number of baccalaureate degrees they earned. White men earned degrees in mathematics in 1987, parallel to the lower number of degrees they earned in all fields. The number of biological and physical science degrees has declined for White men and for White women, despite an increase in the total number of baccalaureate degrees earned by White women.

RACIAL/ETHNIC AND GENDER REPRESENTATION IN SCIENCE. The extent to which various groups are under-represented in science and mathematics typically has been measured by comparing the proportion of the degrees in each field that are earned by members of each group to the relative position of the group in the general population. This is important information but it does not tell the whole story.

First, different groups have different rates of participation in higher education. Variations in the number of baccalaureate degrees earned in any particular field reflect, in part, variations in the total number of baccalaureate degrees awarded. The total number of degrees, in turn, is affected by the numbers of people in each age category in the population, by variations in the number of high school graduates, and by the rates at which various groups attend college and earn degrees.

Second, the proportion of the degrees earned by a particular group is influenced by changes among other groups. A National Academy of Sciences workshop on the under-representation of women in science and engineering (Dix, 1987) focused on engineering and the physical sciences, noting that women have achieved "parity" in the biological sciences. Clearly the fields of engineering and the physical sciences are ones in which women are acutely under-represented. In 1989, women earned 40% of the baccalaureate degrees in chemistry, but only 15% of the physics degrees, and one-fourth of the geology degrees. Women earned one-half of the baccalaureate biology degrees in 1989. However, the status of women in the biological sciences has not improved. The "parity" they have achieved in this field has been due entirely to the precipitous decline in the number of degrees awarded to men, not to any increase in the number for women.

It is clear that various groups are not proportionately represented among those earning college degrees and they are not proportionately represented among those earning baccalaureates in mathematics and science. The question remaining is whether the various groups are more or less well-represented in mathematics and the biological and physical sciences, relative to their general status among college graduates. Are there special problems for participation in mathematics and science for these students, beyond those factors leading to different success rates in college in general?

The total number of baccalaureate degrees earned in all fields increased between 1977 and 1989 (Figures 14-15). This increase was due to an increase in the number of degrees earned by women, while the number earned by men decreased. The total for Whites increased, due again to an increase among women--the number of degrees awarded to White men has been steady since 1981. The total number earned by Blacks declined from 1977 to 1988, due to a decrease over the decade in the number earned by Black men. The number of baccalaureate degrees earned by Black women increased from 1977 to 1981 (from 33,489 to 36,162) and then declined to 35,651 in 1989. The total number of baccalaureate degrees awarded to Hispanics and Asians increased consistently during the decade both for men and women. Native American women earned a consistently increasing number of baccalaureate degrees during this decade, while the number earned by Native American men fluctuated, decreasing in 1989 to less than the number in 1977.

These shifts in the numbers of baccalaureate degrees are reflected in the proportions of all baccalaureate degrees that were earned by the members of each group. The proportion of the baccalaureate degrees earned between 1977 and 1989 by Whites dropped from 88% to 84%, and the proportion earned by Blacks dropped from 6.3% to 5.7%. The proportion earned by Native Americans remained the same at 0.4%. The proportion earned by Asians and by non-resident aliens[5] approximately doubled: for Asians from 1.5% to 3.7%; for non-resident aliens from 1.7 to 2.6%. The increase in the number of baccalaureate degrees earned by Hispanics resulted in an increase in their proportion of all baccalaureate degrees from 2.9% in 1977 to 3.9% in 1989.

Comparing the share of the baccalaureate degrees in all fields earned by each group to their representation in the population[6] indicates that Blacks and Native Americans are under-represented by at least one-half. Whites are slightly over-represented. Asians earn more than twice as many degrees as their share of the general population.

The question then becomes whether these groups maintain these relative positions within mathematics and the biological and physical sciences.

The proportion of Native Americans among the biological science, physical science, and mathematics graduates is about the same as their proportion among college graduates in general. Whites earn a smaller proportion of biological science degrees than baccalaureates in all fields, while they earn about the same proportion of physical science and mathematics degrees as their proportion of baccalaureate degrees in all fields. Asians earn mathematics and natural science degrees in higher proportions than other fields.

Hispanics earn a larger proportion of biological science degrees than their proportion of baccalaureate degrees in all fields, but they earn a smaller proportion of the degrees in physical science, and especially in mathematics, than in all fields. There are gender differences for Black graduates in these fields. Black women are represented among physical and biological science graduates at about the same level as for baccalaureate degrees in all fields, but their proportion of mathematics degrees is lower than their proportion of all baccalaureates. The proportion of the mathematics degrees that were earned by Black men is nearly equal to their proportion of baccalaureates in all fields, while the proportion of physical science and biological science degrees earned by Black men is lower.

It appears that there are obstacles for Hispanic men and women in mathematics and physical science, for Black women in mathematics, and for Black men in physical science and biological science, beyond the problems these students have in participation in college in general. It has been well documented that these students, as a group, are much less likely to enter college prepared for majors in mathematics and science. It is not clear whether there are particular attrition problems for these students in mathematics and natural science fields. Retention studies have indicated that Black and Hispanic students have lower rates of graduation within 6 years after college entry (Porter, 1990). Whether there are particular factors leading to attrition from mathematics and science, beyond those leading to attrition from college in general, for these students is not clear. A recent report regarding the students in the "High School and Beyond" study who entered college intending to major in mathematics or science, concludes that, while there are gender differences, there may not be differences among racial groups in their persistence in mathematics and science: "The under-representation of these minorities lies not in their selection of major fields of study, but in their relatively low rates of attendance and graduation," (NCES, 1990d, p. 3). However, a 1987 National Academy of Sciences report concluded, "The under-representation of minorities in science and engineering is partly a matter of persistence in higher education and partly due to the choice of fields by minority students," (Dix, 1987, p. 40). It is likely that this conflict is more apparent than real. The necessary course of action is clear--it will be necessary to provide support for these students both for retention in mathematics and science and for retention in higher education in general.

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[5]The Department of Education does not collect racial/ethnic information for non-resident aliens.

[6]It is not possible to compare directly the Department of Education data and Bureau of the Census data for Hispanics, since they do not define "Hispanic" in the same way.

COMPARISONS BY FIELD, GENDER AND INSTITUTIONAL TYPE. The baccalaureate degrees conferred between 1987 and 1989 by all U.S. institutions in mathematics and the biological and the physical sciences were analyzed by field, by race, by sector, and by institution.

Postsecondary institutions range from the specialized institutions, such as art and music schools, that offer no mathematics and science instruction, to the engineering and technical institutes that are entirely devoted to such fields. The majority of four-year institutions offer mathematics and science education among other courses of instruction. These institutions vary a great deal in the numbers and proportions of their students who graduate with baccalaureate degrees in mathematics and science.

Institutions differ on a number of characteristics: mission, size, selectivity, public/private control, resources in personnel and facilities, breadth of curriculum, and program emphases. Several of the most relevant characteristics were included in the classification scheme developed by the Carnegie Foundation. Institutions were grouped by size; selectivity; control; research emphasis; and the number, fields, and level of degrees conferred (see Appendix A for criteria used in classification).

The criteria used by the Carnegie Foundation in classifying institutions are highly relevant to questions of science-degree productivity. There are several problems with the classification and its use, however (see Appendix B).

Ideally one would begin an analysis of undergraduate mathematics and science productivity with a list of those institutions that offer majors in those fields. However, the current classification systems do not provide such specific information. An additional problem is created by the inability of the Integrated Postsecondary Education Data (IPEDS) format to include all science degrees, especially those granted in interdisciplinary majors (see Appendix B). For the current analysis, the determination of which institutions to include was made on the basis of whether there were any degrees in these fields reported in the National Center for Education Statistics (NCES) data for each institution during 1987-89. This had the effect of excluding several institutions that grant degrees in mathematics and natural science, but whose degrees in these fields do not get reported in the IPEDS data as mathematics or science degrees, for example, Sarah Lawrence College, St. John's College (MD & NM), Evergreen State College, and the College of the Atlantic (see Appendix B).[7]

In 1989, of the 2,135 four-year colleges and universities, approximately 1,200 awarded baccalaureate degrees in biological science, 1,100 awarded baccalaureate degrees in mathematics, and 1,050 awarded baccalaureate degrees in physical science. Most of these degrees were conferred by institutions in the Carnegie categories Liberal Arts Colleges, Comprehensive Universities, Doctorate-Granting Universities, and Research Universities. For particular fields, two of the specialized categories are also important: Engineering and the U.S. Service Academies.

The institutions awarding mathematics and science baccalaureates range in size from those with undergraduate enrollments of fewer than 300 students to those of more than 30,000. Although the absolute number of mathematics and science degrees for many of the larger institutions is comparatively high, for several institutions a high number of mathematics and science graduates merely reflects very high enrollments; for other institutions the number of mathematics and science graduates is higher than would be expected from their size.

There are a number of smaller colleges and universities that are making a significant contribution to the scientific pipeline in absolute numbers of mathematics and science graduates. For some, this reflects specialization or concentration, as in the high numbers for the Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, California Institute of Technology, New Mexico Institute of Mining and Technology, and Harvey Mudd College. Several universities with smaller undergraduate enrollments have high numbers of math and science graduates including, for example, the University of Chicago, Carnegie Mellon University, Johns Hopkins University, Princeton University, Tufts University, the University of Rochester, Yale University, Vanderbilt University, Case Western Reserve University, Rice University, and Dartmouth College. Comprehensive Universities with relatively small undergraduate enrollments and high numbers of graduates in these fields include, for example, SUNY at Potsdam, Fort Lewis College, Houston Baptist University, Sonoma State University, the University of Scranton, the University of Puerto

[7]This exclusion has little effect on the calculations of proportions for any sector except the Public Liberal Arts II Colleges.

Rico-Cayey, Jacksonville University, Mary Washington College, Wake Forest University, and Valparaiso University.

The top 100 institutions in the average number of baccalaureate degrees earned by all graduates, or by women graduates, in each of the mathematics and science fields in 1987-1989 include a number of small liberal arts colleges with undergraduate enrollments below 3,200 (some as low as 1,300). These small colleges include, for example, Spelman College, Gustavus Adolphus College, Whitman College, the College of Wooster, Occidental College, Washington and Jefferson College, Bates College, Allegheny College, Dickinson College, Franklin and Marshall College, Hope College, Kalamazoo College, Grinnell College, Oberlin College, Union College (NY), Mount Holyoke College, and Wellesley College. Indeed, among all the institutions in the nation, **of any size**,

- only 31 have more mathematics graduates than Saint Olaf College;
- only 33 have more physics graduates than Harvey Mudd College or Carleton College, and only 39 have more physics graduates than Reed College;
- only 25 have more chemistry graduates than Saint Olaf College, and only 31 have more chemistry graduates than Xavier University of Louisiana.

The comparisons for mathematics and science degrees earned by women are distributed much less proportionately by size. Comparing all institutions, **of all sizes**,

- only 7 institutions have more women chemistry graduates than Xavier University of Louisiana, and only 20 have more women chemistry graduates than Bryn Mawr College;
- only 2 institutions have more women physics graduates than Bryn Mawr College, and only 6 have more women physics graduates than Carleton College;
- only 3 institutions have more women geology graduates than Carleton College;
- only 29 have more women mathematics graduates than Smith College, and only 35 have more women mathematics graduates than Saint Olaf College.

These findings confirm the conclusions of the OTA report (1988) and the Oberlin reports (Davis-Van Atta, et al., 1985 and Carrier, et al., 1987) that the liberal arts colleges are an especially productive group of institutions. These findings also demonstrate the variety and number of colleges making a significant contribution to undergraduate education in mathematics and science.

Looking at absolute numbers of graduates is useful in assessing the state of the pipeline. However, absolute numbers are not helpful in determining the productivity of individual institutions, since they differ tremendously in size. For example, in 1987-1989 the University of California at Los Angeles granted twice as many baccalaureate degrees in mathematics as did Carnegie Mellon University. But the University of California at Los Angeles has an undergraduate enrollment nearly six times that of Carnegie Mellon University. The 380 degrees conferred by Carnegie Mellon University represented 14% of their baccalaureate degrees, whereas the 770 degrees conferred by the University of California at Los Angeles represented 5% of the baccalaureates they conferred (Table 27).
In order to account for differences in size, the proportion of the baccalaureate degrees granted by each institution that are granted in mathematics or natural science was calculated. The average number of mathematics and science graduates in 1987-1989 were divided by the average number of baccalaureates granted in all fields by each institution in 1987-1989. The data were analyzed separately for the degrees earned by women. The average number of baccalaureates in mathematics and science fields earned by women graduates of each institution were divided by the average number of baccalaureates earned by women in all fields.

The leading institutions in the proportion of their baccalaureate degrees that were awarded in the physical or biological sciences or mathematics were identified for each field and are listed in rank order in Tables 17-21 for all graduates. Institutions are ranked by the absolute number of degrees awarded in these fields in Tables 27-31. Each institution is identified by name, Carnegie category, and whether it is predominantly minority[8], an HBCU, or a women's college (see Appendix A).

[8]The identification of "predominantly minority" was provided by the Quality Education for Minorities Project (see Appendix A).

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The leading institutions in the proportion of their baccalaureate degrees earned by women that were earned in mathematics, chemistry, or biological science are listed in rank order in Tables 22, 24, and 26. Institutions are ranked by the absolute number of degrees earned by women in these fields in tables 32-34. Due to the very small numbers involved, the data for women physics and earth science graduates are presented for all institutions that granted more than 2 degrees in physics or more than 3 in geology to women. These institutions are listed in order by absolute number in Tables 23 and 25.

Looking at the number of mathematics and natural science graduates--relative to the size of the institution--reveals large differences in productivity among the institutions granting baccalaureate degrees in these fields.[9] The most productive institutions include representatives from the liberal arts colleges, the research universities, the comprehensive colleges and universities, the doctorate-granting universities, the engineering schools, and the U.S. service academies.

There are variations in productivity by institutional type and by field. While these lists include institutions from each of the major Carnegie categories, the representation of each type varies by field. For example, the Doctorate-Granting Universities rank higher in productivity in the biological sciences than in mathematics or chemistry, whereas the engineering schools rank higher in mathematics, chemistry, and physics than the biological sciences.

While average values provide a useful snapshot of the central tendency of a group of institutions, they do not necessarily indicate what is the case for the typical institution, or the extreme instances (although mean values are highly subject to distortion due to extreme cases). It is clear that, for each category, there are some most unusual cases. Inspection of the variation in numbers and proportions of degrees granted in these fields, indicates that the "typical" institution has a moderate or low number of mathematics or science graduates, and this number represents a moderate or low proportion of their baccalaureates. There are a few institutions at the extremes. Plotting the number of baccalaureates in each field granted by each institution against the proportion of that institution's graduates who earned degrees in that field reveals how many colleges and universities that deviate from the norm on either or both criteria. (Figures 26-35; a few institutions have been identified on the graphs to give some perspective--others can be identified through Tables 17-34.)

The institutions that were among the top 15% of all institutions[10] <u>both</u> for the absolute number and for the proportion of their graduates receiving degrees in these fields are identified in Table 15 (all graduates) and in Table 16 (women graduates).

The patterns across Carnegie categories are similar for the data for all graduates and for the data analyzed separately for women. The distribution among the Carnegie categories of the number of degrees conferred in part reflect the large differences in their sizes.[11] Tables 10 and 11 summarize, for each of the major Carnegie categories, the average number and the proportion of the baccalaureate degrees granted in 1987-1989 in the biological and physical sciences and in mathematics. Tables 12 and 13 summarize these data for women graduates.

As would be expected, the specialized maritime and military institutions had high proportions of their graduates in the fields of mathematics and physical science. The private Liberal Arts I Colleges were the most productive group of institutions for biological science, and second to the maritime/military institutions for physical science.

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[9]To interpret these lists it is important to recognize that there are distinctly different circumstances leading to high productivity rates. Very small institutions may have high proportions of their graduates receiving mathematics and science degrees even though their absolute number of mathematics and science degrees is low. Larger institutions will have high productivity rates when their number of mathematics and science graduates is high relative to the size of the institution.

[10]With exceptions due to classification problems--See Appendix B.

[11]Table 14 indicates the 1987 undergraduate enrollment in institutions in each of the major Carnegie categories.

Figures 26-30

FIGURE 26

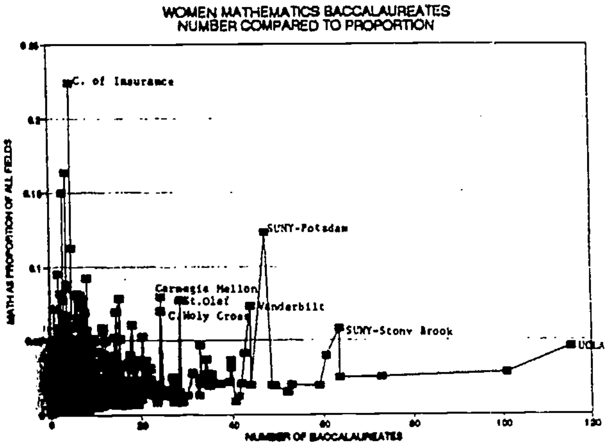


FIGURE 27

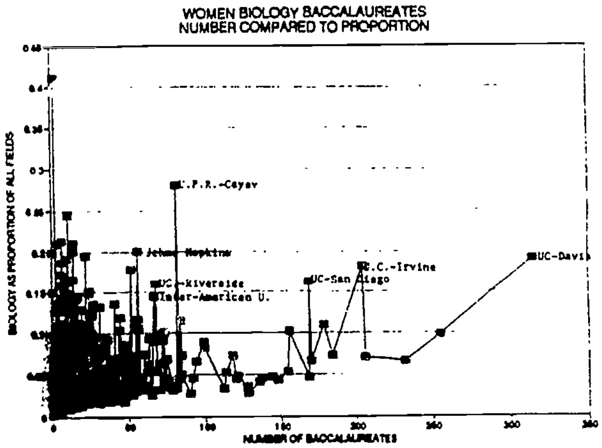


FIGURE 28

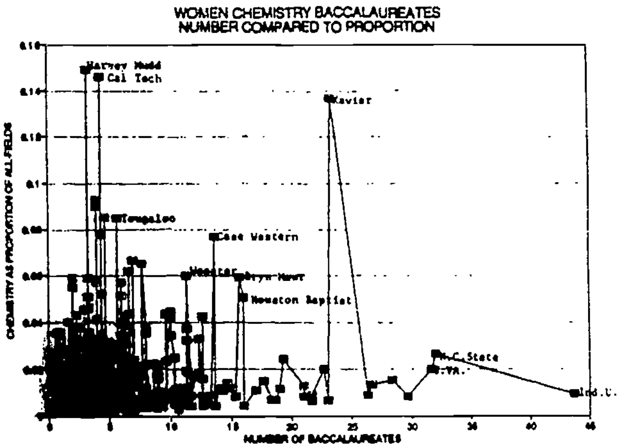


FIGURE 29

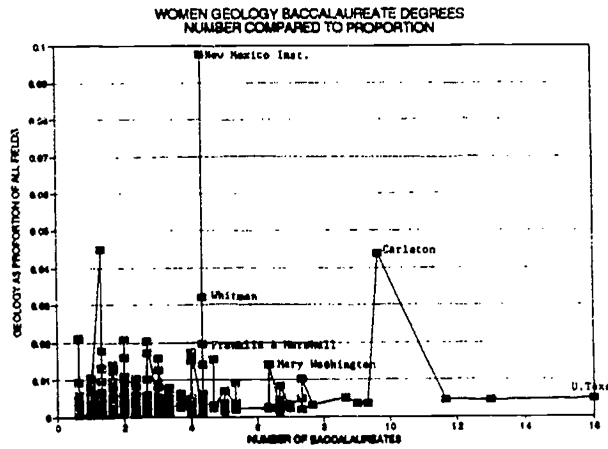
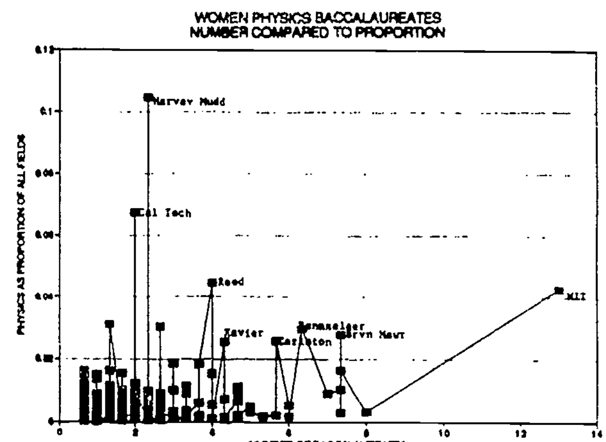


FIGURE 30



Figures 31-35

FIGURE 31

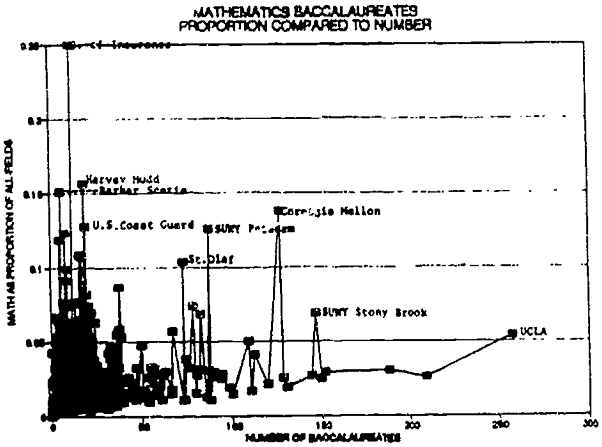


FIGURE 32

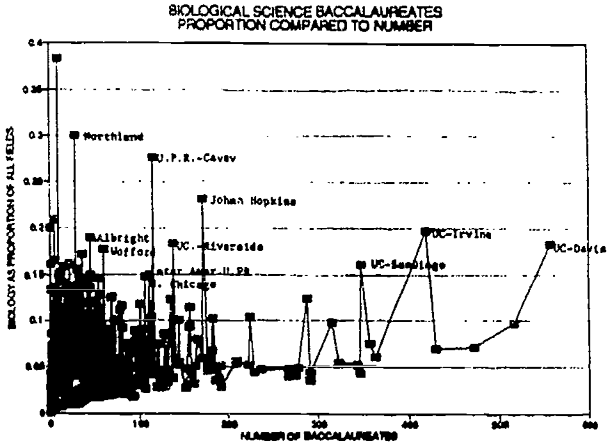


FIGURE 33

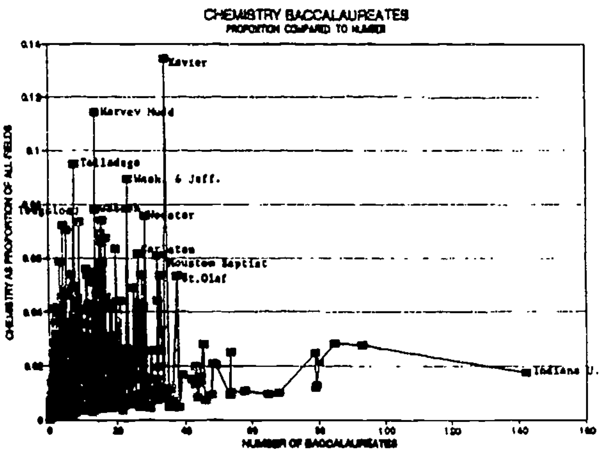


FIGURE 34

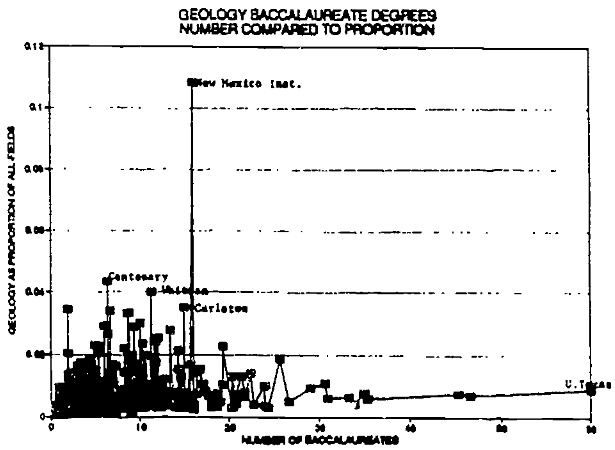
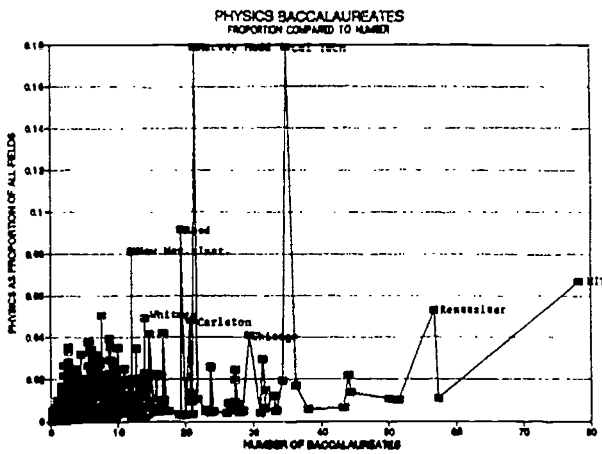


FIGURE 35



The Liberal Arts II Colleges and the Research I Universities also were highly productive groups. There is variation among the women's colleges in their productivity in these fields. The most productive groups of institutions for women mathematics and science graduates were the coeducational liberal arts colleges and the women's liberal arts colleges. The comprehensive women's colleges were more productive than the coeducational comprehensive institutions (Table 47).

The "box and whisker" graphs (figures 36-38) reveal in the boxes the productivity level for the middle 50% of the institutions (in each sector and for all institutions). The "whiskers" indicate the levels between which 90% of the institutions fall. These graphs display the variations within sectors and demonstrate that the average differences between sectors are true for most of the institutions, and not just a few extreme cases.

The women's colleges appear in two Carnegie categories: Liberal Arts and Comprehensive. The data are presented separately for each of these categories for the women's colleges and the comparable coeducational colleges and universities. Previous analyses that compared women's colleges as a group to all coeducational institutions have obscured the differences among the women's colleges and the fact that some of the coeducational liberal arts colleges are an equally significant source of the baccalaureate degrees earned by women in mathematics and science.

COMPARISONS BY FIELD, GENDER, RACE, AND INSTITUTIONAL TYPE. The most important features of the science baccalaureate data for Black, Hispanic, and Native American graduates are 1) the small numbers of degrees; 2) the concomitant small number of institutions granting those degrees; and 3) the concentration of Black students in the Historically Black Colleges and Universities and other predominantly minority institutions, and of Hispanic students in the colleges and universities in Puerto Rico and other predominantly Hispanic institutions.

Those institutions that averaged more than two baccalaureate degrees in mathematics, biological, or physical science in 1986-87 and 1988-89 are listed in Tables 36-38 for Native Americans, in Tables 39-41 for Hispanic graduates, and in Tables 42-44 for Black graduates. The institutions are ranked by the number of degrees conferred in each field. The predominance of the HBCUs, the Puerto Rican institutions, and the other predominantly minority colleges and universities is evident, as is the very small number of institutions granting degrees in mathematics and science to Native American, Black, and Hispanic graduates. However, institutions representing each type are included.

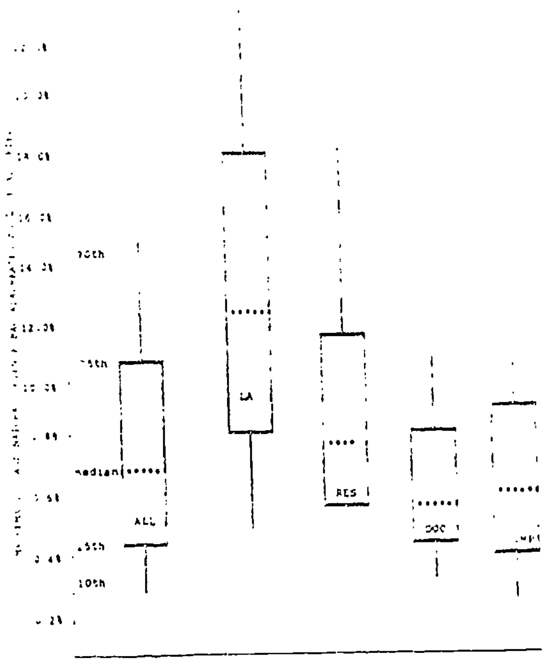
The distribution across types of institutions of the degrees earned by Black and Hispanic graduates is, of course, heavily influenced by the uneven distribution of minority student enrollment by institutional type and by geographical region. These students are highly concentrated in the predominantly minority institutions, which in turn are geographically concentrated (See Appendix D). Most of the predominantly minority institutions are classified as Comprehensive Colleges and Universities.

However, taking into account the large differences in minority representation within sectors reveals that the sectors are not equally productive of minority mathematics and science graduates (Table 35; figures 39-42). The Liberal Arts I and II colleges have relatively low numbers of Black and Hispanic graduates (partly due to the geographical distribution of these colleges[12]), but these colleges have the largest proportion of Hispanic (11%) and Black (12%) graduates with baccalaureates in mathematics or natural science. The Liberal Arts II HBCUs have the highest rate of mathematics and science baccalaureate production: 18%.

Almost all of the predominantly minority four-year institutions are in the Comprehensive I, Comprehensive II, or Liberal Arts II* categories. Both for Black graduates and for Hispanic graduates, the predominantly minority institutions in these categories were more productive than the "majority" institutions. Among the majority institutions, the productivity rates for their minority graduates followed the same pattern as that observed for all graduates: the Liberal Arts I and II institutions had the highest rates, followed by the Research Universities, then the Doctorate-Granting Universities, with the Comprehensive Universities and Colleges having the lowest rates.

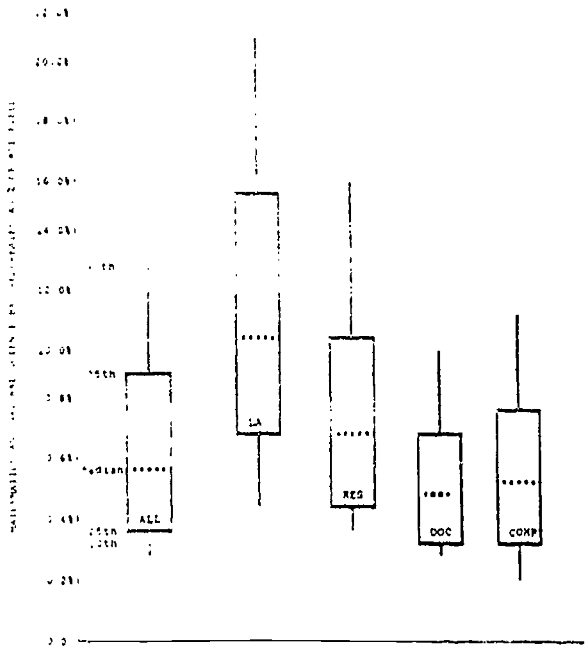
[12]However, several liberal arts colleges are developing programs especially to serve Hispanic students including, for example, Pomona College, Whittier College, Occidental College, Mount Saint Mary's College (CA), St. Edward's College, Hope College, and DePauw University.

FIGURE 36



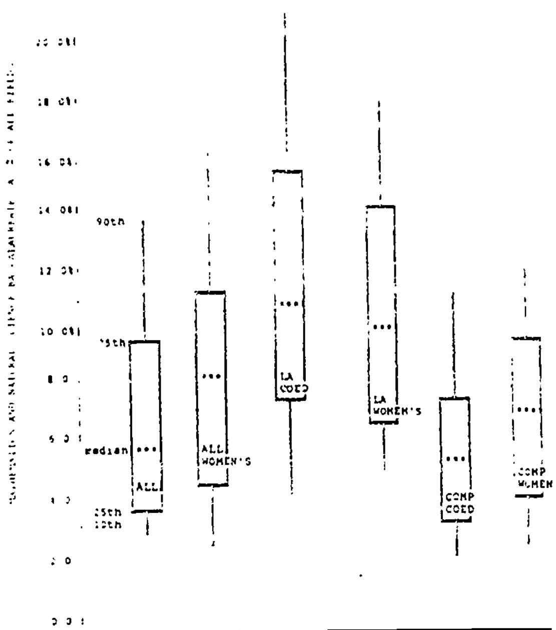
PERCENTILE DISTRIBUTION BY SECTOR OF MATHEMATICS AND NATURAL SCIENCE BACCALAUREATES EARNED BY 1987-89 GRADUATES. SCIENCE AND MATHEMATICS BACCALAUREATES AS A PROPORTION OF DEGREES EARNED IN ALL-FIELDS.

FIGURE 37



PERCENTILE DISTRIBUTION BY SECTOR OF MATHEMATICS AND NATURAL SCIENCE BACCALAUREATES EARNED BY 1987-89 WOMEN GRADUATES. SCIENCE AND MATHEMATICS BACCALAURATES AS A PROPORTION OF DEGREES EARNED IN ALL-FIELDS.

FIGURE 38



PERCENTILE DISTRIBUTION BY SECTOR OF MATHEMATICS AND NATURAL SCIENCE BACCALAUREATES EARNED BY 1987-89 WOMEN GRADUATES. SCIENCE AND MATHEMATICS BACCALAUREATES AS A PROPORTION OF DEGREES EARNED IN ALL-FIELDS.

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Since the culture of the liberal arts colleges is known to provide the features identified as particularly important to effective undergraduate education, and the women's colleges and the HBCUs provide an environment in which these particular students are expected to succeed and are provided the opportunity to succeed, it is not surprising that the combination of the two leads to very high productivity rates.[13] In addition, the majority and coeducational liberal arts colleges graduate a large proportion of their women and minority students with baccalaureate degrees in mathematics and science, just as they do with all of their students.

ASSESSMENT AND RETENTION

Of course, simply knowing either the number or the proportion of the degrees an institution awards in any field does not provide direct information about the effectiveness of the program. To properly evaluate numerical outcomes, it is essential to know the input. The fundamental piece of information needed (but not generally available) would be how many of the students who enter the program successfully complete it. What are the attrition/persistence rates? If an institution enrolls a sufficiently high number of potential majors, it is possible for them to have a large number of mathematics or science graduates even with a program that discourages many **potential** majors. Assessment measures of what students have learned or gained must be considered in relation to retention rates. An institution that "weeds out" large numbers of prospective majors might well show high levels of achievement for the few survivors, compared to an institution that "cultivates" a larger number of majors with a concomitant greater range of mastery. The best programs could be defined as those that not only retain a high proportion of their entering students but attract and enable others as well--majors and non-majors alike.

Individuals f... many institutions and agencies are actively working on problems of measurement and data collection fo retention and assessment. This information will provide essential feedback at the institutional level as well as provide information for policy makers at the state and national levels. Looking at the degree data currently available can provide useful information by making it possible to identify institutions that are unusually productive, especially those that are providing effective learning environments for under-represented groups. Examination of the differences as well as the common features and programs of these productive institutions can provide information and insights about what works, what does not work, and the resources necessary to sustain effective undergraduate mathematics and science programs.

Additional information that would be needed for evaluation would provide the background characteristics, interests, and achievement levels of all entering students, as well as appropriate assessment of the achievement levels of students completing the program. In reviewing the data for choice, persistence, and achievement for particular groups as they enter and exit a program, it is important to consider the distribution of outcomes for each group, not just average values (Edgerton, 1991). Careful attention should be given to the initial decision as to which groups need to be followed. While there are groups that have been identified for national statistics, there are some that may be uniquely appropriate and some not relevant to a particular institution. For example, colleges serving older students as well as the traditional age students may find it important to use age, while a college with few or no older students would not find this relevant. Black women would be a relevant group for all institutions except Spelman College and Bennett College, but women, as a separate group, would not be relevant for women's colleges.

[13]There are no predominantly Hispanic or Native American Indian colleges in the Liberal Arts category in the 1987 Carnegie Foundation Classification.

Figures 39-42

FIGURE 39

BACCALAUREATES IN ALL-FIELDS
BLACK GRADUATES BY SECTOR

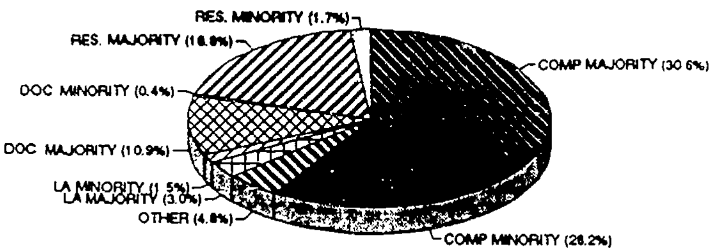


FIGURE 40

BACCALAUREATES IN MATH &NATURAL SCIENCE
BLACK GRADUATES BY SECTOR

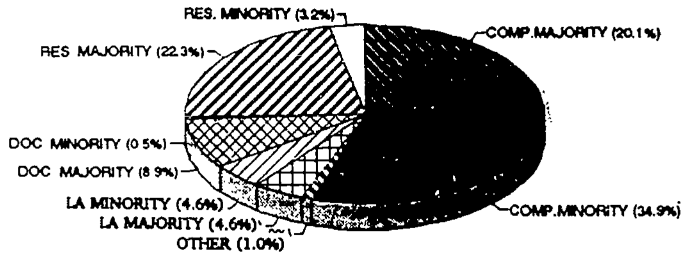


FIGURE 41

BACCALAUREATES IN ALL-FIELDS
HISPANIC GRADUATES BY SECTOR

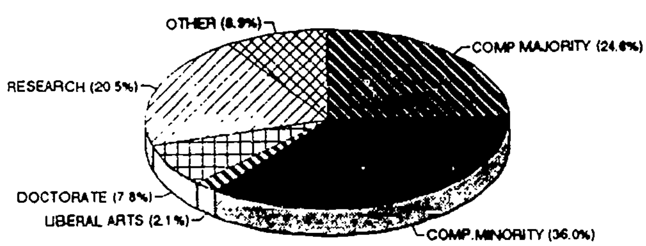
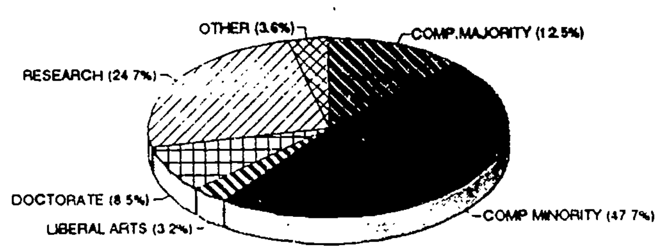


FIGURE 42

BACCALAUREATES IN MATH& NATURAL SCIENCE
HISPANIC GRADUATES BY SECTOR



MEDICAL SCHOOL MATRICULATION

Two studies have been published regarding baccalaureate origins of medical school entrants (Tidball, 1985; Lewis, 1983). Lewis found that, while medical school entrants come from all types of undergraduate institutions, the private Liberal Arts I colleges and the private Research Universities[14] had the highest proportions of their graduates going on to medical school. Tidball made comparisons between "universities" with and without medical schools, and "colleges." She found that the private universities with medical schools had the highest rates of medical school entrants among their graduates, while the women's colleges had the highest rates for women.

LITERACY AND K-12 TEACHER PREPARATION

There are no national data by institution on measures of scientific literacy or current sources of K-12 mathematics and science teachers (Johnston, 1989). However, these are areas in which the liberal arts college context can be expected to provide examples of effective programs. Since the liberal arts colleges provide science education for non-science majors, and a broad education in the humanities for science majors, they are particularly successful in providing well-educated scientists as well as scientifically literate graduates who go on to other types of careers. They provide an education which has breadth and depth as well as an appreciation for the societal context of science. Their science graduates are valued in industry for their ability to read and write competently and for their ability to think critically (OTA, 1985).

A major focus of concern for improving the state of mathematics and science education has been the undergraduate preparation of the pre-collegiate teachers. Much of the discussion has centered on raising standards for teacher training. It is important to focus on their education as well. Research has shown that teachers tend to teach as they were taught. The liberal arts colleges, with their emphasis on quality teaching, provide future teachers with a broad-based education, as well as a model for emulation. Since secondary science teachers typically teach in more than one discipline, as well as in non-science fields, it is critical that they receive a broad-based undergraduate science education, rather than a highly-specialized training course (Aldridge, 1987). In an era when the consensus is developing that secondary teachers must have a major in the field they are to teach, rather than in education, it could be instructive to look at the colleges where that has been the norm (Johnston, 1989).

NATURAL SCIENCE PH.D. PRODUCTIVITY

The baccalaureate origins of the 1970-82 graduates who subsequently (by 1986) received doctorates in the natural sciences were analyzed by baccalaureate institution.[15]

The rate of productivity is expressed as the proportion of all the 1970-1982 baccalaureate recipients of each institution who subsequently earned a doctorate in the natural sciences. This makes it possible to compare the productivity of institutions of very different sizes. The productivity rate for each undergraduate institution was computed for the doctorates earned by all of its graduates and also was computed for the doctorates earned by its women graduates.

The absolute number of doctorates earned by the graduates of an institution is important information only for considerations of such issues as the state of the pipeline. However, in order to make comparisons between institutions of very different sizes and missions, it is necessary to take institutional characteristics into account. For example, the 1970-82 graduates of the public Comprehensive I Universities earned 8,100 doctorates compared to the 8,900 doctorates earned by the 1970-82 graduates of the private Research I Universities (Table 48). But the

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[14]Lewis used the 1976 Carnegie Foundation Classification.

[15]The data on baccalaureate sources of doctorates were collected by the National Research Council through the Survey of Earned Doctorates. The natural science fields include: the physical sciences, mathematics, computer science, and the biological and the agricultural sciences. For additional information about these analyses and for data for other doctoral fields see Fuller (1989).

undergraduate enrollment at the public Comprehensive I Universities is more than ten times greater than at the private Research I Universities (Table 14). Clearly, while the absolute numbers are not enormously different between these two groups, their rates of doctoral productivity are vastly different.

As noted in regard to the distribution of baccalaureate degrees in mathematics and science, the distribution across baccalaureate institutions in the number of doctorates earned by each institution's graduates is not completely predictable by institutional size. This is especially true for the distribution of doctorates earned by women. Several of the colleges and universities with smaller undergraduate enrollments are included among the institutions with the largest absolute numbers of their graduates who had earned a doctorate in the natural sciences: for example, Harvey Mudd College, Reed College, Pomona College, Oberlin College, Carleton College, Bucknell University, Smith College, Mount Holyoke College, Wellesley College, Middlebury College, Saint Olaf College, Goucher College, Barnard College, Vassar College, Bryn Mawr College, Swarthmore College, Occidental College, and Grinnell College. Several universities with smaller undergraduate enrollments also had large numbers of their graduates who earned doctorates: for example, Carnegie Mellon University, Case Western Reserve University, Emory University, Tufts University, Rice University, Johns Hopkins University, Princeton University, Stanford University, the University of Rochester, the University of Chicago, Brandeis University, Dartmouth College, California Institute of Technology, Massachusetts Institute of Technology, and Rensselaer Polytechnic Institute.

While average values provide a useful snapshot of the central tendency of a group of institutions, they do not necessarily indicate what is the case for the typical institution, or the extreme instances. It is clear that, for each category, there are some most unusual cases. Inspection of the variation in numbers and proportions of degrees granted in these fields, indicates that the "typical" institution has a moderate or low number of Ph.D.'s earned by its graduates in the natural sciences, and this number represents a moderate or low proportion of their baccalaureates. There are a few institutions at the extremes. Plotting the number of doctorates earned by the graduates of each institution against the proportion of that institution's graduates who earned doctorates in these fields reveals the number of colleges and universities that deviate from the norm on either or both criteria. (Figures 43-44; A few institutions have been identified on the graphs to give some perspective--others can be identified through Tables 52-55.)

The institutions that were among the top 15% of all institutions both for the absolute number and for the proportion of their graduates receiving doctoral degrees in these fields are identified in Table 50 (all graduates) and in Table 51 (women's degrees).

Table 48 summarizes the data for the Ph.D.'s earned in life science and in mathematics and physical science by the 1970-82 graduates. The data are presented by field and by the 1987 Carnegie Classification. The data for mathematics and physical science and for life science were added to obtain the total for "Natural Science." Table 49 summarizes the data for the doctorates earned by the 1970-82 women graduates.

figures 43-45b

FIGURE 43

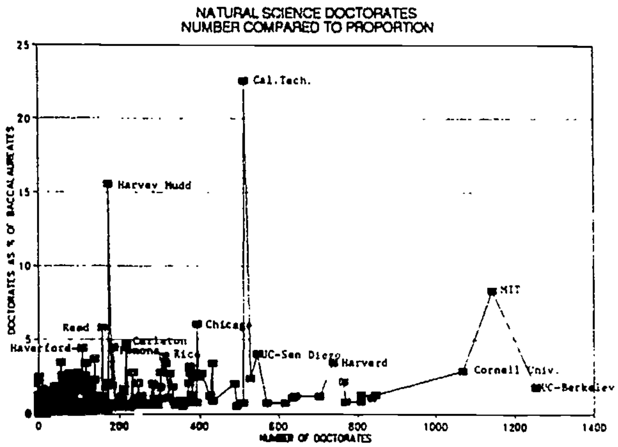


FIGURE 44

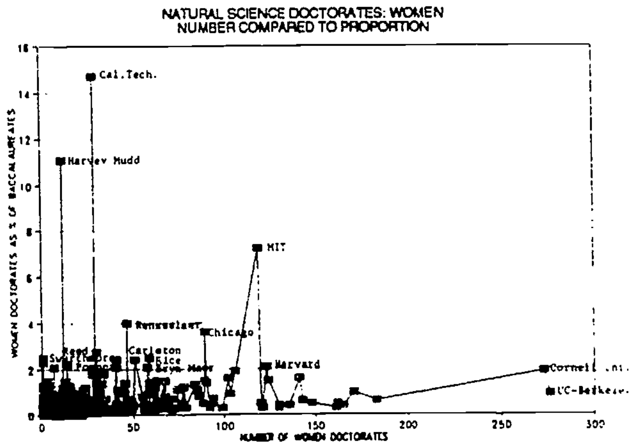


FIGURE 45

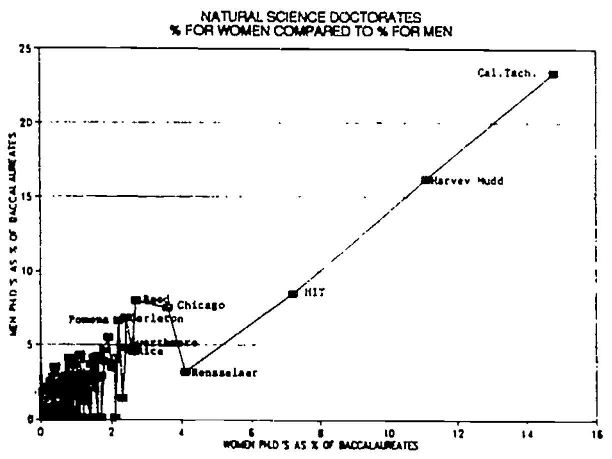
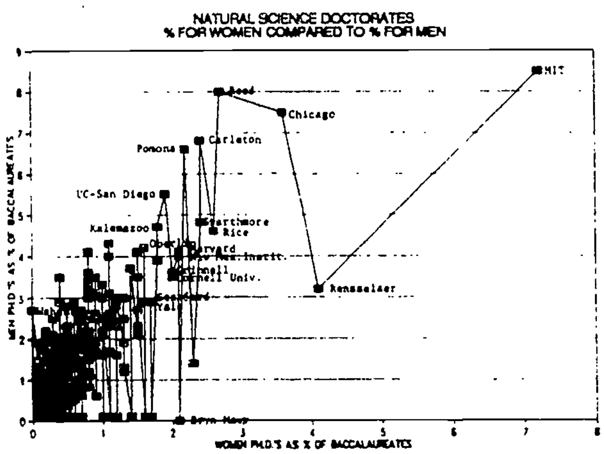


FIGURE 45b



Tables 48 and 49 reveal the consistent differences in productivity between the private and the public institutions, and among the Carnegie categories within the private and the public sectors. For all graduates, and for women graduates analyzed separately, the private institutions were approximately twice as productive as the public institutions for mathematics and physical science. The difference was less for the life sciences.

The private Research I Universities and Liberal Arts I Colleges were the most productive categories for the natural sciences total. The private Engineering schools ranked second for mathematics and physical science. The pattern was similar for the Ph.D.'s earned by women graduates, although the numbers are very small for some categories, especially in mathematics and physical science.

While the average rates are much higher for the Liberal Arts Colleges and the Research Universities, it is important to note that the most productive institutions include representatives from the other categories as well (Tables 52-53). Also, there is great diversity in productivity within the Liberal Arts and Research sectors. The "box and whisker" graphs (figures 46-48) depict the variations in productivity between and within sectors. While the extreme cases among the Research Universities (namely the California Institute of Technology and the Massachusetts Institute of Technology) are quite extreme, the majority of the Research Universities and the Liberal Arts Colleges are comparable. The greater range of levels of productivity among the Liberal Arts Colleges reflects, in part, the greater diversity among the colleges in that sector than among the Research Universities.

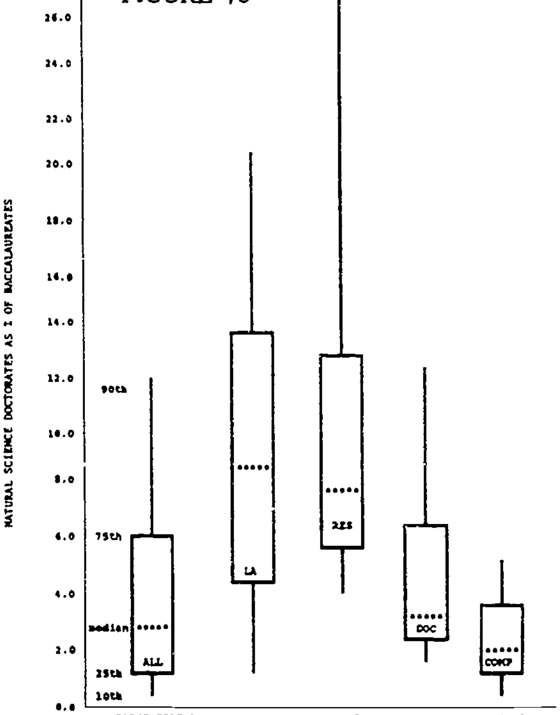
The important role of the Liberal Arts women's colleges as a source of women natural science doctorates is revealed in Table 47. Their very high rate for doctorates compared to the rate for coeducational institutions is in contrast to the data for baccalaureate degrees. This can be interpreted to indicate the significance of the women's colleges in providing women, not only with adequate undergraduate preparation for careers in science, but the confidence and the motivation to persevere in fields that are male-dominated. Sheila Widnall's (1988) description of the graduate school environment for women indicates the need for a great deal of fortitude for women to successfully complete a doctorate in these fields.

Due to the very small numbers in most cases, the data for the natural science doctorates earned by Black and Hispanic graduates are presented only for total numbers. Tables 56-57 list the baccalaureate sources of doctorates earned in the natural sciences by Hispanic and Black 1975-82 men and women graduates from those institutions having at least two Hispanic and/or Black graduates who earned a natural science doctorate. (There were 134 institutions with one Hispanic graduate, and 126 institutions with one Black graduate who received natural science doctorates).

The Ph.D. data depict the predominant contribution of the HBCUs to the production of Black natural scientists. One-third of the natural science doctorates were earned by graduates of HBCUs. The primary feature of the data for the natural science doctorates earned by Hispanics is geographical. While there are institutions on the list from all parts of the country, one-half of the natural science doctorates earned by Hispanics were earned by graduates of institutions in Puerto Rico, Florida, California, and the Southwestern states. This results, in part, from the uneven geographical distribution of the predominantly minority institutions (See Appendix D).

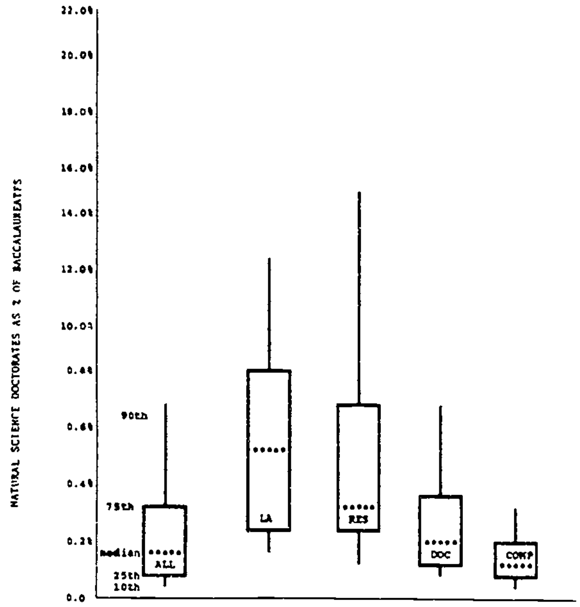
Figures 46-48

FIGURE 46



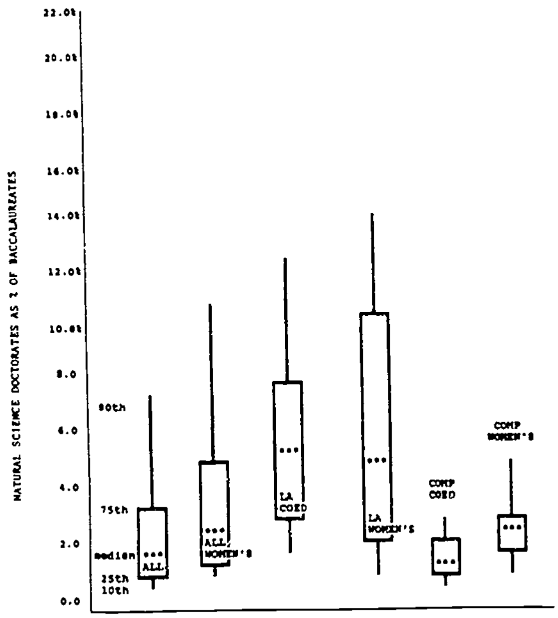
PERCENTILE DISTRIBUTION BY SECTOR OF NATURAL SCIENCE PH.D.'S EARNED BY 1970-82 BACCALAUREATES. PH.D.'S PER 1,000 BACCALAUREATES.

FIGURE 47



PERCENTILE DISTRIBUTION BY SECTOR OF NATURAL SCIENCE PH.D.'S EARNED BY 1970-82 WOMEN BACCALAUREATES. PH.D.'S PER 1,000 BACCALAUREATES.

FIGURE 48



PERCENTILE DISTRIBUTION BY SECTOR OF NATURAL SCIENCE PH.D.'S EARNED BY 1970-82 WOMEN BACCALAUREATES. PH.D.'S PER 1,000 BACCALAUREATES.

Background. The baccalaureate origin of doctorates has been a topic of interest for a long time. The National Research Council has collected data since 1920 on the undergraduate origin of doctorates. The topic has gained urgency from the declining numbers in certain natural science fields earned by U.S. citizens, and the continuing low numbers of doctorates earned by women and minorities (NSF, 1991). U.S. citizens earned 520 doctorates in mathematics in 1980, and 369 in 1990; they earned 3,279 doctorates in biological science in 1980 and 3,104 in 1990. Whites earned 92% of the natural science doctorates in 1990. Those earning 1990 natural science doctorates included 12 Native Americans, 60 Blacks, 169 Hispanics, and 230 Asians. The numbers increased between 1979 and 1989 for Asians and Hispanics. There was a decrease in the number of doctorates earned by Blacks, and the number for Native Americans stayed the same. Women earned 29% of the 1990 natural science doctorates compared to 20% in 1980. The number of doctorates earned by women increased in the fields of chemistry, earth and atmospheric science, computer science, and biological science. The very small number of doctorates earned by women in mathematics and physics increased slightly: from 73 mathematics doctorates to 81; from 45 physics doctorates to 60. The overall declines in mathematics and biological science are due to a drop in the number earned by men.

The higher doctoral productivity rates observed for the liberal arts colleges are consistent with previous research. The high science Ph.D. productivity rate for the liberal arts colleges was first documented by Knapp & Goodrich (1952). They conducted case studies of several liberal arts colleges in their attempt to explain the high productivity rates of these institutions for scientists who earned doctorates between 1924 and 1934. They concluded that the differences in productivity they observed between different types of institutions were due to the size of the institutions and the "degree to which the institution cultivates intellectual as opposed to practical educational objectives," (p. 288). They explained the greater productivity of smaller institutions as due to their "community atmosphere," the exclusive devotion of the faculty to undergraduate teaching, their concentration on basic courses, the more "earnest disposition" of their students, and fewer extracurricular distractions. Knapp and Goodrich concluded that "the importance of the human qualities of the individual teacher stands as a foremost factor influencing the student to the pursuit of science," (p. 296).

In 1985 and 1986, Oberlin College published two reports that documented the exceptionally high productivity of 50 selective liberal arts colleges. Maxfield (1988) computed Ph.D. productivity for science Ph.D.'s earned by 1950-1976 baccalaureate recipients. One-half of the 100 most productive institutions were liberal arts colleges. Echoes of the Knapp and Goodrich conclusions are heard in Educating Scientists and Engineers: Grade School to Grad School (OTA, 1988) in the authors' conclusions that the high productivity of these colleges was due to particular features of the institutional environment: considerable personal attention and support, early research experience, emphasis on teaching, and small student-faculty ratios.

Four studies have analyzed the baccalaureate origins of recent Ph.D.'s. These studies have consistently reported differences in productivity rates among types of institutions, with different patterns for men and for women and for each of the racial/ethnic groups. Tidball (1986) investigated the productivity of 288 institutions for doctorates earned in the natural sciences by men and by women who graduated between 1970-1979. She reported that "private liberal arts colleges continue to be a predominant undergraduate source of natural science doctorates for both men and women," (p. 618), and that the most productive institutions for women were the women's colleges.

Coyle (NRC, 1986) computed the institutional productivity for doctorates earned in 1984 based on the number of baccalaureates granted by each institution in 1974. She compared public and private institutions and groups based on the 1976 Carnegie Classification, and identified the leading institutions for women and for Asians, Blacks, and Hispanics. Unfortunately, Coyle combined data for all of the "Liberal Arts" categories, so the high productivity rate for the Liberal Arts I colleges was obscured. Coyle also identified the leading 30 institutions in Ph.D. productivity, which included 17 liberal arts colleges. It would be erroneous to conclude that these 17 are the only highly productive liberal arts colleges. This apparently was the basis for the conclusion in the 1987 Science and Engineering Indicators: "A small group of selective small universities and colleges produces relatively large percentages of their baccalaureates who go on to obtain S/E Ph.D.'s," (p. 47). The only reason there were only "a few" liberal arts colleges cited was because it was a short list.

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Fuller (1989b) computed productivity rates for the 1970-1986 doctorates earned in the humanities, education, engineering, life science, social science, and mathematics and physical science by 1970-82 baccalaureate recipients. The data were analyzed for all students and separately for women. Fuller (1989a) computed productivity rates for men and for women for each of four racial/ethnic groups: Asians, Blacks, Hispanics, and Whites.

A continuing question about the results of these studies is the extent to which productivity rates reflect institutional effects and the extent to which they are due to differences in the entering characteristics of the students who attend particular types of institutions (Astin, 1962; Pascarella & Terenzini, 1991). The question has not been answered.

We do know that those institutions that have high rates for baccalaureate degrees in mathematics and science are attracting capable students and, at the very least, are not discouraging them from pursuing majors in these fields. Those colleges and universities that have high doctoral productivity rates are giving their studen[illegible] [illegible]equate preparation and encouraging them to pursue advanced degrees. In addition, there is evidence of institutional effects in the follow-up surveys conducted by the Cooperative Institutional Research Program. In 1990 a follow-up survey was conducted of students who had participated in the CIRP Freshmen Survey in 1986. Comparisons were made among four institutional types: private and public "universities" (doctoral level), and private and public four-year "colleges" (undergraduate). For men students at the private four-year colleges there was an increase during those four years in the proportion of the students who aspired to the Ph.D. degree, while there was a decline in this aspiration by men at the universities and the public colleges. Among women students, there was an increase in the proportion aspiring to the Ph.D. degree at the universities and the private colleges, with a decline at the public colleges. The greatest increase was observed for the private colleges.

Interest in careers related to Ph.D. attainment also changed during the four years. For men and for women there was an increase in the proportion of students indicating an interest in college teaching at the universities and at the private colleges. The proportion indicating "research scientist" as a probable career increased for women at the private colleges, while declining at the universities and the public colleges. Among men, the proportion indicating "research scientist" as a probable career increased at the private and public colleges and declined at the universities.

BACCALAUREATE ORIGINS OF NATURAL SCIENCE FACULTY

Little is known about the baccalaureate origins of college faculty. While the information has been collected in several surveys, usually it has not been analyzed. An NSF Advisory Council report (NSF, 1981) listed the baccalaureate institutions for chemistry faculty in 1977 at the "leading" 45 research universities. Spencer and Yoder (1982) reported that a disproportionate number of the chemistry graduate faculty received their baccalaureate degrees from predominantly undergraduate institutions.

Data were obtained for Project Kaleidoscope from a recent survey of a sample of higher education faculty conducted by the U.S. Department of Education (NCES, 1990c) which included the baccalaureate institution for each respondent. An analysis of those data was conducted to investigate the undergraduate background of the faculty included in the sample. The data have not been weighted to form nationally representative figures--they only describe the sample.

The faculty sample was obtained from a stratified random sample of 480 institutions, selected by size and Carnegie type. There were 5,480 full-time faculty in the sample whose undergraduate institution could be identified. Of these, 531 were employed in a natural science field.

Perhaps the most striking observation in these data is the large number of institutions listed as the baccalaureate origin of the faculty. There were 316 baccalaureate institutions listed for the 531 natural science faculty (there were 1,119 baccalaureate institutions listed for 5,480 faculty in any field). The Massachusetts Institute of Technology occurred most frequently, being listed as the baccalaureate source of 13 of the natural science faculty. The University of California at Berkeley and the University of Kansas each was the baccalaureate institution for 8 natural science faculty. The predominantly undergraduate institutions with the largest number of natural science faculty listing them as their undergraduate institution were Brooklyn College (CUNY) and Calvin College--each listed 6 times.

In comparing types of institutions in these data, the greatest limitation is the change in institutions over time. There is no readily identifiable base for evaluating these numbers by controlling for size, since the baccalaureate years of the faculty include an extensive range, going back at least to 1950 (the average age of the faculty has been estimated to be 47, with one quarter more than 55 years old). Since 1950 many institutional changes have occurred in program as well as in size. In the 1987 edition of the Carnegie Classification, "upward drift" was noted in the increase in the number of universities classified as Research and Other Doctorate-Granting, and in the number of Liberal Arts II Colleges shifting to the Comprehensive category. Between 1976 and 1989, the number of institutions classified as Comprehensive increased from 456 to 5[illegible], while the number classified as Liberal Arts II declined from 575 to 430.

One-half of the natural science faculty in the sample received their baccalaureate degree from an institution currently classified as primarily undergraduate (Comprehensive or Liberal Arts), and one-half from a doctoral level institution (Research or Other Doctorate-Granting).

The distribution of baccalaureate institutions across sectors as origins for faculty is parallel to the distribution for doctorates earned by the 1970-82 graduates. The two sectors with the largest undergraduate enrollments, the Research Universities and the Comprehensive I Universities were the baccalaureate institution of 41% and 23%, respectively, of the full-time natural science faculty in this sample. The Liberal Arts I and Liberal Arts II Colleges were the baccalaureate institutions of 15% of this sample, the Liberal Arts II* Colleges and the Comprehensive II Universities accounted for 10%, and the Other Doctorate-Granting Universities accounted for 11%.

There are two bases for suggesting that, while the contribution of liberal arts colleges to today's faculty is significant in these data, their contribution is not fully counted. First, the 480 institutions in the survey sample included 40 colleges classified as Liberal Arts I, II or II*. Of the total 6,627 faculty respondents, 755 were employed at an institution classified as Liberal Arts I, II, or II*. Splete, Austin, and Rice (1987) observed that the majority (56%) of the liberal arts faculty they surveyed were graduates of liberal arts colleges. Thus, the contribution of the liberal arts colleges to the faculty sample is limited by the small representation in the sample of faculty employed at liberal arts colleges. Second, a potentially large number of the faculty are graduates of institutions that were liberal arts colleges during the period of their undergraduate experience, but that are no longer in that classification.

FURTHER QUESTIONS

Knowing which institutions are more productive of mathematics or natural scientists provides a base from which to pose further questions, including:

- Which institutions are recruiting as well as retaining students in these fields?
- What kinds of assessment tools do we need to measure achievement?
- What are the essential features of the most effective programs? What is necessary to recruit and retain students from underrepresented groups?
- How can the central principals of effective practices be adapted to the diverse set of institutions?
- What resources are necessary to create and sustain effective undergraduate mathematics and science programs?
- How can these resources be developed and distributed?
- What policies at the federal and state levels promote and support the programs that work?
- What information does an individual institution need to evaluate its programs?

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APPENDIX A
INSTITUTIONAL CLASSIFICATIONS

1987 CARNEGIE FOUNDATION CLASSIFICATION CATEGORIES

All of the categories are further divided into Public and Private.

TWO-YEAR (1,367 institutions)

SPECIALIZED (642 institutions):
Grant at least 50% of degrees in a single field.

RESEARCH AND OTHER DOCTORATE-GRANTING (213 institutions):
Full range of baccalaureate programs and graduate education through doctorate.

RESEARCH UNIVERSITIES:
High priority to research and award at least 50 Ph.D.'s per year.

RESEARCH I (70 institutions):
Receive at least $33.5 million per year in federal support.

RESEARCH II (34 institutions):
Receive $12.5 to $33.5 million per year in federal support.

OTHER DOCTORATE-GRANTING UNIVERSITIES

DOCTORATE-GRANTING I (51 institutions):
Award at least 40 Ph.D.'s in 5 or more academic disciplines.

DOCTORATE-GRANTING II (58 institutions):
Award at least 20 or more Ph.D.'s in at least one discipline or 10 or more Ph.D.'s in 3 or more disciplines.

COMPREHENSIVE (595 institutions):
Full range of baccalaureate programs and graduate education through masters and more than 50% of baccalaureates in 2 or more occupational or professional fields.

COMPREHENSIVE I (424 institutions):
Enroll at least 2,500 students.

COMPREHENSIVE II (171 institutions):
Enroll 1,500-2,500 students.

LIBERAL ARTS (572 institutions):
Award more than half of baccalaureate degrees in arts and sciences fields.

LIBERAL ARTS I (142 institutions) and LIBERAL ARTS II (115 institutions) are distinguished by selectivity.

LIBERAL ARTS II* (315) have the same criteria as Comprehensive but enroll fewer than 1,500 students.[1]

[1] In this report when data are summed for all Comprehensives the Liberal Arts II* colleges are included.

PREDOMINANTLY MINORITY INSTITUTIONS[2]

Compiled with information from Quality Education for Minorities Project

Alabama A&M U.	HBCU
Alabama State U.	HBCU
Albany State C. GA	HBCU
Alcorn State U. MS	HBCU
Allen U. SC	HBCU
Antillian C. PR	
Arkansas Baptist C.	HBCU
Barber-Scotia C. NC	HBCU
Barry U. Fl	
Bayamon Central U. PR	
Benedict C. SC	HBCU
Bennett C. NC	(women's) HBCU
Bethune-Cookman C. FL	HBCU
Bluefield State C. WV	HBCU
Boricua C. NY	
Bowie State U. MD	HBCU
C. of New Rochelle NY	
C. of Santa Fe NM	
California State U. Los Angeles	
California State U. Dominguez Hills	
Caribbean U. PR	
Caribbean Center for Advanced Studies PR	
Catholic U. of PR	
Central State U. OH	HBCU
Cheyney U. PA	HBCU
Chicago State U.	
Claflin C. SC	HBCU
Clark-Atlanta GA	HBCU
Coppin State C. MD	HBCU
Corpus Christi State U.	
CUNY Lehman C.	
CUNY Medgar Evers C.	
CUNY City C.	
CUNY York C.	
Delaware State C.	HBCU
Dillard U. LA	HBCU
Edward Waters C. FL	HBCU
Elizabeth City State U. NC	HBCU
Fayetteville State U. NC	HBCU
Fisk U. TN	HBCU
Florida International U.	
Florida A&M U.	HBCU
Florida Memorial C.	HBCU
Fort Valley State C. GA	HBCU
Grambling State U. LA	HBCU
Hampton U. VA	HBCU
Harris-Stowe State C. MO	
Howard U. DC	HBCU
Huston-Tillotson C. TX	HBCU
Incarnate Word C. TX	
Inter-American U. PR	
Jackson State U. MS	HBCU
Jarvis Christian C. TX	HBCU
Johnson C. Smith U. NC	HBCU
Jordan C. MI	
Kentucky State U.	HBCU
Knoxville C. TN	HBCU
Lane C. TN	HBCU
Langston U. OK	HBCU
Laredo State U. TX	
LeMoyne-Owen C. TN	HBCU
Limestone C. SC	
Lincoln U. MO	HBCU
Lincoln U. PA	HBCU
Livingstone C. NC	HBCU
Loyola U. of Chicago	
Marygrove C. MI	
Mercy C. NY	
Metropolitan U. PR	
Miles C. AL	HBCU
Mississippi Valley State U.	HBCU
Morehouse C. GA	HBCU
Morgan State U. MD	HBCU
Morris Brown C. GA	HBCU
Morris C. SC	HBCU
Mount Saint Mary's CA	
NAES C. IL	
New Mexico Highlands U.	
Norfolk State U. VA	HBCU
North Carolina A&T State U.	HBCU
North Carolina Central U.	HBCU
Northern Arizona U.	
Oakwood C. AL	HBCU
Our Lady of the Lake U. TX	
Paine C. GA	HBCU
Pan American U., U. of Texas	
Patten C. CA	
Paul Quinn C. TX	HBCU
Philander Smith C. AR	HBCU
Prairie View A&M TX	HBCU
Rust C. MS	HBCU
Saint Augustine's C. NC	HBCU
Saint Mary's TX	
Saint Paul's C. VA	HBCU

2 This list does not include two-year institutions.

Saint Thomas U. FL	
Savannah State C. GA	HBCU
Selma U. AL	HBCU
Shaw U. NC	HBCU
Sheldon Jackson C. AK	
Sojourner-Douglass C. MD	
South Carolina State C.	HBCU
Southeastern U. DC	
Southern U. Baton Rouge	HBCU
Southern U. New Orleans	HBCU
Southern U. Shreveport	HBCU
Spelman C. GA	(women's) HBCU
Stillman C. AL	HBCU
Sul Ross State U. TX	
Talladega C. AL	HBCU
Tennessee State U.	HBCU
Texas A&I U.	
Texas C.	HBCU
Texas Southern U.	HBCU
Tougaloo C. MS	HBCU
Turabo U. PR	
Tuskegee U. AL	HBCU
U. Arkansas Pine Bluff	HBCU
U. District of Columbia	HBCU
U. Guam	
U. Maryland Eastern Shore	HBCU
U. Missouri Saint Louis	
U. PR Humacao	
U. PR Mayaguez	
U. PR Cayey	
U. PR Rio Piedras	
U. Sacred Heart PR	
U. Texas El Paso	
U. Texas San Antonio	
U. of the Virgin Islands	
Virginia State U.	HBCU
Virginia Union U.	HBCU
Voorhees C. SC	HBCU
West Coast Christian CA	
West Virginia State C.	HBCU
Western New Mexico	
Wilberforce U. OH	HBCU
Wiley C. TX	HBCU
Winston-Salem State U. NC	HBCU
Xavier U. LA	HBCU

APPENDIX B

SOME LIMITATIONS OF THE DATA
(Are These Numbers Worth Crunching?)

1. INCOMPLETE COUNT. Colleges and universities have more mathematics and science majors than are being reported in the IPEDS data of the National Center for Education Statistics (NCES). The number is under-counted due to double (or triple) majors, interdisciplinary programs, student-designed majors, and, in some reports, omission of groups of institutions.

There is no way to estimate how many mathematics or science majors are not reported, although the data collected by the American Institute of Physics (1989) provide a potential indicator of the under-count for one field: for 1988 the AIP reported 5,152 baccalaureate degrees in physics compared to 4,097 reported by NCES (1990, page 242). Comparing the data from NCES (NSF, 1991) and AIP (1989) for each of the years between 1979 and 1988 indicates a consistent difference between their reports of 929 to 1,078 baccalaureate degrees in physics. This discrepancy represents one-fifth of the degrees in this field. Where are these degrees in the IPEDS data?

(a) When students complete more than one major, only one major is reported to NCES. The colleges are not asked even to report the number of double majors, and there is no rule provided to the colleges for deciding which major to report. A survey by the Independent Colleges Office (ICO) of 21 colleges has revealed approximately 100 mathematics and natural science graduates in 1988-89 who were not reported as having received degrees in mathematics and science fields. There is no way of projecting this nationally since institutions vary tremendously in the number of double majors they have, but there clearly is a significant under-count. (20 of the colleges reported having double or triple majors--ranging from 5% to 46% of their graduates were completing at least two majors. They used a variety of schemes for deciding which major to report, ranging from the first major declared, to the field with the greater number of credits, to random choice.)

(b) Many new programs and interdisciplinary majors are lumped into the catch-all categories of "interdisciplinary" or "other." Thus we find several institutions, such as The College of the Atlantic, Evergreen State College, St. John's College (NM and MD), and Sarah Lawrence College listed as awarding no science baccalaureate degrees. It is hoped that the new Classification of Instructional Programs, published by the NCES, will take care of these problems, but future data will need to be reviewed to determine whether there are science degrees still not being appropriately coded.

2. INCONSISTENCIES IN REPORTING. Some reports include Puerto Rico, others do not, usually with no indication. Given the tremendous impact the Puerto Rico data have on Hispanic totals, this is an essential piece of information. Sometimes national data include the U.S. Service Academies, but, depending on the source, they may not be included. Given the significant role of these institutions in granting physical science degrees, their inclusion or exclusion can have a great impact on data analysis.

3. INCONSISTENCIES IN FIELD NAMES. Using the designations employed by the various agencies tasked with reporting science data leaves the reader not comparing apples with oranges, but comparing apples or oranges with fruit salad. The various agencies need to be consistent. The term "life science" is used by the Department of Education to refer only to the biological sciences, and by NSF and the National Academy of Sciences to include biological, agricultural, and health sciences. The Department of Education includes physics, astronomy, chemistry, and geology in the physical sciences. The National Academy of Sciences includes these fields plus mathematics and computer science in the physical sciences, while NSF places the geological sciences with the atmospheric and oceanographic sciences in a separate category called "environmental science." In NCES terminology, however, environmental science refers to a set of interdisciplinary programs.

As a result of these inconsistencies, the 1989 Science and Engineering Indicators reports 108,285 baccalaureate degrees in life science, and 15,786 baccalaureate degrees in physical science in 1986, while the 1989 Digest of

Education Statistics reported 38,114 baccalaureate degrees in life science, and 19,885 degrees in physical science in the same year. Someone trying to assemble information from several sources could be seriously misled by these inconsistencies.

4. INCONSISTENCIES IN INSTITUTIONAL CLASSIFICATION. It is not unusual to find reports citing data for "universities" and "colleges" with no specification for how institutions are grouped. Even the seemingly obvious term "four-year" is ambiguous: sometimes it means "other than two-year;" in other cases it is used to mean a baccalaureate-level program, i.e., "not more than four-years."

There is no adequate classification system for all purposes, although the Carnegie Foundation classification is widely used. There is a particular problem in the Carnegie classification in the categories of Liberal Arts and Comprehensive. Most of the members of the Liberal Arts I and II categories are generally considered to be appropriately classified (although there are several that appear to belong in specialized categories--most of these are bible colleges or business schools). On the other hand, there are institutions in the Comprehensive and the specialized categories that could appropriately be included in one of the Liberal Arts categories. The Liberal Arts and Comprehensive categories were primarily differentiated on the basis of the distribution across fields of the baccalaureate degrees that they grant (see Appendix A). This criterion excludes some institutions that otherwise would be considered to be liberal arts colleges, such as Harvey Mudd College (Engineering), a member of the Claremont Colleges, and Rollins College (Comprehensive). Currently the Comprehensive category, as indicated by its size, serves as a "miscellaneous" category (Wong, 1990).

There is a particular problem with the label given to the "Liberal Arts II*" category--especially since the asterisk is not usually noted. Some of these colleges are appropriately labelled as liberal arts colleges. However, the category is defined as institutions that meet the criteria for Comprehensive, but are considered to be too small to be included with the others in that group. **Just as subject-matter coverage does not define the liberal arts college, neither does size.** Size and subject-matter coverage are relevant but not sufficient (see Appleton & Wong, 1990; Jacobson, 1990; and Kean, 1990).

The label presents a problem--since the Liberal Arts II* Colleges are specified only by an asterisk, it is common for them to be grouped with the Liberal Arts I and II Colleges for the general category "Liberal Arts." This practice is not appropriate. The Liberal Arts II* category should have been labelled "Comprehensive II*," thus preventing this common misunderstanding.

5. MISSING AND INCORRECT DATA. This is a problem especially for racial/ethnic reports. The numbers for certain racial and ethnic groups are so very small that even small errors can produce major distortions. Examples:

a) ERRORS. In the 1984 IPEDS data, the Hispanic graduates of the University of Puerto Rico were classified as "other." The omission of these graduates in the Hispanic data for that year suggest that there was a significant drop in the number of Hispanic graduates when there was, in fact, an increase. It is not unusual for data for Radcliffe College to be counted twice--once for the college and again for Harvard University. In the 1989 IPEDS data, the numbers of Native American graduates in the biological sciences was inflated by 50% (47 out of 145 graduates were erroneously counted) due to errors in classifying students from two colleges--neither of which had any Native American graduates that year (or in previous years).

b) INCOMPLETE DATA. The Office of Civil Rights at the Department of Education provides data only as reported. Missing data can lead to serious distortions as well as inconsistencies. In 1989, for example, there were no racial/ethnic data for most of the colleges in the City University of New York system, the University of Wisconsin system, and the entire state of South Carolina. The National Center for Education Statistics imputes values using data from previous years to fill in the missing data. Since the small numbers for certain groups in particular fields can shift significantly from year to year, this introduces some unknown degree of error and results in different values between OCR and NCES. (The imputation system does not work perfectly--Morehouse College is listed as granting no biological science degrees for 1989, although they were listed as having granted 21 degrees in this field in the previous year.)

6. MORE DETAIL IS NEEDED IN THE MINORITY DATA. More categories are needed in the racial classifications, as well as in the field classifications. The professional societies can make a real contribution by their efforts to collect data by race and gender. For example, there appears to be improvement in the status of Black women in the physical sciences. Is this occurring in chemistry, physics, or some combination of fields? In addition, it is critical that the Hispanic data be disaggregated. For example, in many surveys the category "Hispanic" overlaps the categories "White" and "Black," but in the Department of Education classification, these are three distinct categories. Agencies need to consider how disaggregated data can be collected so that it would be possible to make comparisons.

7. DATA NEEDS TO BE PRESENTED SEPARATELY AND CLEARLY FOR EACH INSTITUTION. The National Science Foundation's CASPAR database is a valuable resource, integrating a great deal of data from several government sources. An unnecessary difficulty in its use has been created by the merging of data for the branches and main campuses for several universities. Unfortunately, in many instances the merger is not indicated, even for institutions whose branches have had separate identification for many years, such as the University of Michigan, the University of Minnesota, and Rutgers University. This merging results in missing data for each of the branches and makes sector analyses very difficult in any case, and impossible for many items. Identification of specific institutions is made unnecessarily difficult by the lack of consistent identification of the state in the name. Absolutely identical names are specified by inclusion of the state code, but many others, while not identical, are too close to make identification simple, e.g., Metropolitan State College (CO) and Metropolitan State University (MN), or Bluefield College (VA) and Bluefield State College (WV).

8. SOME SURVEYS COULD HAVE BEEN MORE USEFUL, for example:

a) all those that asked respondents to indicate their undergraduate institution but never recorded the data or made it available.

b) all those that could have asked for undergraduate origins but did not (such as those by the National Science Teachers Association).

c) the report on the Department of Education survey of faculty: data reported by field and separately by sector. This gives summary data for science and for undergraduate institutions--but not science faculty at undergraduate institutions.

d) the Department of Education recent graduates survey, designed to sample teachers. Unfortunately, "teachers" were defined as those who had completed a bachelor's degree in education--thus ruling out all the liberal arts graduates with degrees in other fields.

e) those with sampling schemes that sample by size in such a way that only large institutions are likely to be included.

TABLE 1
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE, MATHEMATICS, AND PHYSICAL SCIENCE 1976-1989

				PHYSICAL SCIENCE			
	ALL FIELDS	BIOLOGICAL SCIENCE	MATHEMATICS	ALL PHYSICAL SCIENCE	CHEMISTRY	PHYSICS	EARTH SCIENCE
1965-66	524,008	27,010	20,090	17,185	9,735	4,608	1,510
1975-76	934,443	59,012	16,085	21,559	11,107	3,544	4,441
1976-77	928,228	58,273	14,303	22,618	11,322	3,420	4,998
1977-78	930,197	56,111	12,701	23,175	11,474	3,330	5,416
1978-79	931,340	53,454	11,901	23,363	11,643	3,338	5,467
1979-80	940,251	50,496	11,473	23,661	11,446	3,397	5,536
1980-81	946,877	47,920	11,173	24,175	11,540	3,441	6,110
1981-82	964,043	45,806	11,708	24,372	11,316	3,475	6,429
1982-83	980,679	44,067	12,557	23,497	11,039	3,800	6,774
1983-84	986,345	42,310	13,342	23,759	10,912	3,921	7,285
1984-85	990,880	41,933	15,267	23,847	10,701	4,111	7,001
1985-86	1,000,352	41,725	16,388	21,862	10,317	4,189	5,555
1986-87	1,003,532	41,133	16,515	20,155	9,830	4,324	4,189
1987-88	1,006,033	39,949	15,981	17,817	9,158	4,103	3,061
1988-89	1,030,171	39,053	15,314	17,329	8,822	4,347	2,707

TABLE 2
BACCALAUREATE DEGREES EARNED BY MEN IN BIOLOGICAL SCIENCE, MATHEMATICS, AND PHYSICAL SCIENCE 1976-1989

	ALL FIELDS	BIOLOGICAL SCIENCE	MATHEMATICS	PHYSICAL SCIENCE: ALL PHYSICAL SCIENCE	PHYSICAL SCIENCE: CHEMISTRY	PHYSICAL SCIENCE: PHYSICS	PHYSICAL SCIENCE: EARTH SCIENCE
1965-66	301,037	19,390	13,401	14,852	7,934	4,384	1,353
1975-76	508,549	38,714	9,531	17,420	8,610	3,156	3,568
1976-77	499,121	37,325	8,354	18,067	8,720	3,062	3,896
1977-78	491,066	34,574	7,455	18,188	8,593	2,961	4,185
1978-79	481,394	31,997	6,943	18,076	8,530	2,939	4,153
1979-80	477,750	29,405	6,625	18,010	8,169	2,963	4,170
1980-81	474,336	26,898	6,392	18,195	8,065	3,009	4,550
1981-82	477,543	25,141	6,650	18,033	7,703	3,014	4,731
1982-83	483,395	23,962	7,059	17,036	7,303	3,317	5,007
1983-84	486,750	22,653	7,428	17,168	7,087	3,361	5,477
1984-85	486,662	21,922	8,231	17,149	6,807	3,550	5,244
1985-86	490,306	21,702	8,772	15,812	6,573	3,578	4,292
1986-87	485,003	21,215	8,833	14,422	6,156	3,629	3,218
1987-88	481,236	19,911	8,569	12,384	5,506	3,492	2,298
1988-89	487,566	19,452	8,264	12,157	5,391	3,705	1,995

TABLE 3
BACCALAUREATE DEGREES EARNED BY WOMEN IN BIOLOGICAL SCIENCE, MATHEMATICS, AND PHYSICAL SCIENCE 1976-1989

	ALL FIELDS	BIOLOGICAL SCIENCE	MATHEMATICS	PHYSICAL SCIENCE: ALL PHYSICAL SCIENCE	PHYSICAL SCIENCE: CHEMISTRY	PHYSICAL SCIENCE: PHYSICS	PHYSICAL SCIENCE: EARTH SCIENCE
1965-66	222,971	7,620	6,689	2,333	1,801	224	157
1975-76	425,894	20,298	6,554	4,139	2,497	388	873
1976-77	429,107	20,948	5,949	4,551	2,602	358	1,102
1977-78	439,131	21,537	5,246	4,987	2,881	369	1,231
1978-79	449,946	21,457	4,958	5,287	3,113	399	1,314
1979-80	462,501	21,091	4,848	5,651	3,277	434	1,366
1980-81	472,541	21,022	4,781	5,980	3,475	432	1,560
1981-82	486,500	20,665	5,058	6,339	3,613	461	1,698
1982-83	497,284	20,105	5,498	6,461	3,[illegible]36	483	1,767
1983-84	499,595	19,657	5,914	6,591	3,825	560	1,808
1984-85	504,218	20,011	7,036	6,698	3,894	561	1,757
1985-86	510,046	20,023	7,616	6,050	3,744	611	1,263
1986-87	518,529	19,918	7,682	5,733	3,674	695	971
1987-88	524,797	20,038	7,412	5,433	3,652	611	763
1988-89	542,605	19,601	7,050	5,172	3,431	642	712

TABLE 4

BIOLOGICAL SCIENCE DEGREES 1977-1989 BY RACE AND GENDER

	BLACK		HISPANIC		WHITE		ASIAN		NATIVE AMERICAN		NON-RESIDENT ALIEN	
	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN
1976-77	1197	1218	896	663	30728	16967	837	479	103	54	697	331
1978-79	1149	1342	950	875	25874	16871	824	640	98	51	567	320
1980-81	954	1316	952	999	21092	16200	830	663	67	70	565	338
1984-85	806	1241	1048	1142	16809	15009	1024	928	89	72	504	411
1986-87	723	1167	1018	1128	15985	14564	1314	1251	77	67	433	429
1988-89	700	1216	965	1125	14377	14027	1442	1465	51	47	426	447

TABLE 5
MATHEMATICS DEGREES 1977-1989 BY RACE AND GENDER

	BLACK		HISPANIC		WHITE		ASIAN		NATIVE AMERICAN		NON-RESIDENT ALIEN	
	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN
1976-77	353	359	183	138	7384	5218	174	142	16	10	236	82
1978-79	320	332	153	135	6024	4205	171	153	28	13	245	120
1980-81	276	309	161	114	5423	4024	223	169	10	8	299	157
1984-85	376	394	206	160	6509	5654	474	411	36	23	476	287
1986-87	399	435	196	125	7050	6215	532	502	32	20	421	234
1988-89	374	418	218	141	6598	5689	527	492	35	14	347	19[illegible]

TABLE 6
PHYSICAL SCIENCE DEGREES 1977-1989 BY RACE AND GENDER

	BLACK		HISPANIC		WHITE		ASIAN		NATIVE AMERICAN		NON-RESIDENT ALIEN	
	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN
1976-77	494	198	363	121	16410	4007	280	97	51	17	461	110
1978-79	436	268	351	144	16356	4602	320	119	45	18	561	134
1980-81	618	293	420	197	16126	5123	413	186	44	21	572	160
1984-85	457	373	442	219	14980	5561	504	259	65	33	580	200
1986-87	433	390	377	208	12139	4514	598	296	45	27	461	174
1988-89	365	332	362	201	10173	4065	626	296	43	15	406	199

TABLE 7
DISTRIBUTION OF BACCALAUREATE DEGREES EARNED BY BLACK GRADUATES IN 1988-89

	MATHEMATICS		BIOLOGICAL SCIENCE		PHYSICAL SCIENCE	
	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS
			74	1		
			51	1		
					44	1
			34	1		
			32	1		
			26	1		
			25		25	1
			24	2		
			23	2		
			22	1		
			20	1		
			19	1		
	18	2				
			17	3	17	2
	16	3				
			15	5	15	1
			14	3	14	1
			13	3		
	12	1	12	1		
	11	1	11	11	11	1
	10	4	10	3	10	3
	9	5	9	8	9	4
	8	6	8	13	8	2
	7	8	7	18	7	6
	6	8	6	16	6	5
	5	9	5	24	5	8
	4	17	4	36	4	7
	3	36	3	40	3	15
	2	48	2	86	2	56
	1	131	1	220	1	175
	0	817	0	699	0	733
TOTAL	792		1,916		697	

TABLE 8

DISTRIBUTION OF BACCALAUREATE DEGREES EARNED BY HISPANIC GRADUATES IN 1988-89

	MATHEMATICS		BIOLOGICAL SCIENCE		PHYSICAL SCIENCE	
	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS
			184	1		
			121	1		
			104	1		
			95	1		
			90	1		
			87	1		
			42	1		
			41	2		
			39	1		
			38	1	38	1
			34	1		
			33	1		
			29	1	29	1
			27	2		
			26	1	26	1
			25	1		
			24	1	24	1
					22	1
			21	2		
			19	1		
	18	1	18	2		
					16	2
			14	3		
	13	1	13	1		
			12	4	12	1
			11	1	11	1
	10	2	10	7	10	1
	9	2	9	6	9	1
	8	3	8	6	8	3
			7	6	7	3
	6	2	6	12	6	4
	5	4	5	9	5	2
	4	7	4	20	4	13
	3	19	3	27	3	20
	2	26	2	58	2	24
	1	91	1	165	1	112
	0	937	0	852	0	829
TOTAL	359		2,090		563	

TABLE 9

DISTRIBUTION OF BACCALAUREATE DEGREES EARNED BY NATIVE AMERICAN GRADUATES IN 1988-89

	MATHEMATICS		BIOLOGICAL SCIENCE		PHYSICAL SCIENCE	
	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS	NUMBER OF DEGREES	NUMBER OF INSTITUTIONS
			5	1		
			4	2	4	1
	3	3	3	5	3	2
	2	7	2	10	2	4
	1	26	1	50	1	40
	0	1060	0	1133	0	974
TOTAL	49		98		58	

TABLE 10
AVERAGE NUMBER BACCALAUREATE DEGREES AWARDED 1987-89
IN BIOLOGICAL AND PHYSICAL SCIENCE AND MATHEMATICS
BY FIELD AND BY CARNEGIE CLASSIFICATION[1]

	ALL FIELDS	BIOL. SCI.	% ALL FLDS	MATH	% ALL FLDS	PHYS. SCI.	% ALL FLDS
LIBERAL ARTS I							
Public	658	29	4.4	13	2.0	15	2.3
Private	42,958	3,338	7.8	1,266	2.9	1,927	4.5
LIBERAL ARTS II							
Public	688	50	7.3	25	3.6	9	1.3
Private	10,376	674	6.5	270	2.6	246	2.4
RESEARCH I							
Public	177,249	9,372	5.3	3,410	1.9	3,583	2.0
Private	36,418	2,460	6.8	842	2.3	1,102	3.0
RESEARCH II							
Public	75,341	2,550	3.4	843	1.1	1,191	1.6
Private	11,247	626	5.6	142	1.3	238	2.1
DOCTORATE I							
Public	62,811	2,212	3.5	843	1.3	1,020	1.6
Private	23,508	965	4.1	341	1.5	348	1.5
DOCTORATE II							
Public	45,028	1,588	3.5	676	1.5	822	1.8
Private	21,856	701	3.2	208	1.0	315	1.4
COMP. I							
Public	274,422	8,362	3.0	4,212	1.5	4,627	1.7
Private	84,418	2,972	3.5	1,012	1.2	1,144	1.4
COMP.II							
Public	11,339	388	3.4	276	2.4	191	1.7
Private	35,592	1,424	4.0	607	1.7	574	1.6
LIBERAL ARTS II*							
Public	2,951	117	4.0	57	1.9	72	2.4
Private	37,641	1,491	4.0	709	1.9	512	1.4

[1]Calculations exclude institutions reported as granting no baccalaureate degrees in these fields (See Appendix B).

	ALL FIELDS	BIOL. SCI.	% ALL FLDS	MATH	% ALL FLDS	PHYS. SCI.	% ALL FLDS
ENGINEER-ING							
Public	· 2,389	23	1.0	26	1.1	54	2.3
Private	4,266	2	---	35	0.8	56	1.3
MILITARY- MARITIME							
Public	3,938	33	0.8	111	2.8	371	9.4

	ALL FIELDS	BIOL. SCIENCE	MATH	PHYSICAL SCIENCE
TOTAL PUBLIC	668,000	24,724	10,488	11,966
TOTAL PRIVATE	345,000	15,321	5,448	6,467
TOTAL	1,013,000	40,045	15,937	18,434

1987 CARNEGIE CLASSIFICATION[2]
NUMBER OF INSTITUTIONS

	PUBLIC	PRIVATE
Liberal Arts I	2	137
Liberal Arts II	4	78
Research I	44	25
Research II	26	8
Doctorate-Granting I	29	18
Doctorate-Granting II	33	23
Comprehensive I	283	133
Comprehensive II	46	121
Liberal Arts II*[3]	19	265
Engineering	7	22
Maritime/Military	11	0

[2]Calculations exclude institutions reported as granting no baccalaureate degrees in these fields (See Appendix B)

[3]The Liberal Arts II* institutions are those that otherwise meet the criteria for Comprehensive (fewer than half their baccalaureate degrees in liberal arts fields) but that enroll fewer than 1,500 students.

TABLE 11
AVERAGE NUMBER BACCALAUREATE DEGREES AWARDED TO WOMEN IN BIOLOGICAL AND PHYSICAL SCIENCE AND MATHEMATICS 1987-89 BY FIELD AND BY CARNEGIE CLASSIFICATION

	ALL FIELDS	BIOL. SCI.	% ALL FLDS	MATH	% ALL FLDS	PHYS. SCI.	% ALL FLDS
LIBERAL ARTS I							
Public	236	8	--	4	--	2	--
Private	24,669	1,853	7.5	665	2.7	656	2.7
LIBERAL ARTS II							
Public	400	25	6.3	11	2.8	2	---
Private	6,348	358	5.6	134	2.1	104	1.6
RESEARCH I							
Public	86,864	4,534	5.2	1,415	1.6	926	1.1
Private	16,677	1,102	6.6	295	1.8	297	1.8
RESEARCH II							
Public	36,194	1,158	3.2	350	1.0	299	0.8
Private	5,362	285	5.3	63	1.2	61	1.1
DOCTORATE I							
Public	33,546	1,028	3.1	405	1.2	297	0.9
Private	11,246	410	3.6	177	1.6	91	0.8
DOCTORATE II							
Public	22,512	781	3.5	312	1.4	240	1.1
Private	10,452	336	3.2	107	1.0	83	0.8
COMP. I							
Public	150,976	4,296	2.8	2,020	1.3	1,346	0.9
Private	45,501	1,533	3.4	531	1.2	416	0.9
COMP.II							
Public	6,540	220	3.4	116	1.8	67	1.0
Private	21,596	778	3.6	357	1.7	256	1.2
LIBERAL ARTS II*							
Public	1,709	63	3.7	29	1.7	21	1.2
Private	22,667	853	3.8	360	1.6	213	0.9

	ALL FIELDS	BIOL. SCI.	% ALL FLDS	MATH	% ALL FLDS	PHYS. SCI.	% ALL FLDS
ENGINEER-ING							
Public	636	15	2.4	11	1.7	16	2.5
Private	545	1	--	4	--	7	1.3
MILITARY	MARITIME						
Public	372	11	3.0	11	3.0	38	10.2

	ALL FIELDS	BIOL. SCIENCE	MATH	PHYSICAL SCIENCE
TOTAL PUBLIC	346,000	12,139	4,682	3,260
TOTAL PRIVATE	182,000	7,713	2,699	2,186
TOTAL	529,000	19,852	7,381	5,446

TABLE 12
AVERAGE NUMBER BACCALAUREATE DEGREES AWARDED
IN CHEMISTRY, PHYSICS AND EARTH SCIENCE 1987-89
BY FIELD AND BY CARNEGIE CLASSIFICATION[4]

	ALL FIELDS	CHEM.	% ALL FLDS	PHYS.	% ALL FLDS	EARTH SCI.	% ALL FLDS
LIBERAL ARTS I							
Public	658	9	1.4	6	---	0	
Private	42,958	1,050	2.4	567	1.3	251	0.6
LIBERAL ARTS II							
Public	688	2	---	0	---	6	---
Private	10,376	157	1.5	57	0.5	16	0.2
RESEARCH I							
Public	177,249	1,689	1.0	890	0.5	691	0.4
Private	36,418	512	1.4	393	1.1	109	0.3
RESEARCH II							
Public	75,341	542	0.7	230	0.3	309	0.4
Private	11,247	116	1.0	93	0.8	31	0.3
DOCTORATE I							
Public	62,811	491	0.8	207	0.3	303	0.5
Private	23,508	182	0.8	104	0.4	43	0.2
DOCTORATE II							
Public	45,028	396	0.9	156	0.3	236	0.5
Private	21,856	144	0.7	72	0.3	58	0.3
COMP. I							
Public	274,422	2,160	0.8	953	0.3	1,111	0.4
Private	84,418	797	0.9	222	0.3	57	0.1
COMP.II							
Public	11,339	116	1.0	26	0.2	29	0.3
Private	35,592	403	1.1	114	0.3	24	0.1
LIBERAL ARTS II*							
Public	2,951	32	1.1	16	0.5	3	---
Private	37,641	402	1.1	63	0.2	20	0.1

[4]Calculations exclude institutions reported as granting no baccalaureate degrees in these fields.

	ALL FIELDS	CHEM.	% ALL FLDS	PHYS.	% ALL FLDS	EARTH SCI.	% ALL FLDS
ENGINEER-ING							
Public	2,389	16	0.7	17	0.7	19	0.8
Private	4,266	21	0.5	28	0.7	0	---
MILITARY- MARITIME							
Public	3,938	29	0.7	44	1.1	0	---

	ALL FIELDS	CHEMISTRY	PHYSICS	EARTH SCIENCE
TOTAL PUBLIC	668,000	5,483	2,545	2,709
TOTAL PRIVATE	345,000	3,787	1,713	610
TOTAL	1,013,000	9,270	4,258	3,319

TABLE 13
AVERAGE NUMBER BACCALAUREATE DEGREES AWARDED TO WOMEN IN CHEMISTRY, PHYSICS AND EARTH SCIENCE 1987-89
BY FIELD AND BY CARNEGIE CLASSIFICATION

	ALL FIELDS	CHEM.	% ALL FLDS	PHYSICS	% ALL FLDS	EARTH SCIENCE	% ALL FLDS
LIBERAL ARTS I							
Public	236	2	--	0	--	0	--
Private	24,669	427	1.7	113	0.5	91	0.4
LIBERAL ARTS II							
Public	400	1	---	0	---	0	---
Private	6,348	84	1.3	9	0.1	2	---
RESEARCH I							
Public	86,864	574	0.7	115	0.1	171	0.2
Private	16,677	180	1.1	56	0.3	40	0.2
RESEARCH II							
Public	36,194	191	0.5	31	0.1	62	0.2
Private	5,362	40	0.7	12	0.2	9	0.2
DOCTORATE I							
Public	33,546	192	0.6	34	0.1	66	0.2
Private	11,246	59	0.5	19	0.2	10	0.1
DOCTORATE II							
Public	22,512	152	0.7	19	0.1	57	0.3
Private	10,452	49	0.5	9	0.1	15	0.1
COMP. I							
Public	150,976	829	0.5	139	0.1	257	0.2
Private	45,501	329	0.7	45	0.1	15	---
COMP.II							
Public	6,540	50	0.8	4	0.1	7	0.1
Private	21,596	208	1.0	24	0.1	4	---
LIBERAL ARTS II*							
Public	1,709	12	0.7	4	0.2	1	---
Private	22,667	187	0.8	10	---	4	---

	ALL FIELDS	CHEM.	% ALL FLDS	PHYSICS	% ALL FLDS	EARTH SCIENCE	% ALL FLDS
ENGINEERING							
Public	636	8	1.3	2	---	5	---
Private	545	3	--	2	---	0	---
MILITARY	MARITIME						
Public	372	7	---	2	---	0	---

	ALL FIELDS	CHEMISTRY	PHYSICS	EARTH SCIENCE
TOTAL PUBLIC	346,000	2,017	350	625
TOTAL PRIVATE	182,000	1,569	299	190
TOTAL	529,000	3,586	649	815

TABLE 14
OPENING FALL ENROLLMENTS 1987
BY CARNEGIE CLASSIFICATION

	UNDERGRADUATE			GRADUATE
	TOTAL	FULL TIME	PART TIME	
Liberal Arts I				
Private	200,268	183,385	16,883	12,099
Public	5,454	3,633	1,821	19
Liberal Arts II				
Private	73,917	57,751	16,166	5,829
Public	19,282	10,263	9,019	736
Liberal Arts II*				
Private	255,462	192,723	62,739	14,145
Public	19,510	14,065	5,445	1,182
Comprehensive I				
Private	522,779	374,583	148,196	137,188
Public	2,037,811	1,441,077	596,734	348,174
Comprehensive II				
Private	214,524	158,306	56,218	31,581
Public	95,091	69,728	25,363	9,982
Doctorate-Granting I				
Private	118,963	103,717	15,246	53,630
Public	427,953	323,276	104,677	104,592
Doctorate-Granting II				
Private	120,203	92,563	27,640	46,439
Public	294,543	216,088	78,455	72,537
Research I				
Private	179,736	153,277	26,459	128,026
Public	979,043	824,029	155,014	282,059
Research II				
Private	52,947	46,687	6,260	27,735
Public	436,733	359,867	76,866	121,606

TABLE 15
INSTITUTIONS RANKED AMONG TOP 15% IN **BOTH** ABSOLUTE NUMBER AND PROPORTION OF GRADUATES RECEIVING BACCALAUREATES IN MATHEMATICS AND BIOLOGICAL AND PHYSICAL SCIENCE
DATA FOR ALL GRADUATES AVERAGED 1987-1989

MATH & SCIENCE AS % OF ALL FIELDS	AVERAGE NUMBER MATH & SCIENCE	ACADEMIC INSTITUTION	STATE	CLASSIFICATION[5]	
33.0%	349	US Naval Academy	MD	OTHER	
32.7%	137	University of Puerto Rico-Cayey U. C.	PR	COMPI	PM
30.2%	225	Johns Hopkins University	MD	RESI	
29.5%	208	Saint Olaf College	MN	LAI	
29.3%	212	University of Chicago	IL	RESI	
27.0%	573	University of California-Irvine	CA	RESI	
26.5%	200	University of California-Riverside	CA	DOCI	
25.9%	111	Carleton College	MN	LAI	
24.6%	532	University of California-San Diego	CA	RESI	
24.2%	736	University of California-Davis	CA	RESI	
23.6%	275	Massachusetts Institute of Technology	MA	RESI	
22.3%	155	SUNY-College at Potsdam	NY	COMPI	
21.0%	452	SUNY-Stony Brook	NY	RESI	
20.3%	187	Carnegie-Mellon University	PA	RESI	
18.8%	103	Union College	NY	LAI	
18.6%	256	University of California-Santa Cruz	CA	DOCI	
18.5%	137	Inter American U. of PR-San German	PR	COMPI	PM
18.0%	198	University of Rochester	NY	RESI	
17.8%	104	Gustavus Adolphus College	MN	LAI	
17.7%	317	Harvard University	MA	RESI	

[5] Classification: Carnegie category, Predominantly Minority (PM), Historically Black Colleges and Universities (HB), and Women's Colleges (W)(See Appendix A).

TABLE 15 (CONTINUED)
INSTITUTIONS RANKED AMONG TOP 15% IN **BOTH** ABSOLUTE NUMBER AND PROPORTION OF GRADUATES RECEIVING BACCALAUREATES IN MATHEMATICS AND BIOLOGICAL AND PHYSICAL SCIENCE
DATA FOR ALL GRADUATES AVERAGED 1987-1989

MATH & SCIENCE AS % OF ALL FIELDS	AVERAGE NUMBER MATH & SCIENCE	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
17.7%	129	Creighton University	NE	COMPI
17.3%	106	Case Western Reserve University	OH	RESI
17.2%	113	College of the Holy Cross	MA	LAI
16.9%	133	Wake Forest University	NC	COMPI
16.2%	126	Bucknell University	PA	LAI
15.9%	137	University of Scranton	PA	COMPI
15.7%	167	Rensselaer Polytechnic Institute	NY	RESII
15.2%	808	University of California-Berkeley	CA	RESI
15.2%	218	Brown University	RI	RESII
15.0%	716	University of California-Los Angeles	CA	RESI
15.0%	346	University of Puerto Rico-Rio Piedras C.	PR	COMPI PM
15.0%	167	Princeton University	NJ	RESI
14.9%	103	Brandeis University	MA	RESII
14.6%	124	Humboldt State University	CA	COMPI
14.4%	126	Sonoma State University	CA	COMPI
14.3%	116	Stockton State College	NJ	COMPI
14.2%	238	Stanford University	CA	RESI
14.2%	457	Cornell University	NY	RESI
13.7%	222	Duke University	NC	RESI
13.3%	146	University of Missouri-Kansas City	MO	DOCII

TABLE 16
INSTITUTIONS RANKED AMONG TOP 15% IN **BOTH** ABSOLUTE NUMBER AND PROPORTION OF GRADUATES RECEIVING BACCALAUREATES IN MATHEMATICS AND BIOLOGICAL AND PHYSICAL SCIENCE
DATA FOR WOMEN GRADUATES AVERAGED 1987-1989

MATH & SCIENCE AS % OF ALL FIELDS	AVERAGE NUMBER MATH & SCIENCE	ACADEMIC INSTITUTION	STATE	CLASSIFICATION[6]
32.2%	93	University of Puerto Rico-Cayey U. C.	PR	COMPI PM
28.3%	85	Massachusetts Institute of Technology	MA	RESI
26.3%	73	Johns Hopkins University	MD	RESI
26.2%	45	Xavier University of Louisiana	LA	COMPII PM HB
24.4%	91	Saint Olaf College	MN	LAI
24.1%	70	University of Chicago	IL	RESI
23.5%	264	University of California-Irvine	CA	RESI
22.9%	51	Carleton College	MN	LAI
22.5%	370	University of California-Davis	CA	RESI
22.3%	231	University of California-San Diego	CA	RESI
21.3%	56	Bryn Mawr College	PA	LAI W
21.1%	44	Union College	NY	LAI
20.9%	88	University of California-Riverside	CA	DOCI
20.8%	44	Rensselaer Polytechnic Institute	NY	RESII
18.5%	55	Spelman College	GA	LAII PM HB W
18.5%	71	SUNY-College at Potsdam	NY	COMPI
17.6%	68	Bucknell University	PA	LAI
17.6%	90	Mount Holyoke College	MA	LAI W
16.5%	181	SUNY-Stony Brook	NY	RESI
16.4%	76	Inter American U. of PR-San German	PR	COMPI PM

[6] Classification: Carnegie category, Predominantly Minority (PM), Historically Black Colleges and Universities (HB), and Women's Colleges (W) (See Appendix B).

TABLE 16 (CONTINUED)
INSTITUTIONS RANKED AMONG TOP 15% IN **BOTH** ABSOLUTE NUMBER AND PROPORTION OF GRADUATES RECEIVING BACCALAUREATES IN MATHEMATICS AND BIOLOGICAL AND PHYSICAL SCIENCE
DATA FOR WOMEN GRADUATES AVERAGED 1987-1989

MATH & SCIENCE AS % OF ALL FIELDS	AVERAGE NUMBER MATH & SCIENCE	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
15.9%	55	College of the Holy Cross	MA	LAI		
15.7%	56	Wake Forest University	NC	COMPI		
15.7%	74	University of Rochester	NY	RESI		
15.5%	113	University of California-Santa Cruz	CA	DOCI		
14.6%	50	Gustavus Adolphus College	MN	LAI		
14.5%	61	Princeton University	NJ	RESI		
14.4%	114	Duke University	NC	RESI		
14.3%	44	Carnegie-Mellon University	PA	RESI		
14.2%	101	Brown University	RI	RESII		
13.8%	355	University of California-Berkeley	CA	RESI		
13.6%	97	Smith College	MA	LAI		W
13.5%	72	University of Puerto Rico-Mayaguez Cam	PR	COMPI	PM	
13.4%	104	Harvard University	MA	RESI		
13.4%	202	Cornell University	NY	RESI		
13.2%	159	North Carolina State University-Raleigh	NC	RESI		
12.9%	208	University of Puerto Rico-Rio Piedras C	PR	COMPI	PM	
12.6%	54	College of Charleston	SC	COMPI		
12.6%	73	Wellesley College	MA	LAI		W
12.6%	50	Stockton State College	NJ	COMPI		
12.4%	92	Stanford University	CA	RESI		
12.4%	51	University of Scranton	PA	COMPI		
12.3%	66	Sonoma State University	CA	COMPI		
12.2%	45	Oberlin College	OH	LAI		
12.1%	306	University of California-Los Angeles	CA	RESI		

TABLE 17
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY PROPORTION OF ALL-FIELDS

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
1.6%	15,937	All Academic Institutions				
25.0%	12	C. of Insurance	NY	CORP		
15.6%	19	Harvey Mudd College	CA	ENGR		
15.1%	6	Barber-Scotia College	NC	LAII*	PM	HB
13.8%	127	Carnegie-Mellon University	PA	RESI		
12.8%	19	US Coast Guard Academy	CT	OTHER		
12.6%	87	SUNY-College at Potsdam	NY	COMPI		
12.3%	8	Voorhees College	SC	LAII	PM	HB
11.9%	5	Miles College	AL	LAII*	PM	HB
10.8%	16	New Mexico Institute of Mining & Tech.	NM	ENGR		
10.7%	17	Rio Grande College	OH	COMPII		
10.4%	73	Saint Olaf College	MN	LAI		
9.9%	9	Claflin College	SC	LAII*	PM	HB
9.2%	9	Tougaloo College	MS	LAII	PM	HB
9.2%	9	Morris College	SC	LAII	PM	HB
8.6%	38	Citadel Military College	SC	COMPI		
8.1%	20	Saint Vincent College & Seminary	PA	LAII		
7.7%	13	La Grange College	GA	LAII*		
7.7%	7	Wells College	NY	LAI		W
7.6%	8	C. of Idaho	ID	LAII		
7.6%	14	Lebanon Valley College	PA	LAI		
7.4%	9	Virginia Union University	VA	LAII*	PM	HB
7.4%	8	Newberry College	SC	LAII*		
7.4%	9	King's College (NY)	NY	LAII		
7.4%	20	Fayetteville State University	NC	COMPI	PM	HB
7.4%	78	US Naval Academy	MD	OTHER		

TABLE 17 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
6.9%	20	Whitman College	WA	LAI	
6.9%	22	Pembroke State University	NC	COMPII	
6.9%	21	Grinnell College	IA	LAI	
6.8%	147	SUNY-Stony Brook	NY	RESI	
6.8%	82	Vanderbilt University	TN	RESI	
6.7%	3	Schreiner College	TX	LAII*	
6.6%	5	Fisk University	TN	LAII	PM HB
6.5%	17	Delaware State College	DE	COMPII	PM HB
6.4%	4	Jarvis Christian College	TX	LAII*	PM HB
6.3%	16	Rose-Hulman Institute of Technology	IN	ENGR	
6.3%	12	Saint Joseph's College (IN)	IN	LAII*	
6.3%	8	Laredo State University	TX	LAII*	PM
6.3%	24	Francis Marion College	SC	COMPI	
6.2%	5	Le Moyne-Owen College	TN	LAII*	PM HB
6.2%	16	Morehouse College	GA	LAII	PM HB
6.2%	16	Westminster College	PA	LAII*	
6.0%	18	Spelman College	GA	LAII	PM HB W
5.9%	5	Eureka College	IL	LAII*	
5.8%	38	Northern Kentucky University	KY	COMPI	
5.7%	10	Emory and Henry College	VA	LAII*	
5.7%	67	Massachusetts Institute of Technology	MA	RESI	
5.6%	6	C. of Great Falls	MT	LAII*	
5.6%	14	U. of the South	TN	LAI	
5.5%	9	Mount Union College	OH	LAII*	
5.5%	36	C. of the Holy Cross	MA	LAI	

TABLE 17 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
5.4%	257	U of California-Los Angeles	CA	RESI		
5.4%	15	Wartburg College	IA	LAI		
5.4%	5	Saint Paul's College	VA	LAII*	PM	HB
5.3%	3	Blue Mountain College	MS	LAII*		W
5.3%	4	King College	TN	LAI		
5.3%	6	Belhaven College	MS	LAII*		
5.3%	38	U. of Chicago	IL	RESI		
5.3%	12	Saint Mary's College of Maryland	MD	LAII		
5.2%	17	Macalester College	MN	LAI		
5.2%	3	Rocky Mountain College	MT	LAII*		
5.1%	6	Huntingdon College	AL	LAII*		
5.1%	5	Milligan College	TN	LAII*		
5.1%	15	Willamette University	OR	LAI		
5.1%	4	Missouri Baptist College	MO	LAII*		
5.1%	10	Regis College	MA	LAI		W
5.0%	109	U. of California-San Diego	CA	RESI		
5.0%	5	Agnes Scott College	GA	LAI		W
5.0%	22	Hamilton College	NY	LAI		
5.0%	6	Greenville College	IL	LAII*		
5.0%	3	Texas College	TX	LAII*	PM	HB
5.0%	13	Central State University	OH	COMPII	PM	HB
5.0%	4	Talladega College	AL	LAII*	PM	HB
5.0%	9	Wabash College	IN	LAI		
5.0%	7	Bethel College	KS	LAII*		
4.9%	20	Bates College	ME	LAI		

TABLE 17 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
4.9%	10	Beloit College	WI	LAI		
4.9%	18	Saint Norbert College	WI	COMPII		
4.8%	11	Malone College	OH	LAII*		
4.8%	50	Shippensburg University of Pennsylvania	PA	COMPI		
4.7%	7	Goucher College	MD	LAI		W
4.7%	4	Keuka College	NY	LAII*		W
4.7%	33	Smith College	MA	LAI		W
4.6%	12	U. of Maine-Farmington	ME	COMPII		
4.6%	8	Centre College of Kentucky	KY	LAI		
4.6%	22	Fort Lewis College	CO	COMPI		
4.6%	34	Creighton University	NE	COMPI		
4.6%	10	Nebraska Wesleyan University	NE	LAI		
4.6%	10	Kalamazoo College	MI	LAI		
4.6%	9	Adrian College	MI	LAII		
4.5%	16	Pomona College	CA	LAI		
4.5%	8	Coppin State College	MD	COMPII	PM HB	
4.5%	10	Randolph-Macon College	VA	LAI		
4.5%	11	Houghton College	NY	LAI		
4.5%	5	Fresno Pacific College	CA	LAII		
4.4%	9	Benedict College	SC	LAII*	PM HB	
4.4%	5	Chestnut Hill College	PA	LAI		W
4.4%	6	Seton Hill College	PA	LAII*		W
4.4%	5	Westminster College	MO	LAII*		
4.4%	22	Minot State College	ND	COMPI		
4.4%	16	Messiah College	PA	COMPII		

TABLE 18
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.4%	4,258	All Academic Institutions		
17.9%	21	Harvey Mudd College	CA	ENGR
17.9%	35	California Institute of Technology	CA	RESI
9.1%	19	Reed College	OR	LAI
8.1%	12	New Mexico Institute of Mining & Tech.	NM	ENGR
6.7%	78	Massachusetts Institute of Technology	MA	RESI
5.3%	57	Rensselaer Polytechnic Institute	NY	RESII
5.0%	8	Lincoln University (PA)	PA	LAII* PM HB
4.9%	14	Whitman College	WA	LAI
4.8%	21	Carleton College	MN	LAI
4.2%	17	Bates College	ME	LAI
4.2%	15	Jacksonville University	FL	COMPII
4.1%	29	U. of Chicago	IL	RESI
3.9%	9	Hendrix College	AR	LAI
3.8%	6	Hastings College	NE	LAII
3.6%	9	Morehouse College	GA	LAII PM HB
3.5%	3	Fisk University	TN	LAII PM HB
3.5%	10	Hamline University	MN	LAI
3.4%	13	Occidental College	CA	LAI
3.4%	6	Wabash College	IN	LAI
3.3%	6	Centre College of Kentucky	KY	LAI
3.3%	3	Talladega College	AL	LAII* PM HB
3.2%	5	Centenary College of Louisiana	LA	LAI
3.1%	7	U. of Dallas	TX	LAI
3.1%	7	Kalamazoo College	MI	LAI
3.0%	31	US Naval Academy	MD	OTHER

TABLE 18 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
2.9%	9	Grinnell College	IA	LAI		
2.9%	7	Xavier University of Louisiana	LA	COMPII	PM	HB
2.8%	3	Tougaloo College	MS	LAII	PM	HB
2.7%	7	Bryn Mawr College	PA	LAI		W
2.7%	9	Pomona College	CA	LAI		
2.7%	2	King College	TN	LAI		
2.6%	6	Earlham College	IN	LAI		
2.6%	7	Rose-Hulman Institute of Technology	IN	ENGR		
2.6%	24	Carnegie-Mellon University	PA	RESI		
2.5%	11	Augustana Collge	IL	LAI		
2.5%	4	Monmouth College	IL	LAII*		
2.5%	3	Stillman College	AL	LAII*	PM	HB
2.5%	4	Pacific University	OR	LAII*		
2.5%	27	Princeton University	NJ	RESI		
2.5%	6	U. of the South	TN	LAI		
2.3%	10	Allegheny College	PA	LAI		
2.3%	14	Case Western Reserve University	OH	RESI		
2.3%	4	Hampden-Sydney College	VA	LAI		
2.3%	16	SUNY-College at Potsdam	NY	COMPI		
2.3%	8	Bowdoin College	ME	LAI		
2.2%	3	Bethel College (KS)	KS	LAII*		
2.2%	6	Haverford College	PA	LAI		
2.2%	8	Kenyon College	OH	LAI		
2.2%	2	Maharishi International University	IA	LAII		
2.2%	44	Georgia Institute of Tech.-All Campuses	GA	RESI		

TABLE 18 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
2.2%	8	Swarthmore College	PA	LAI
2.1%	13	Rice University	TX	DOCI
2.1%	12	Gustavus Adolphus College	MN	LAI
2.0%	14	Saint Olaf College	MN	LAI
2.0%	5	Virginia Military Institute	VA	LAI
2.0%	8	Mansfield University of Pennsylvania	PA	COMPI
2.0%	27	U. of California-Santa Cruz	CA	DOCI
2.0%	4	Alma College	MI	LAI
2.0%	7	Illinois Wesleyan University	IL	COMPII
2.0%	9	Franklin and Marshall College	PA	LAI
2.0%	11	John Carroll University	OH	COMPI
2.0%	5	Wofford College	SC	LAII
1.9%	9	Illinois Institute of Technology	IL	DOCI
1.9%	5	Gordon College (MA)	MA	LAI
1.9%	34	Harvard University	MA	RESI
1.9%	7	Saint John's University (MN)	MN	LAI
1.9%	9	Dickinson College	PA	LAI
1.9%	3	Benedictine College	KS	LAI
1.8%	5	Berea College	KY	COMPII
1.8%	3	Dillard University	LA	LAII* PM HB
1.8%	5	South Dakota School of Mines & Tech.	SD	ENGR
1.8%	5	Cornell College	IA	LAI
1.8%	4	Benedict College	SC	LAII* PM HB
1.8%	9	Middlebury College	VT	LAI
1.8%	12	C. of the Holy Cross	MA	LAI

TABLE 18 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.8%	13	U. of California-Riverside	CA	DOCI
1.8%	9	Colorado College	CO	LAI
1.8%	3	Bethany College (WV)	WV	LAI
1.7%	6	North Georgia College	GA	COMPII
1.7%	6	Davidson College	NC	LAI
1.7%	3	Wheeling Jesuit College	WV	LAII*
1.7%	4	Lawrence University	WI	LAI
1.7%	26	U. of California-Irvine	CA	RESI
1.7%	9	Williams College	MA	LAI
1.7%	2	Erskine College	SC	LAII
1.6%	3	North Park College & Theological Sem	IL	LAII
1.6%	5	U. of Wisconsin-Superior	WI	COMPII
1.6%	4	Lycoming College	PA	LAII*
1.6%	3	Presbyterian College	SC	LAII
1.6%	6	Albion College	MI	LAI
1.6%	4	Goshen College	IN	LAI
1.6%	6	C. of Wooster	OH	LAI
1.6%	8	Longwood College	VA	COMPI
1.6%	3	Thomas More College	KY	LAI
1.6%	2	Agnes Scott College	GA	LAI
1.6%	3	Knox College	IL	LAI
1.6%	6	Francis Marion College	SC	COMPI
1.6%	5	Willamette University	OR	LAI

TABLE 19
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	AVERAGE NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.9%	9,270	All Academic Institutions		
13.4%	34	Xavier University of Louisiana	LA	COMPII PM HB
11.5%	14	Harvey Mudd College	CA	ENGR
9.5%	8	Talladega College	AL	LAII* PM HB
9.0%	23	Washington and Jefferson College	PA	LAI
7.8%	14	Wabash College	IN	LAI
7.7%	7	Tougaloo College	MS	LAII PM HB
7.6%	28	C. of Wooster	OH	LAI
7.4%	16	Knox College	IL	LAI
7.3%	9	Lambuth College	TN	LAII*
7.2%	4	Piedmont College	GA	LAII*
7.0%	5	Fisk University	TN	LAII PM HB
6.9%	15	Hendrix College	AR	LAI
6.9%	15	Kalamazoo College	MI	LAI
6.7%	17	Millsaps College	MS	LAI
6.6%	16	Armstrong State College	GA	COMPI
6.3%	20	Grinnell College	IA	LAI
6.2%	26	Carleton College	MN	LAI
6.1%	32	Houston Baptist University	TX	COMPI
5.9%	3	Judson College (AL)	AL	LAII W
5.8%	16	Bryn Mawr College	PA	LAI W
5.6%	11	California Institute of Technology	CA	RESI
5.5%	13	Juniata College	PA	LAI
5.4%	27	Gannon University	PA	COMPI
5.4%	7	Huntingdon College	AL	LAII*
5.4%	15	Haverford College	PA	LAI

TABLE 19 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	AVERAGE NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
5.4%	11	Reed College	OR	LAI
5.4%	33	Case Western Reserve University	OH	RESI
5.3%	38	Saint Olaf College	MN	LAI
5.1%	13	SUNY-C. of Environ Sci. & Forestry	NY	DOCII
5.0%	7	New Mexico Institute of Mining & Tech.	NM	ENGR
4.9%	25	Williams College	MA	LAI
4.8%	5	Rust College	MS	LAII* PM HB
4.8%	15	U. of Puerto Rico-Humacao U. C.	PR	COMPI PM
4.7%	5	Kentucky Wesleyan College	KY	LAII*
4.7%	14	Ursinus College	PA	LAI
4.6%	7	Lincoln University (PA)	PA	LAII* PM HB
4.6%	4	Arkansas College	AR	LAII*
4.6%	17	Saint Norbert College	WI	COMPII
4.5%	8	Lebanon Valley College	PA	LAI
4.4%	32	U. of Chicago	IL	RESI
4.4%	21	Hope College	MI	LAI
4.4%	18	Allegheny College	PA	LAI
4.3%	12	Berea College	KY	COMPII
4.3%	18	U. of Puerto Rico-Cayey U. C.	PR	COMPI PM
4.3%	8	Spring Hill College	AL	LAII
4.2%	13	Spelman College	GA	LAII PM HB W
4.2%	28	C. of the Holy Cross	MA	LAI
4.2%	3	Kansas Wesleyan	KS	LAII*
4.2%	16	Kenyon College	OH	LAI
4.1%	1	Saint Mary's College	MI	LAII*

TABLE 19 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	AVERAGE NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
4.1%	9	Muskingum College	OH	LAII*		
4.1%	9	Southwestern University	TX	LAII*		
4.1%	10	Rhodes College	TN	LAI		
4.1%	15	Bowdoin College	ME	LAI		
4.1%	4	Chatham College	PA	LAI		W
4.1%	10	Wofford College	SC	LAII		
4.0%	13	Washington and Lee University	VA	LAI		
3.9%	3	Tabor College	KS	LAII*		
3.9%	7	Texas Lutheran College	TX	LAII*		
3.8%	7	Whittier College	CA	COMPII		
3.6%	4	Mount Marty College	SD	LAII*		
3.6%	2	Wiley College	TX	LAII*	PM	HB
3.6%	5	Clarke College (IA)	IA	LAII*		W
3.6%	10	Berry College	GA	LAII*		
3.5%	12	Birmingham Southern College	AL	LAI		
3.5%	4	C. of Idaho	ID	LAII		
3.5%	6	Converse College	SC	LAII		W
3.4%	5	Lincoln Memorial University	TN	LAII*		
3.4%	7	Earlham College	IN	LAI		
3.4%	26	Wake Forest University	NC	COMPI		
3.3%	4	Bethany College (KS)	KS	LAII*		
3.3%	5	Oakwood College	AL	LAII*	PM	HB
3.3%	8	Saint Vincent College & Seminary	PA	LAII		
3.3%	6	Wheeling Jesuit College	WV	LAII*		
3.2%	5	Ripon College	WI	LAI		

TABLE 19 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	AVERAGE NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
3.2%	4	Chestnut Hill College	PA	LAI		W
3.2%	2	Jarvis Christian College	TX	LAII*	PM	HB
3.1%	19	Oral Roberts University	OK	COMPI		
3.1%	3	Stillman College	AL	LAII*	PM	HB
3.1%	11	North Georgia College	GA	COMPII		
3.0%	11	Muhlenberg College	PA	LAI		
3.0%	2	Huntington College	IN	LAII*		
3.0%	12	Bates College	ME	LAI		
3.0%	9	Willamette University	OR	LAI		
3.0%	4	Saint Joseph College (CT)	CT	LAII*		W
3.0%	10	Pomona College	CA	LAI		
3.0%	11	West Virginia State College	WV	COMPI	PM	HB
2.9%	10	Albion College	MI	LAI		
2.9%	3	Eureka College	IL	LAII*		
2.9%	6	Nebraska Wesleyan University	NE	LAI		
2.9%	10	Davidson College	NC	LAI		
2.9%	5	Hampden-Sydney College	VA	LAI		
2.9%	2	Rocky Mountain College	MT	LAII*		
2.9%	8	Central University of Iowa	IA	COMPII		
2.9%	7	Hiram College	OH	LAII		

TABLE 20
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.3%	3,319	All Academic Institutions		
10.8%	16	New Mexico Institute Mining & Tech.	NM	ENGR
4.3%	6	Centenary College of Louisiana	LA	LAI
4.0%	11	Whitman College	WA	LAI
3.5%	15	Carleton College	MN	LAI
3.5%	2	Rocky Mountain College	MT	LAII*
3.4%	7	Beloit College	WI	LAI
3.3%	9	U. of Texas-Permian Basin	TX	COMPII
3.0%	10	Lake Superior State College	MI	COMPI
2.9%	6	Sul Ross State University	TX	COMPII PM
2.9%	9	Western State College of Colorado	CO	COMPI
2.8%	13	Fort Lewis College	CO	COMPI
2.7%	6	Marietta College	OH	LAII*
2.5%	12	Franklin and Marshall College	PA	LAI
2.4%	12	Midwestern State University	TX	COMPI
2.4%	10	U. of Alaska-Fairbanks	AK	COMPI
2.3%	5	Earlham College	IN	LAI
2.3%	5	Lawrence University	WI	LAI
2.3%	19	Humboldt State University	CA	COMPI
2.2%	8	C. of Wooster	OH	LAI
2.1%	14	Colgate University	NY	LAI
2.1%	5	Cornell College	IA	LAI
2.0%	2	Northland College	WI	LAII
2.0%	11	Saint Lawrence University	NY	LAI
2.0%	9	Wilkes College	PA	COMPI
1.9%	4	Hardin-Simmons University	TX	COMPII

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TABLE 20 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.9%	26	U. of California-Santa Cruz	CA	DOCI
1.8%	9	Colorado College	CO	LAI
1.8%	9	Denison University	OH	LAI
1.8%	4	Juniata College	PA	LAI
1.8%	12	Fort Hays State University	KS	COMPI
1.8%	3	Adrian College	MI	LAII
1.7%	10	U. of Tulsa	OK	DOCII
1.7%	16	Clarion University of Pennsylvania	PA	COMPI
1.7%	7	Amherst College	MA	LAI
1.6%	3	McMurry College	TX	LAII*
1.6%	7	Arkansas Tech University	AR	COMPI
1.6%	10	Mary Washington College	VA	COMPI
1.6%	17	SUNY-College at Brockport	NY	COMPI
1.6%	14	U. of Nevada-Reno	NV	DOCII
1.5%	5	Macalester College	MN	LAI
1.5%	4	Bryn Mawr College	PA	LAI W
1.5%	8	Texas A & I University	TX	COMPI PM
1.5%	2	Thiel College	PA	LAII
1.5%	16	SUNY-College at Oneonta	NY	COMPI
1.4%	5	Washington and Lee University	VA	LAI
1.4%	22	Northern Arizona University	AZ	DOCII PM
1.4%	4	California Lutheran University	CA	COMPII
1.4%	2	Monmouth College (IL)	IL	LAII*
1.4%	3	California Institute of Technology	CA	RESI
1.3%	7	Minot State College	ND	COMPI

TABLE 20 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.3%	5	U. of Wisconsin-Parkside	WI	COMPI
1.3%	20	Wright State University	OH	COMPI
1.3%	7	Williams College	MA	LAI
1.3%	21	U. of Wyoming	WY	RESII
1.3%	15	U. of Montana	MT	DOCI
1.3%	4	Haverford College	PA	LAI
1.2%	10	Edinboro U. of Pennsylvania	PA	COMPI
1.2%	3	Adams State College	CO	COMPII
1.2%	13	Shippensburg U. of Pennsylvania	PA	COMPI
1.2%	3	South Dakota School Mines & Tech.	SD	ENGR
1.2%	3	Millsaps College	MS	LAI
1.2%	3	Mercyhurst College	PA	COMPII
1.2%	2	Mount Union College	OH	LAII*
1.2%	6	Longwood College	VA	COMPI
1.2%	9	California U. of Pennsylvania	PA	COMPI
1.2%	4	Hartwick College	NY	LAI
1.2%	5	Alfred University-Main Campus	NY	COMPII
1.1%	5	Colby College	ME	LAI
1.1%	10	Sonoma State University	CA	COMPI
1.1%	2	Hanover College	IN	LAI
1.1%	12	Bloomsburg U. of Pennsylvania	PA	COMPI
1.1%	31	Central Michigan University	MI	COMPI
1.1%	4	Occidental College	CA	LAI
1.1%	9	Boise State University	ID	COMPI
1.1%	11	U. of Texas-Dallas	TX	DOCII

TABLE 20 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.1%	17	Montana State University	MT	DOCII
1.1%	5	California State C., Bakersfield	CA	COMPI
1.0%	2	New Mexico Highlands University	NM	COMPII PM
1.0%	19	Stephen F. Austin State University	TX	COMPI
1.0%	7	Idaho State University	ID	DOCII
1.0%	12	U. of South Alabama	AL	COMPI
1.0%	11	Millersville University	PA	COMPI
1.0%	12	Massachusetts Institute of Tech.	MA	RESI
1.0%	5	Middlebury College	VT	LAI
1.0%	24	West Virginia University	WV	RESII
1.0%	12	U. of New Orleans	LA	DOCII
1.0%	1	Phillips University	OK	LAII*
1.0%	3	Pomona College	CA	LAI
1.0%	1	Western New Mexico University	NM	COMPII PM
1.0%	5	De Pauw University	IN	LAI
1.0%	3	Albion College	MI	LAI
1.0%	4	Allegheny College	PA	LAI

TABLE 21
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE[1]
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
4.0%	40,045	All Academic Institutions		
30.0%	29	Northland College	WI	LAII
27.6%	116	U. of Puerto Rico-Cayey U. C.	PR	COMPI PM
23.1%	172	Johns Hopkins University	MD	RESI
20.9%	6	Marlboro College	VT	LAI
19.8%	421	U. of California-Irvine	CA	RESI
19.0%	45	Wofford College	SC	LAII
18.3%	557	U. of California-Davis	CA	RESI
18.3%	138	U. of California-Riverside	CA	DOCI
17.8%	61	Albright College	PA	LAI
17.2%	36	U. of Dallas	TX	L .I
16.5%	6	Wilson College	PA	LAII W
16.2%	23	Oakwood College	AL	LAII* PM HB
16.1%	348	U. of California-San Diego	CA	RESI
16.1%	2	Divine Word College	IA	LAII
15.9%	17	C. of Idaho	ID	LAII
15.5%	31	Alma College	MI	LAI
15.3%	13	Warren Wilson College	NC	LAII
15.0%	112	Inter American U. of PR-San German	PR	COMPI PM
14.9%	46	Ursinus College	PA	LAI
14.8%	107	U. of Chicago	IL	RESI

[1]These data do not include specialized optometric, chiropractic or podiatric institutions.

TABLE 21 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
14.6%	38	Washington and Jefferson College	PA	LAI		
14.6%	55	Muhlenberg College	PA	LAI		
14.5%	12	Talladega College	AL	LAII*	PM	HB
14.4%	43	Andrews University	MI	DOCII		
14.3%	34	Juniata College	PA	LAI		
14.1%	16	Chestnut Hill College	PA	LAI		W
13.9%	25	Centre College of Kentucky	KY	LAI		
13.7%	30	Hendrix College	AR	LAI		
13.7%	13	Tougaloo College	MS	LAII	PM	HB
13.6%	7	Felician College	NJ	LAII*		W
13.6%	45	Yeshiva University	NY	RESI		
13.5%	13	Rust College	MS	LAII*	PM	HB
13.3%	2	Shimer College	IL	OTHER		
13.2%	10	Fisk University	TN	LAII	PM	HB
13.1%	8	Paine College	GA	LAII*	PM	HB
12.9%	57	Augustana College	IL	LAI		
12.9%	23	Transylvania University	KY	LAII		
12.6%	27	Reed College	OR	LAI		
12.6%	26	Inter American U. of Pr-Bayamon	PR	PM		
12.6%	69	Union College	NY	LAI		
12.5%	23	Pacific Union College	CA	LAII*		
12.5%	288	U. of Puerto Rico-Rio Piedras C.	PR	COMPI	PM	
12.4%	9	King College	TN	LAI		
12.3%	135	U. of Rochester	NY	RESI		
12.2%	51	Saint Mary's University of San Antonio	TX	COMPI	PM	

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TABLE 21 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
12.0%	45	Saint John's University	MN	LAI
12.0%	21	Wabash College	IN	LAI
12.0%	44	Bowdoin College	ME	LAI
11.8%	8	McPherson College	KS	LAII*
11.7%	101	U. of Scranton	PA	COMPI
11.7%	25	Earlham College	IN	LAI
11.7%	81	Brandeis University	MA	RESII
11.6%	31	Illinois Benedictine College	IL	COMPII
11.6%	30	Austin College	TX	LAI
11.5%	17	Baker University	KS	LAII*
11.5%	158	U. of California-Santa Cruz	CA	DOCI
11.4%	8	Concordia College	NY	LAII*
11.2%	13	Southwestern College	KS	LAII*
11.2%	79	Saint Olaf College	MN	LAI
11.0%	26	Lawrence University	WI	LAI
11.0%	15	Saint Andrews Presbyterian College	NC	LAII*
10.9%	25	Delaware Valley C. of Science & Agri.	PA	COMPII
10.9%	24	Nebraska Wesleyan University	NE	LAI
10.8%	20	Lebanon Valley College	PA	LAI
10.8%	43	Bates College	ME	LAI
10.8%	51	Luther College	IA	LAI
10.7%	20	Eastern Mennonite College	VA	LAII*
10.7%	9	Greensboro College	NC	LAII*
10.7%	55	Mount Holyoke College	MA	LAI W
10.6%	20	Adrian College	MI	LAII

TABLE 21 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
10.6%	25	Saint Mary's College of Maryland	MD	LAII
10.6%	23	Kalamazoo College	MI	LAI
10.6%	6	U. of Maine-Fort Kent	ME	LAII
10.5%	19	Heidelberg College	OH	LAII*
10.4%	27	SUNY-College of Environ Sci & Forestry	NY	DOCII
10.4%	224	SUNY-Stony Brook	NY	RESI
10.4%	114	U. of Missouri-Kansas City	MO	DOCII
10.3%	38	Occidental College	CA	LAI
10.3%	29	Haverford College	PA	LAI
10.2%	183	Harvard University	MA	RESI
10.2%	25	Hiram College	OH	LAII
10.2%	20	Beloit College	WI	LAI
10.1%	23	Carroll College (MT)	MT	COMPII
10.1%	35	Albion College	MI	LAI
10.1%	145	Brown University	RI	RESII
10.1%	42	Allegheny College	PA	LAI
10.0%	48	Hope College	MI	LAI
10.0%	25	Millsaps College	MS	LAI
10.0%	25	Philadelphia College of Pharmacy & Sci	PA	HLTH
10.0%	49	Colorado College	CO	LAI
10.0%	8	Dana College	NE	LAII*
9.8%	316	Cornell University	NY	RESI
9.7%	57	Gustavus Adolphus College	MN	LAI
9.7%	27	Wartburg College	IA	LAI
9.7%	517	U. of California-Berkeley	CA	RESI

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TABLE 22
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
IN ORDER BY % OF WOMEN BACCALAUREATES IN ALL-FIELDS

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.4%	7,381	All Academic Institutions		
22.4%	5	C. of Insurance	NY	CORP
16.4%	4	Harvey Mudd College	CA	ENGR
15.0%	3	US Coast Guard Academy	CT	OTHER
12.3%	47	SUNY-College at Potsdam	NY	COMPI
11.3%	5	New Mexico Institute Mining & Tech.	NM	ENGR
9.5%	2	Barber-Scotia College	NC	LAII* PM HB
9.2%	8	Rio Grande College	OH	COMPII
8.8%	4	Eureka College	IL	LAII*
8.5%	4	South Dakota School Mines & Tech.	SD	ENGR
8.1%	2	Miles College	AL	LAII* PM HB
8.1%	6	Laredo State University	TX	LAII* PM
8.0%	7	US Naval Academy	MD	OTHER
8.0%	5	Claflin College	SC	LAII* PM HB
7.9%	24	Carnegie-Mellon University	PA	RESI
7.8%	15	Lawrence Institute of Technology	MI	COMPI
7.7%	3	Newberry College	SC	LAII*
7.7%	29	Saint Olaf College	MN	LAI
7.7%	7	Wells College	NY	LAI W
7.3%	44	Vanderbilt University	TN	RESI
7.2%	7	Saint Vincent College & Seminary	PA	LAII
7.1%	1	Le Tourneau College	TX	LAII
7.0%	24	C. of the Holy Cross	MA	LAI
6.9%	15	Francis Marion College	SC	COMPI
6.9%	8	Malone College	OH	LAII*
6.7%	4	Fisk University	TN	LAII PM HB

TABLE 22 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
6.5%	3	Blue Mountain College	MS	LAII*	W
6.5%	6	La Grange College	GA	LAII*	
6.3%	7	Lebanon Valley College	PA	LAI	
6.2%	3	C. of Idaho	ID	LAII	
6.0%	18	Spelman College	GA	LAII	PM HB W
6.0%	4	Tougaloo College	MS	LAII	PM HB
6.0%	5	Colorado School of Mines	CO	DOCII	
6.0%	5	Saint Joseph's College	IN	LAII*	
5.9%	6	Hendrix College	AR	LAI	
5.9%	4	King's College	NY	LAII	
5.9%	12	Bates College	ME	LAI	
5.8%	2	Missouri Baptist College	MO	LAII*	
5.8%	64	SUNY-Stony Brook	NY	RESI	
5.7%	8	Westminster College	PA	LAII*	
5.6%	2	Paine College	GA	LAII*	PM HB
5.6%	12	Union College	NY	LAI	
5.5%	4	C. of Great Falls	MT	LAII*	
5.4%	7	Whitman College	WA	LAI	
5.4%	3	Talladega College	AL	LAII*	PM HB
5.3%	3	Howard Payne University	TX	LAII*	
5.3%	20	Bucknell University	PA	LAI	
5.2%	14	Michigan Technological University	MI	COMPI	
5.2%	4	Virginia Union University	VA	LAII*	PM HB
5.2%	4	Emory and Henry College	VA	LAII*	
5.2%	9	Fayetteville State University	NC	COMPI	PM HB

TABLE 22
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
5.1%	2	Jarvis Christian College	TX	LAII*	PM	HB
5.1%	4	Huntingdon College	AL	LAII*		
5.1%	10	Regis College	MA	LAI		W
5.1%	3	Le Moyne-Owen College	TN	LAII*	PM	HB
5.1%	15	Massachusetts Institute of Tech.	MA	RESI		
5.0%	5	Agnes Scott College	GA	LAI		W
5.0%	1	Schreiner College	TX	LAII*		
5.0%	6	Worcester Polytechnic Institute	MA	COMPI		
5.0%	10	Saint Norbert College	WI	COMPII		
5.0%	12	Grove City College	PA	COMPII		
4.8%	9	Pembroke State University	NC	COMPII		
4.8%	3	Morris College	SC	LAII	PM	HB
4.7%	7	Goucher College	MD	LAI		W
4.7%	33	Smith College	MA	LAI		W
4.6%	116	U of California-Los Angeles	CA	RESI		
4.5%	3	Albertus Magnus College	CT	LAII		W
4.5%	1	California Institute of Technology	CA	RESI		
4.5%	2	King College	TN	LAI		
4.5%	6	Nebraska Wesleyan University	NE	LAI		
4.5%	3	Greenville College	IL	LAII*		
4.5%	5	Chestnut Hill College	PA	LAI		W
4.4%	6	Seton Hill College	PA	LAII*		W
4.3%	8	Hamilton College	NY	LAI		
4.3%	7	Wartburg College	IA	LAI		
4.3%	5	Earlham College	IN	LAI		

TABLE 22 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
4.3%	4	Randolph-Macon College	VA	LAI
4.3%	7	Macalester College	MN	LAI
4.2%	11	Le Moyne College	NY	COMPII
4.2%	3	Wilmington College (OH)	OH	LAII*
4.2%	4	Benedictine College	KS	LAI
4.2%	6	Sweet Briar College	VA	LAI W
4.2%	9	Allegheny College	PA	LAI
4.2%	6	Dillard University	LA	LAII* PM HB
4.2%	9	U. of Tampa	FL	COMPII
4.1%	4	Muskingum College	OH	LAII*
4.1%	43	U. of California-San Diego	CA	RESI
4.1%	3	Centre College of Kentucky	KY	LAI
4.1%	4	Roberts Wesleyan College	NY	LAII*
4.1%	6	Atlantic Christian College	NC	LAII*
4.1%	9	Franklin and Marshall College	PA	LAI
4.1%	12	South Carolina State College	SC	COMPI PM HB
4.0%	2	Central Methodist College	MO	LAII*
4.0%	2	Milligan College	TN	LAII*
4.0%	14	Wake Forest University	NC	COMPI
4.0%	18	Fairfield University	CT	COMPI
4.0%	2	Campbellsville College	KY	LAII*
4.0%	4	Heidelberg College	OH	LAII*
4.0%	61	Central Michigan University	MI	COMPI
3.9%	2	Erskine College	SC	LAII
3.9%	3	Ripon College	WI	LAI
3.9%	6	Grinnell College	IA	LAI
3.9%	3	Lubbock Christian University	TX	LAII*

TABLE 23
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.1%	649	All Academic Institutions			
4.3%	13	Massachusetts Institute of Tech.	MA	RESI	
0.3%	8	U of California-Los Angeles	CA	RESI	
2.8%	7	Bryn Mawr College	PA	LAI	W
1.6%	7	Georgia Instit. of Tech.-All Campuses	GA	RESI	
0.3%	7	U. of California-Berkeley	CA	RESI	
0.9%	7	Harvard University	MA	RESI	
3.0%	6	Rensselaer Polytechnic Institute	NY	RESII	
0.2%	6	Rutgers State U.-All Campuses	NJ	RESI	
0.5%	6	U. of California-Irvine	CA	RESI	
2.6%	6	Carleton College	MN	LAI	
0.2%	6	U. of Washington	WA	RESI	
0.3%	5	Cornell University	NY	RESI	
0.5%	5	U. of California-San Diego	CA	RESI	
0.9%	5	Mount Holyoke College	MA	LAI	W
0.1%	5	Pennsylvania State U.-All Campuses	PA	RESI	
1.1%	5	Princeton University	NJ	RESI	
0.7%	5	Smith College	MA	LAI	W
0.2%	5	U. of Massachusetts-Amherst	MA	RESII	
0.7%	4	U. of Lowell	MA	COMPI	
0.2%	4	U. of Maryland-College Park	MD	RESI	
2.5%	4	Xavier University of Louisiana	LA	COMPII PM HB	
1.5%	4	Dickinson College	PA	LAI	
4.5%	4	Reed College	OR	LAI	
1.5%	4	Rice University	TX	DOCI	
0.5%	4	Stanford University	CA	RESI	

TABLE 23 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.1%	4	U. of Texas-Austin	TX	RESI	
1.8%	4	Bates College	ME	LAI	
0.6%	4	Southern U. and A & M C.	LA	COMPI	PM HB
0.2%	4	U. of California-Santa Barbara	CA	RESII	
0.1%	4	U. of Colorado-All Campuses	CO	RESI	
0.4%	3	C. of William and Mary	VA	DOCI	
1.2%	3	John Carroll University	OH	COMPI	
0.9%	3	Saint Olaf College	MN	LAI	
0.2%	3	U. of Arizona	AZ	RESI	
0.2%	3	U. of California-Davis	CA	RESI	
0.1%	3	U. of Illinois-Urbana	IL	RESI	
0.1%	3	U. of Michigan-All Campuses	MI	RESI	
0.1%	3	U. of Minnesota-All Campuses	MN	RESI	
0.2%	3	Virginia Polytechnic Institute	VA	RESI	
0.1%	3	Brigham Young U.-All Campuses	UT	DOCI	
1.9%	3	Hamline University	MN	LAI	
0.3%	3	Loyola University of Chicago	IL	DOCI	PM
0.2%	3	Miami University-All Campuses	OH	DOCI	
0.1%	3	Michigan State University	MI	RESI	
0.1%	3	Purdue University-All Campuses	IN	RESI	
0.3%	3	SUNY-Binghamton	NY	DOCI	
0.2%	3	San Francisco State University	CA	COMPI	
0.2%	3	San Jose State University	CA	COMPI	
1.0%	3	Spelman College	GA	LAII	PM HB W
0.1%	3	California State U., Northridge	CA	COMPI	

TABLE 23 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.9%	3	Carnegie-Mellon University	PA	RESI	
0.3%	3	Clemson University	SC	DOCI	
0.2%	3	George Mason University	VA	COMPI	
3.0%	3	Lincoln University	PA	LAII*	PM HB
0.1%	3	Ohio State University-All Campuses	OH	RESI	
0.4%	3	U. of California-Santa Cruz	CA	DOCI	
0.9%	3	U. of Chicago	IL	RESI	
0.2%	3	U. of Nebraska-Lincoln	NE	RESII	
0.1%	3	U. of North Carolina-Chapel Hill	NC	RESI	
0.3%	3	U. of Wisconsin-Eau Claire	WI	COMPI	
0.7%	3	Wake Forest University	NC	COMPI	
0.5%	3	Wellesley College	MA	LAI	W

TABLE 24
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
IN ORDER BY % OF WOMEN BACCALAUREATES IN ALL-FIELDS

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
0.7%	3,586	All Academic Institutions				
14.9%	3	Harvey Mudd College	CA	ENGR		
14.6%	4	California Institute of Technology	CA	RESI		
13.7%	23	Xavier University of Louisiana	LA	COMPII	PM	HB
9.3%	4	South Dakota School of Mines & Tech.	SD	ENGR		
9.0%	4	New Mexico Institute Mining & Tech.	NM	ENGR		
8.5%	5	Fisk University	TN	LAII	PM	HB
8.5%	6	Tougaloo College	MS	LAII	PM	HB
7.8%	4	Talladega College	AL	LAII*	PM	HB
7.7%	14	Case Western Reserve University	OH	RESI		
6.7%	7	Washington and Jefferson College	PA	LAI		
6.5%	8	Kalamazoo College	MI	LAI		
6.2%	7	Hendrix College	AR	LAI		
6.0%	11	C. of Wooster	OH	LAI		
5.9%	16	Bryn Mawr College	PA	LAI		W
5.9%	3	Judson College	AL	LAII		W
5.9%	2	Piedmont College	GA	LAII*		
5.7%	6	Knox College	IL	LAI		
5.7%	4	Lambuth College	TN	LAII*		
5.5%	2	Kansas Wesleyan	KS	LAII*		
5.2%	4	US Naval Academy	MD	OTHER		
5.1%	6	Juniata College	PA	LAI		
5.1%	3	Kentucky Wesleyan College	KY	LAII*		
5.1%	16	Houston Baptist University	TX	COMPI		
4.7%	3	Wofford College	SC	LAII		
4.6%	3	Huntingdon College	AL	LAII*		

TABLE 24 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION			
4.6%	3	SUNY-C. of Environ Sci. & Forestry	NY	DOCII			
4.4%	10	Williams College	MA	LAI			
4.4%	10	Carleton College	MN	LAI			
4.4%	7	Armstrong State College	GA	COMPI			
4.3%	2	Arkansas College	AR	LAII*			
4.2%	13	Spelman College	GA	LAII	PM	HB	W
4.2%	10	Gannon University	PA	COMPI			
4.1%	4	Chatham College	PA	LAI			W
4.0%	6	Berea College	KY	COMPII			
4.0%	2	Eureka College	IL	LAII*			
3.9%	6	Ursinus College	PA	LAI			
3.9%	8	Allegheny College	PA	LAI			
3.8%	3	Stillman College	AL	LAII*	PM	HB	
3.8%	11	Massachusetts Inst. of Technology	MA	RESI			
3.7%	2	C. of Idaho	ID	LAII			
3.6%	1	Huntington College	IN	LAII*			
3.6%	3	Clarke College (IA)	IA	LAII*			W
3.6%	1	Saint Mary's College	MI	LAII*			
3.6%	8	U. of Puerto Rico-Humacao U. C.	PR	COMPI	PM		
3.5%	4	Millsaps College	MS	LAI			
3.5%	6	Converse College	SC	LAII			W
3.4%	10	U. of Puerto Rico-Cayey U. C.	PR	COMPI	PM		
3.3%	2	Rust College	MS	LAII*	PM	HB	
3.3%	1	Wiley College	TX	LAII*	PM	HB	
3.3%	12	Saint Olaf College	MN	LAI			

TABLE 24 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
3.3%	4	Chestnut Hill College	PA	LAI		W
3.2%	11	C. of the Holy Cross	MA	LAI		
3.2%	5	Berry College	GA	LAII*		
3.1%	6	Saint Norbert College	WI	COMPII		
3.1%	4	Haverford College	PA	LAI		
3.1%	5	Grinnell College	IA	LAI		
3.1%	6	Kenyon College	OH	LAI		
3.1%	1	Jarvis Christian College	TX	LAII*	PM	HB
3.0%	3	Lincoln University	PA	LAII*	PM	HB
3.0%	4	Saint Joseph College	CT	LAII*		W
3.0%	3	Spring Hill College	AL	LAII		
2.9%	1	Tabor College	KS	LAII*		
2.8%	3	Agnes Scott College	GA	LAI		W
2.8%	1	Maryville College	TN	LAII		
2.8%	4	Davidson College	NC	LAI		
2.8%	2	Montana C. of Mineral Sci. & Tech.	MT	COMPII		
2.8%	2	Delaware Valley C. of Sci. & Agr.	PA	COMPII		
2.7%	6	Union College (NY)	NY	LAI		
2.7%	2	Saint Mary College	KS	LAII*		W
2.7%	5	U. of Missouri-Rolla	MO	DOCII		
2.7%	3	Lebanon Valley College	PA	LAI		
2.7%	1	King College	TN	LAI		
2.7%	32	North Carolina State U.-Raleigh	NC	RESI		
2.7%	2	Sioux Falls College	SD	LAII*		
2.6%	6	C. of Mount Saint Joseph	OH	COMPII		W

TABLE 24 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
2.6%	3	Hanover College	IN	LAI
2.6%	4	Bowdoin College	ME	LAI
2.6%	2	Ripon College	WI	LAI
2.6%	5	Pomona College	CA	LAI
2.6%	6	Franklin and Marshall College	PA	LAI
2.6%	2	Colorado School of Mines	CO	DOCII
2.6%	2	Wells College	NY	LAI W
2.6%	4	Dillard University	LA	LAII* PM HB
2.5%	6	Grove City College	PA	COMPII
2.5%	5	Lynchburg College	VA	COMPII
2.5%	4	Alcorn State University	MS	COMPII PM HB
2.5%	3	Hiram College	OH	LAII
2.5%	4	Cabrini College	PA	LAII*
2.5%	5	Rensselaer Polytechnic Institute	NY	RESII
2.5%	10	U. of Scranton	PA	COMPI
2.5%	2	Wesleyan College	GA	LAII W
2.5%	5	Clarkson University	NY	DOCII
2.5%	2	Saint Andrews Presbyterian College	NC	LAII*
2.5%	6	Fort Lewis College	CO	COMPI
2.5%	2	Adrian College	MI	LAII
2.5%	5	Regis College (MA)	MA	LAI W
2.5%	3	Earlham College	IN	LAI
2.5%	5	Lafayette College	PA	LAI
2.5%	19	Duke University	NC	RESI
2.5%	2	Oakwood College	AL	LAII* PM HB

TABLE 25
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.2%	815	All Academic Institutions			
0.5%	16	U. of Texas-Austin	TX	RESI	
0.4%	13	U. of Wisconsin-Madison	WI	RESI	
0.5%	12	Texas A & M U.-All Campuses	TX	RESI	
4.4%	10	Carleton College	MN	LAI	
0.4%	9	U. of Washington	WA	RESI	
0.4%	9	U. of Colorado-All Campuses	CO	RESI	
0.5%	9	U. of California-Santa Barbara	CA	RESII	
0.5%	7	Central Michigan University	MI	COMPI	
0.2%	7	Pennsylvania State U.-All Campuses	PA	RESI	
1.0%	7	U. of California-Santa Cruz	CA	DOCI	
0.2%	7	U. of Minnesota-All Campuses	MN	RESI	
0.3%	7	U. of South Florida	FL	DOCI	
0.5%	7	Eastern Michigan University	MI	COMPI	
0.1%	7	Indiana University-All Campuses	IN	RESI	
0.8%	7	Northern Arizona University	AZ	DOCII	PM
0.3%	7	San Diego State University	CA	COMPI	
1.4%	6	Mary Washington College	VA	COMPI	
0.2%	6	U. of California-Berkeley	CA	RESI	
0.4%	5	Colorado State University	CO	RESI	
0.2%	5	U. of Florida	FL	RESI	
0.9%	5	U. of Lowell	MA	COMPI	
0.2%	5	U. of Maryland-College Park	MD	RESI	
0.1%	5	Rutgers State U.-All Campuses	NJ	RESI	
0.7%	5	Sam Houston State University	TX	COMPI	
0.7%	5	Stanford University	CA	RESI	

TABLE 25 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.3%	5	U. of Arizona	AZ	RESI	
0.4%	5	U. of Houston	TX	DOCI	
0.2%	5	California State U., Northridge	CA	COMPI	
0.2%	5	California State U., Sacramento	CA	COMPI	
0.3%	5	Cornell University	NY	RESI	
1.5%	5	Massachusetts Institute of Tech.	MA	RESI	
0.3%	5	U. of Delaware	DE	RESII	
0.3%	5	Virginia Polytechnic Institute	VA	RESI	
1.4%	4	Colgate University	NY	LAI	
0.5%	4	C. of William and Mary	VA	DOCI	
2.0%	4	Franklin and Marshall College	PA	LAI	
9.8%	4	New Mexico Institute Mining & Tech.	NM	ENGR	
0.1%	4	Ohio State U.-All Campuses	OH	RESI	
0.6%	4	Smith College	MA	LAI	W
0.3%	4	U. of Texas-Arlington	TX	DOCII	
3.2%	4	Whitman College	WA	LAI	
1.5%	4	Bryn Mawr College	PA	LAI	W
1.7%	4	Fort Lewis College	CO	COMPI	
0.2%	4	Louisiana State U.-All Campuses	LA	RESI	
0.3%	4	Oregon State University	OR	RESI	
0.2%	4	U. of California-Davis	CA	RESI	
0.5%	4	U. of Massachusetts-Boston	MA	COMPI	
0.1%	4	U. of Michigan-All Campuses	MI	RESI	
0.3%	4	U. of Oregon	OR	RESII	
0.5%	4	Wright State University	OH	COMPI	

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TABLE 25 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.3%	4	Baylor University	TX	DOCII	
0.5%	4	Bloomsburg University	PA	COMPI	
0.5%	4	Cleveland State University	OH	DOCII	
0.3%	4	Kent State University-All Campuses	OH	DOCI	
0.5%	4	Middle Tennessee State University	TN	DOCII	
0.5%	4	SUNY-College at Oneonta	NY	COMPI	
0.6%	4	U. of New Orleans	LA	DOCII	
0.3%	4	U. of Wisconsin-Milwaukee	WI	DOCI	
0.6%	4	Wellesley College	MA	LAI	W
0.3%	4	West Virginia University	WV	RESII	

TABLE 26
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE[2]
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
IN ORDER BY % OF WOMEN BACCALAUREATES IN ALL-FIELDS

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
3.8%	19,852	All Academic Institutions		
28.0%	81	U. of Puerto Rico-Cayey U. C.	PR	COMPI PM
24.4%	11	Northland College	WI	LAII
21.3%	6	California Institute of Technology	CA	RESI
21.1%	14	Oakwood College	AL	LAII* PM HB
20.9%	3	Marlboro College	VT	LAI
20.1%	14	Wofford College	SC	LAII
20.1%	56	Johns Hopkins University	MD	RESI
19.5%	22	U. of Dallas	TX	LAI
19.3%	10	C. of Idaho	ID	LAII
19.1%	314	U. of California-Davis	CA	RESI
18.8%	7	King College	TN	LAI
18.2%	204	U. of California-Irvine	CA	RESI
17.8%	52	U. of Chicago	IL	RESI
17.3%	6	Wilson College	PA	LAII W
16.6%	14	Delaware Valley C. of Sci. & Agr.	PA	COMPII
16.2%	11	SUNY-C. of Envir. Sci. & Forestry	NY	DOCII
16.2%	168	U. of California-San Diego	CA	RESI
16.0%	67	U. of California-Riverside	CA	DOCI
15.9%	6	Paine College	GA	LAII* PM HB
15.1%	25	Andrews University	MI	DOCII

[2]These data do not include specialized optometric, chiropractic or podiatric institutions.

TABLE 26 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION			
15.0%	1	Shimer College	IL	OTHER			
15.0%	10	Tougaloo College	MS	LAII	PM	HB	
14.8%	24	Ursinus College	PA	LAI			
14.8%	12	Centre College of Kentucky	KY	LAI			
14.6%	17	Juniata College	PA	LAI			
14.5%	67	Inter American U. of PR-San German	PR	COMPI	PM		
14.4%	8	Talladega College	AL	LAII*	PM	HB	
14.3%	6	Warren Wilson College	NC	LAII			
14.2%	16	Chestnut Hill College	PA	LAI			W
14.2%	15	Alma College	MI	LAI			
14.0%	15	Washington and Jefferson College	PA	LAI			
13.9%	13	Beloit College	WI	LAI			
13.7%	7	Felician College	NJ	LAII*			W
13.6%	41	Massachusetts Institute of Tech.	MA	RESI			
13.5%	27	Albright College	PA	LAI			
13.3%	8	Rust College	MS	LAII*	PM	HB	
13.3%	31	Augustana College	IL	LAI			
13.2%	14	Earlham College	IN	LAI			
13.0%	14	Hendrix College	AR	LAI			
12.9%	19	Inter American U. of Pr-Bayamon	PR	PM			
12.8%	7	Fisk University	TN	LAII	PM	HB	
12.5%	26	Union College	NY	LAI			
12.2%	11	Heidelberg College	OH	LAII*			
12.2%	26	Saint Mary's U. of San Antonio	TX	COMPI	PM		
11.9%	44	Saint Olaf College	MN	LAI			

TABLE 26 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
11.9%	11	Reed College	OR	LAI		
11.9%	6	Greensboro College	NC	LAII*		
11.7%	56	U. of Rochester	NY	RESI		
11.5%	84	U. of California-Santa Cruz	CA	DOCI		
11.4%	13	Hanover College	IN	LAI		
11.4%	8	Saint Andrews Presbyterian College	NC	LAII*		
11.3%	15	Hiram College	OH	LAII		
11.3%	20	Case Western Reserve University	OH	RESI		
11.2%	19	Albion College	MI	LAI		
11.1%	24	Rensselaer Polytechnic Institute	NY	RESII		
11.1%	12	Lebanon Valley College	PA	LAI		
11.1%	22	Bates College	ME	LAI		
11.1%	8	Stillman College	AL	LAII*	PM	HB
11.0%	178	U. of Puerto Rico-Rio Piedras C.	PR	COMPI	PM	
11.0%	3	Texas College	TX	LAII*	PM	HB
10.9%	21	Muhlenberg College	PA	LAI		
10.8%	4	Concordia College	NY	LAII*		
10.7%	14	Haverford College	PA	LAI		
10.7%	55	Mount Holyoke College	MA	LAI		W
10.6%	20	Occidental College	CA	LAI		
10.5%	56	U. of Puerto Rico-Mayaguez	PR	COMPI	PM	
10.5%	4	McPherson College	KS	LAII*		
10.5%	12	Kalamazoo College	MI	LAI		
10.5%	10	Transylvania University	KY	LAII		
10.4%	44	Princeton University	NJ	RESI		

TABLE 26 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
10.4%	7	Southwestern College (KS)	KS	LAII*
10.3%	17	Bowdoin College	ME	LAI
10.3%	155	Cornell University	NY	RESI
10.3%	18	Mississippi Valley State U.	MS	COMPII PM HB
10.2%	19	Millikin University	IL	COMPII
10.2%	73	Brown University	RI	RESII
10.2%	13	Austin College	TX	LAI
10.1%	25	Colorado College	CO	LAI
10.0%	8	Ripon College	WI	LAI
10.0%	21	Allegheny College	PA	LAI
9.9%	14	Saint Mary's College of Maryland	MD	LAII
9.9%	26	Hope College	MI	LAI
9.9%	255	U. of California-Berkeley	CA	RESI
9.9%	12	Lawrence University	WI	LAI
9.8%	9	Adrian College	MI	LAII
9.8%	8	Baker University	KS	LAII*
9.7%	26	Luther College	IA	LAI
9.7%	14	Illinois Benedictine College	IL	COMPII
9.7%	25	Rice University	TX	DOCI
9.7%	16	Grinnell College	IA	LAI
9.6%	4	Dana College	NE	LAII*
9.5%	10	Knox College	IL	LAI
9.5%	19	Tuskegee University	AL	COMPI PM HB
9.5%	21	Carleton College	MN	LAI
9.5%	22	Gannon University	PA	COMPI

TABLE 27
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.6%	15,937	All Academic Institutions		
5.4%	257	U of California-Los Angeles	CA	RESI
2.6%	209	Pennsylvania State U.-All Campuses	PA	RESI
3.0%	188	U. of Illinois-Urbana	IL	RESI
2.9%	152	U. of Washington	WA	RESI
2.5%	150	U. of Wisconsin-Madison	WI	RESI
6.8%	147	SUNY-Stony Brook	NY	RESI
2.7%	144	U. of California-Berkeley	CA	RESI
1.9%	131	U. of Minnesota-All Campuses	MN	RESI
2.6%	129	U. of Colorado-All Campuses	CO	RESI
13.8%	127	Carnegie-Mellon University	PA	RESI
2.1%	120	Purdue University-All Campuses	IN	RESI
4.1%	112	U. of Illinois-Chicago	IL	RESI
1.7%	111	U. of Michigan-All Campuses	MI	RESI
5.0%	109	U. of California-San Diego	CA	RESI
1.5%	100	Rutgers State U.-All Campuses	NJ	RESI
1.9%	98	Brigham Young University-All Campuses	UT	DOCI
2.5%	94	U. of Pittsburgh-All Campuses	PA	RESI
2.8%	94	San Jose State University	CA	COMPI
2.9%	89	U. of California-Davis	CA	RESI
2.7%	89	U. of North Carolina-Chapel Hill	NC	RESI
1.1%	88	Indiana University-All Campuses	IN	RESI
12.6%	87	SUNY-College at Potsdam	NY	COMPI
3.1%	86	Central Michigan University	MI	COMPI
1.3%	85	U. of Texas-Austin	TX	RESI
6.8%	82	Vanderbilt University	TN	RESI

TABLE 27 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
3.2%	82	U. of Texas-Arlington	TX	DOCII
2.8%	80	U. of Connecticut	CT	RESI
1.5%	79	U. of Florida	FL	RESI
7.4%	78	US Naval Academy	MD	OTHER
3.2%	76	SUNY-Albany	NY	RESII
3.8%	74	U. of New Hampshire	NH	DOCII
1.1%	73	Ohio State University-All Campuses	OH	RESI
10.4%	73	Saint Olaf College	MN	LAI
1.1%	73	Michigan State University	MI	RESI
5.7%	67	Massachusetts Institute of Technology	MA	RESI
1.5%	66	San Diego State University	CA	COMPI
1.8%	66	Virginia Polytechnic Inst. & State U	VA	RESI
3.0%	63	U. of California-Irvine	CA	RESI
2.7%	61	Boston College	MA	DOCI
2.1%	60	Colorado State University	CO	RESI
1.9%	59	Miami University-All Campuses	OH	DOCI
2.1%	58	SUNY-Buffalo	NY	RESII
1.4%	58	Auburn University-All Campuses	AL	RESII
1.5%	57	U. of Iowa	IA	RESI
3.1%	56	Harvard University	MA	RESI
2.7%	55	SUNY-Binghamton	NY	DOCI
3.3%	55	Metropolitan State College	CO	COMPI
1.8%	55	U. of Virginia	VA	RESI
1.0%	54	U. of Maryland-College Park	MD	RESI
2.6%	54	Clemson University	SC	DOCI

TABLE 27 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.5%	53	Illinois State University	IL	DOCII
1.7%	53	U. of California-Santa Barbara	CA	RESII
1.2%	52	U. of Massachusetts-Amherst	MA	RESII
1.4%	52	Northern Illinois University	IL	DOCI
1.6%	51	North Carolina State U.-Raleigh	NC	RESI
4.8%	50	Shippensburg University of Pennsylvania	PA	COMPI
1.7%	48	U. of Utah	UT	RESI
1.3%	47	U. of South Carolina-All Campuses	SC	RESII
3.3%	47	Brown University	RI	RESII
1.1%	47	Iowa State U. of Science & Tech.	IA	RESII
1.7%	45	Ball State University	IN	DOCI
2.2%	45	U. of Southern Mississippi	MS	DOCI
1.9%	45	U. of Pennsylvania	PA	RESI
1.3%	45	California State U., Northridge	CA	COMPI
1.6%	45	U. of Nebraska-Lincoln	NE	RESII
2.1%	45	Georgia State University	GA	DOCI
1.3%	43	U. of Tennessee-Knoxville	TN	RESI
1.3%	43	Cornell University	NY	RESI
2.6%	43	C. of William and Mary	VA	DOCI
2.4%	42	U. of Vermont	VT	DOCII
2.5%	42	Appalachian State University	NC	COMPI
1.5%	41	California Poly St U, San Luis Obispo	CA	COMPI
1.6%	41	Kent State University-All Campuses	OH	DOCI
1.6%	40	U. of Akron	OH	DOCI
0.9%	39	California State U., Long Beach	CA	COMPI

TABLE 27 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.4%	39	New York University	NY	RESI
1.5%	39	Oregon State University	OR	RESI
1.2%	39	Temple University	PA	RESII
2.3%	39	Stanford University	CA	RESI
2.4%	39	U. of Wisconsin-Eau Claire	WI	COMPI
1.2%	38	Syracuse University-All Campuses	NY	RESII
5.3%	38	U. of Chicago	IL	RESI
5.8%	38	Northern Kentucky University	KY	COMPI
8.6%	38	Citadel Military College of S Carolina	SC	COMPI
1.4%	37	U. of Oklahoma	OK	RESII
1.4%	37	U. of Houston	TX	DOCI
2.3%	37	Duke University	NC	RESI
2.3%	37	Montana State University	MT	DOCII
3.3%	37	SUNY-College at Oneonta	NY	COMPI
1.5%	36	U. of Oregon	OR	RESII
1.5%	36	Eastern Michigan University	MI	COMPI
1.9%	36	Virginia Commonwealth University	VA	RESII
3.3%	36	Millersville University of Pennsylvania	PA	COMPI
5.5%	36	C. of the Holy Cross	MA	LAI
2.5%	36	U. of Texas-San Antonio	TX	COMPI PM
1.4%	35	California State Univ, Chico	CA	COMPI
2.8%	35	U. of Wisconsin-Stout	WI	COMPI
1.0%	35	California State Univ, Sacramento	CA	COMPI

TABLE 28
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.4%	4,258	All Academic Institutions		
6.7%	78	Massachusetts Institute of Technology	MA	RESI
1.1%	57	U. of California-Berkeley	CA	RESI
5.3%	57	Rensselaer Polytechnic Institute	NY	RESII
1.0%	51	U. of Washington	WA	RESI
1.0%	50	U of California-Los Angeles	CA	RESI
1.4%	44	Cornell University	NY	RESI
2.2%	44	Georgia Institute of Tech.-All Campuses	GA	RESI
0.7%	43	Rutgers State U.-All Campuses	NJ	RESI
0.6%	38	U. of Minnesota-All Campuses	MN	RESI
1.7%	36	U. of California-Irvine	CA	RESI
17.9%	35	California Institute of Technology	CA	RESI
1.9%	34	Harvard University	MA	RESI
0.5%	33	U. of Texas-Austin	TX	RESI
1.2%	33	U. of Utah	UT	RESI
1.5%	32	U. of California-San Diego	CA	RESI
0.6%	32	U. of Colorado-All Campuses	CO	RESI
3.0%	31	US Naval Academy	MD	OTHER
0.4%	31	Pennsylvania State U.-All Campuses	PA	RESI
4.1%	29	U. of Chicago	IL	RESI
0.4%	28	U. of Michigan-All Campuses	MI	RESI
0.8%	28	San Jose State University	CA	COMPI
0.5%	28	U. of Maryland-College Park	MD	RESI
2.5%	27	Princeton University	NJ	RESI
0.9%	27	U. of California-Davis	CA	RESI
2.0%	27	U. of California-Santa Cruz	CA	DOCI

TABLE 28 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.9%	26	U. of California-Santa Barbara	CA	RESII
0.4%	26	Ohio State University-All Campuses	OH	RESI
0.5%	24	Brigham Young University-All Campuses	UT	DOCI
2.6%	24	Carnegie-Mellon University	PA	RESI
0.4%	24	Purdue University-All Campuses	IN	RESI
0.5%	23	San Diego State University	CA	COMPI
0.5%	23	U. of Massachusetts-Amherst	MA	RESII
1.0%	22	SUNY-Binghamton	NY	DOCI
17.9%	21	Harvey Mudd College	CA	ENGR
1.0%	21	SUNY-Stony Brook	NY	RESI
0.3%	21	Texas A & M University-All Campuses	TX	RESI
4.8%	21	Carleton College	MN	LAI
1.3%	21	U. of Lowell	MA	COMPI
0.3%	20	U. of Illinois-Urbana	IL	RESI
0.3%	19	Michigan State University	MI	RESI
9.1%	19	Reed College	OR	LAI
0.3%	19	U. of Wisconsin-Madison	WI	RESI
0.5%	17	Virginia Polytechnic Institute	VA	RESI
0.5%	17	California State U., Northridge	CA	COMPI
4.2%	17	Bates College	ME	LAI
0.7%	17	SUNY-Albany	NY	RESII
1.0%	17	Stanford University	CA	RESI
0.5%	16	U. of Virginia	VA	RESI
1.0%	16	C. of William and Mary	VA	DOCI
2.3%	16	SUNY-College at Potsdam	NY	COMPI

TABLE 28 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.5%	16	U. of North Carolina-Chapel Hill	NC	RESI
0.5%	15	North Carolina State U.-Raleigh	NC	RESI
0.6%	15	Oregon State University	OR	RESI
4.2%	15	Jacksonville University	FL	COMPII
0.4%	15	U. of Arizona	AZ	RESI
0.3%	14	Iowa State U. of Science & Tech	IA	RESII
2.0%	14	Saint Olaf College	MN	LAI
1.2%	14	American University	DC	DOCI
2.3%	14	Case Western Reserve University	OH	RESI
0.3%	14	U. of Florida	FL	RESI
1.3%	14	U. of Rochester	NY	RESI
0.4%	14	U. of South Florida	FL	DOCI
4.9%	14	Whitman College	WA	LAI
1.5%	14	SUNY-College at Fredonia	NY	COMPI
0.2%	13	Arizona State University	AZ	RESII
0.3%	13	Auburn University-All Campuses	AL	RESII
0.5%	13	Colorado State University	CO	RESI
1.8%	13	U. of California-Riverside	CA	DOCI
1.2%	13	Millersville University of Pennsylvania	PA	COMPI
2.1%	13	Rice University	TX	DOCI
0.7%	13	U. of New Hampshire	NH	DOCII
0.3%	13	California State U., Long Beach	CA	COMPI
3.4%	13	Occidental College	CA	LAI
0.8%	13	U. of Wisconsin-Eau Claire	WI	COMPI
1.1%	12	Michigan Technological University	MI	COMPI

TABLE 28 (CONTINUED)
BACCALAUREATE DEGREES IN PHYSICS
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.2%	12	US Air Force Academy	CO	OTHER
0.4%	12	U. of Nebraska-Lincoln	NE	RESII
2.1%	12	Gustavus Adolphus College	MN	LAI
0.1%	12	Indiana University-All Campuses	IN	RESI
8.1%	12	New Mexico Institute of Mining & Tech.	NM	ENGR
0.5%	12	U. of Akron	OH	DOCI
1.8%	12	C. of the Holy Cross	MA	LAI
0.7%	12	Duke University	NC	RESI
0.8%	11	Drexel University	PA	DOCII
0.4%	11	San Francisco State University	CA	COMPI
0.4%	11	U. of Connecticut	CT	RESI
1.3%	11	U. of Tennessee-Chattanooga	TN	COMPI
1.1%	11	U. of Texas-Dallas	TX	DOCII
0.9%	11	Yale University	CT	RESI
2.5%	11	Augustana Collge (IL)	IL	LAI
0.7%	11	Montana State University	MT	DOCII
0.4%	11	U. of Oregon	OR	RESII
0.4%	11	U. of Texas-Arlington	TX	DOCII
2.0%	11	John Carroll University	OH	COMPI
0.9%	11	SUNY-College at Plattsburgh	NY	COMPI
0.9%	11	Southern University and A & M College	LA	COMPI PM HB

TABLE 29
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.9%	9,270	All Academic Institutions		
1.7%	142	Indiana University-All Campuses	IN	RESI
2.8%	93	U. of North Carolina-Chapel Hill	NC	RESI
2.8%	85	U. of Virginia	VA	RESI
2.1%	80	U. of Pittsburgh-All Campuses	PA	RESI
1.3%	79	U. of Illinois-Urbana	IL	RESI
1.2%	79	Rutgers State U.-All Campuses	NJ	RESI
2.5%	79	North Carolina State U.-Raleigh	NC	RESI
1.0%	68	U. of Michigan-All Campuses	MI	RESI
1.0%	65	U. of Minnesota-All Campuses	MN	RESI
1.1%	58	U. of California-Berkeley	CA	RESI
2.5%	54	U. of California-Irvine	CA	RESI
1.0%	54	U. of Washington	WA	RESI
1.0%	53	Purdue University-All Campuses	IN	RESI
2.0%	49	West Virginia University	WV	RESII
2.1%	48	Wayne State University	MI	RESII
0.9%	48	U. of Colorado-All Campuses	CO	RESI
0.8%	46	U. of Wisconsin-Madison	WI	RESI
2.8%	45	Duke University	NC	RESI
1.4%	44	Cornell University	NY	RESI
1.6%	44	U. of Delaware	DE	RESII
0.8%	44	U. of Florida	FL	RESI
1.3%	43	Miami University-All Campuses	OH	DOCI
2.0%	43	U. of California-San Diego	CA	RESI
1.5%	42	New York University	NY	RESI
1.7%	39	U. of Puerto Rico-Rio Piedras C.	PR	COMPI PM

TABLE 29 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.5%	38	Pennsylvania State U.-All Campuses	PA	RESI
5.3%	38	Saint Olaf College	MN	LAI
0.7%	36	Brigham Young University-All Campuses	UT	DOCI
0.5%	36	Michigan State University	MI	RESI
1.2%	36	U. of California-Davis	CA	RESI
0.5%	35	Ohio State University-All Campuses	OH	RESI
13.4%	34	Xavier University of Louisiana	LA	COMPII PM HB
0.9%	34	Illinois State University	IL	DOCII
0.8%	34	U. of South Florida	FL	DOCI
5.4%	33	Case Western Reserve University	OH	RESI
2.6%	32	Emory University	GA	RESII
2.0%	32	C. of William and Mary	VA	DOCI
6.1%	32	Houston Baptist University	TX	COMPI
1.5%	32	SUNY-Stony Brook	NY	RESI
1.3%	32	U. of Akron	OH	DOCI
4.4%	32	U. of Chicago	IL	RESI
0.8%	32	California State Univ, Long Beach	CA	COMPI
1.5%	32	U. of Southern Mississippi	MS	DOCI
1.1%	31	SUNY-Buffalo	NY	RESII
0.8%	30	Virginia Polytechnic Inst. & State U	VA	RESI
2.6%	30	Massachusetts Institute of Technology	MA	RESI
0.9%	30	San Jose State University	CA	COMPI
0.4%	30	U. of Texas-Austin	TX	RESI
0.6%	29	U of California-Los Angeles	CA	RESI

TABLE 29 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
0.5%	29	U. of Maryland-College Park	MD	RESI	
1.6%	29	U. of Miami	FL	RESI	
1.0%	29	U. of Connecticut	CT	RESI	
7.6%	28	C. of Wooster	OH	LAI	
0.9%	28	U. of Kansas	KS	RESII	
4.2%	28	C. of the Holy Cross	MA	LAI	
1.5%	28	Harvard University	MA	RESI	
1.0%	28	U. of Illinois-Chicago	IL	RESI	
5.4%	27	Gannon University	PA	COMPI	
1.5%	27	Rochester Institute of Technology	NY	COMPI	
1.0%	27	U. of Oklahoma	OK	RESII	
0.5%	27	Arizona State University	AZ	RESII	
0.7%	27	Auburn University-All Campuses	AL	RESII	
0.7%	27	U. of Arizona	AZ	RESI	
1.7%	27	U. of Wisconsin-Eau Claire	WI	COMPI	
6.2%	26	Carleton College	MN	LAI	
3.4%	26	Wake Forest University	NC	COMPI	
0.9%	26	U. of Cincinnati	OH	RESI	
4.9%	25	Williams College	MA	LAI	
2.1%	25	Howard University	DC	RESI PM	HB
0.6%	25	U. of Massachusetts-Amherst	MA	RESII	
0.8%	24	Colorado State University	CO	RESI	
2.3%	23	Marshall University	WV	COMPI	
9.0%	23	Washington and Jefferson College	PA	LAI	
0.9%	23	U. of Pennsylvania	PA	RESI	

TABLE 29
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
2.7%	23	U. of Scranton	PA	COMPI
2.0%	23	Catholic University of Puerto Rico	PR	COMPI PM
0.6%	23	Northern Illinois University	IL	DOCI
2.6%	23	U. of Tennessee-Chattanooga	TN	COMPI
0.8%	23	U. of Utah	UT	RESI
1.1%	22	SUNY-Binghamton	NY	DOCI
0.4%	22	Texas A & M University-All Campuses	TX	RESI
0.8%	21	Kent State University-All Campuses	OH	DOCI
1.3%	21	U. of Louisville	KY	DOCI
1.7%	21	U. of Wisconsin-Stevens Point	WI	COMPI
4.4%	21	Hope College	MI	LAI
1.3%	21	Northern Arizona University	AZ	DOCII PM
0.5%	21	U. of Iowa	IA	RESI
1.1%	21	Virginia Commonwealth University	VA	RESII
1.4%	21	Loyola University of Chicago	IL	DOCI PM
1.9%	21	Princeton University	NJ	RESI
1.9%	21	Rensselaer Polytechnic Institute	NY	RESII
0.9%	21	SUNY-Albany	NY	RESII
1.7%	21	Saint Louis University	MO	DOCI
0.8%	20	U. of Oregon	OR	RESII
2.7%	20	Creighton University	NE	COMPI
0.8%	20	Eastern Michigan University	MI	COMPI
0.6%	20	U. of Missouri-Columbia	MO	RESI
1.8%	20	U. of Missouri-Kansas City	MO	DOCII
6.3%	20	Grinnell College	IA	LAI
0.4%	20	San Diego State University	CA	COMPI
0.6%	20	Temple University	PA	RESII

TABLE 30
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.3%	3,319	All Academic Institutions		
0.9%	60	U. of Texas-Austin	TX	RESI
0.7%	47	U. of Minnesota-All Campuses	MN	RESI
0.7%	45	U. of Wisconsin-Madison	WI	RESI
0.6%	35	Texas A & M U.-All Campuses	TX	RESI
0.8%	35	San Diego State University	CA	COMPI
0.4%	34	Pennsylvania State U.-All Campuses	PA	RESI
0.7%	33	U. of Colorado-All Campuses	CO	RESI
1.1%	31	Central Michigan University	MI	COMPI
0.9%	29	U. of California-Santa Barbara	CA	RESII
0.5%	27	U. of Washington	WA	RESI
1.9%	26	U. of California-Santa Cruz	CA	DOCI
0.3%	24	Indiana University-All Campuses	IN	RESI
0.4%	24	Rutgers State U.-All Campuses	NJ	RESI
1.0%	24	West Virginia University	WV	RESII
1.4%	22	Northern Arizona University	AZ	DOCII PM
0.7%	22	California State U., Northridge	CA	COMPI
0.8%	22	U. of Oklahoma	OK	RESII
1.3%	21	U. of Wyoming	WY	RESII
0.4%	21	Brigham Young U.-All Campuses	UT	DOCI
0.7%	21	Colorado State University	CO	RESI
0.3%	20	Ohio State U.-All Campuses	OH	RESI
1.3%	20	Wright State University	OH	COMPI
2.3%	19	Humboldt State University	CA	COMPI
1.0%	19	Stephen F. Austin State U.	TX	COMPI
0.5%	19	Louisiana State U.-All Campuses	LA	RESI

TABLE 30 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.4%	19	U. of California-Berkeley	CA	RESI
0.5%	19	U. of South Carolina-All Campuses	SC	RESII
0.8%	19	U. of Wisconsin-Milwaukee	WI	DOCI
0.5%	19	Virginia Polytechnic Institute	VA	RESI
0.6%	19	Western Michigan University	MI	DOCI
0.6%	18	Oklahoma State University	OK	RESII
0.3%	18	Purdue University-All Campuses	IN	RESI
0.6%	18	U. of California-Davis	CA	RESI
0.6%	18	U. of Kansas	KS	RESII
0.7%	18	Kent State U.-All Campuses	OH	DOCI
0.7%	18	U. of Houston	TX	DOCI
0.8%	17	Eastern Illinois University	IL	COMPI
1.1%	17	Montana State University	MT	DOCII
1.6%	17	SUNY-College at Brockport	NY	COMPI
1.5%	16	SUNY-College at Oneonta	NY	COMPI
0.8%	16	U. of Alabama	AL	DOCI
0.2%	16	Michigan State University	MI	RESI
10.8%	16	New Mexico Institute Mining & Tech.	NM	ENGR
0.4%	16	U. of Arizona	AZ	RESI
0.3%	16	U. of Illinois-Urbana	IL	RESI
1.7%	16	Clarion University of Pennsylvania	PA	COMPI
0.6%	16	Eastern Michigan University	MI	COMPI
0.6%	16	U. of Delaware	DE	RESII
0.6%	16	U. of Texas-Arlington	TX	DOCII
0.4%	15	Illinois State University	IL	DOCII

TABLE 30 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.5%	15	Texas Tech University	TX	DOCI
0.3%	15	U. of Maryland-College Park	MD	RESI
0.4%	15	U. of Pittsburgh-All Campuses	PA	RESI
0.4%	15	U. of South Florida	FL	DOCI
3.5%	15	Carleton College	MN	LAI
0.6%	15	Oregon State University	OR	RESI
0.8%	15	SUNY-College at Buffalo	NY	COMPI
0.4%	15	California State U., Sacramento	CA	COMPI
1.3%	15	U. of Montana	MT	DOCI
2.1%	14	Colgate University	NY	LAI
0.3%	14	U. of Florida	FL	RESI
1.6%	14	U. of Nevada-Reno	NV	DOCII
0.3%	14	Southern Illinois U.-Carbondale	IL	RESII
0.8%	14	U. of North Carolina-Charlotte	NC	COMPI
0.8%	14	Stanford University	CA	RESI
2.8%	13	Fort Lewis College	CO	COMPI
0.7%	13	U. of Northern Iowa	IA	COMPI
0.4%	13	California State U., Fullerton	CA	COMPI
0.8%	13	Cleveland State University	OH	DOCII
0.5%	13	SUNY-Buffalo	NY	RESII
0.8%	13	Western Washington University	WA	COMPI
0.6%	13	Baylor University	TX	DOCII
1.2%	13	Shippensburg University	PA	COMPI
0.7%	13	U. of New Mexico	NM	RESI
0.8%	12	New Mexico State U.-All Campuses	NM	RESI

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TABLE 30 (CONTINUED)
BACCALAUREATE DEGREES IN EARTH SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.9%	12	Sam Houston State University	TX	COMPI
0.3%	12	U. of Massachusetts-Amherst	MA	RESII
1.1%	12	Bloomsburg University	PA	COMPI
2.5%	12	Franklin and Marshall College	PA	LAI
1.0%	12	Massachusetts Institute of Tech.	MA	RESI
0.9%	12	Northeast Louisiana University	LA	COMPI
0.3%	12	U. of Iowa	IA	RESI
1.0%	12	U. of New Orleans	LA	DOCII
0.8%	12	Brown University	RI	RESII
1.8%	12	Fort Hays State University	KS	COMPI
0.4%	12	Miami University-All Campuses	OH	DOCI
2.4%	12	Midwestern State University	TX	COMPI
0.5%	12	U. of Akron	OH	DOCI
1.0%	12	U. of South Alabama	AL	COMPI
1.0%	11	Millersville University	PA	COMPI
0.7%	11	U. of Arkansas-Fayetteville	AR	DOCI
4.0%	11	Whitman College	WA	LAI
0.8%	11	Wichita State University	KS	COMPI
0.6%	11	Southwest Missouri State University	MO	COMPI
0.4%	11	U. of Utah	UT	RESI
2.0%	11	Saint Lawrence University	NY	LAI
0.3%	11	U. of Tennessee-Knoxville	TN	RESI
1.1%	11	U. of Texas-Dallas	TX	DOCII
0.9%	11	Western Kentucky University	KY	COMPI

TABLE 31
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE[1]
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
4.0%	40,045	All Academic Institutions		
18.3%	557	U. of California-Davis	CA	RESI
9.7%	517	U. of California-Berkeley	CA	RESI
7.1%	472	Rutgers State U.-All Campuses	NJ	RESI
7.0%	430	U. of Illinois-Urbana	IL	RESI
19.8%	421	U. of California-Irvine	CA	RESI
6.0%	363	Texas A & M University-All Campuses	TX	RESI
7.5%	358	U of California-Los Angeles	CA	RESI
16.1%	348	U. of California-San Diego	CA	RESI
4.3%	347	Pennsylvania State U.-All Campuses	PA	RESI
5.2%	344	U. of Michigan-All Campuses	MI	RESI
5.4%	324	U. of Wisconsin-Madison	WI	RESI
9.8%	316	Cornell University	NY	RESI
4.3%	291	U. of Minnesota-All Campuses	MN	RESI
3.6%	291	Indiana University-All Campuses	IN	RESI
12.5%	288	U. of Puerto Rico-Rio Piedras C.	PR	COMPI PM
4.9%	278	U. of Maryland-College Park	MD	RESI
4.1%	275	U. of Texas-Austin	TX	RESI
4.0%	267	Michigan State University	MI	RESI
4.7%	237	U. of Colorado-All Campuses	CO	RESI
4.4%	229	U. of Washington	WA	RESI

[1] These data do not include specialized optometric, chiropractic or podiatric institutions.

TABLE 31 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
10.4%	224	SUNY-Stony Brook	NY	RESI
5.3%	222	U. of Massachusetts-Amherst	MA	RESII
5.7%	209	Virginia Polytechnic Institute	VA	RESI
2.8%	192	Ohio State University-All Campuses	OH	RESI
5.1%	191	U. of Pittsburgh-All Campuses	PA	RESI
3.7%	189	Brigham Young University-All Campuses	UT	DOCI
4.7%	186	U. of South Florida	FL	DOCI
3.6%	186	U. of Florida	FL	RESI
10.2%	183	Harvard University	MA	RESI
6.8%	182	Oregon State University	OR	RESI
5.8%	178	U. of California-Santa Barbara	CA	RESII
5.3%	177	U. of North Carolina-Chapel Hill	NC	RESI
4.6%	177	U. of Georgia	GA	RESI
23.1%	172	Johns Hopkins University	MD	RESI
6.0%	171	Colorado State University	CO	RESI
8.0%	166	SUNY-Binghamton	NY	DOCI
5.1%	163	North Carolina State U.-Raleigh	NC	RESI
4.2%	158	U. of Arizona	AZ	RESI
11.5%	158	U. of California-Santa Cruz	CA	DOCI
9.4%	157	Stanford University	CA	RESI
4.8%	154	Miami University-All Campuses	OH	DOCI
2.7%	153	Purdue University-All Campuses	IN	RESI
10.1%	145	Brown University	RI	RESII
5.5%	145	Kansas State U. of Ag & Appl Science	KS	RESII
5.3%	144	Washington State University	WA	RESII

TABLE 31 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
6.0%	140	SUNY-Albany	NY	RESII
18.3%	138	U. of California-Riverside	CA	DOCI
3.7%	137	U. of South Carolina-All Campuses	SC	RESII
12.3%	135	U. of Rochester	NY	RESI
4.0%	131	U. of Kansas	KS	RESII
3.4%	131	U. of Iowa	IA	RESI
4.5%	131	U. of Connecticut	CT	RESI
8.6%	129	Loyola University of Chicago	IL	DOCI PM
3.4%	128	Louisiana State University-All Campuses	LA	RESI
2.8%	128	Southern Illinois University-Carbondale	IL	RESII
2.8%	123	San Diego State University	CA	COMPI
7.5%	122	Duke University	NC	RESI
2.9%	121	California State Univ, Long Beach	CA	COMPI
4.4%	121	U. of Delaware	DE	RESII
5.1%	118	Wayne State University	MI	RESII
27.6%	116	U. of Puerto Rico-Cayey U. C.	PR	COMPI PM
4.3%	115	California Poly St U, San Luis Obispo	CA	COMPI
4.5%	115	U. of Akron	OH	DOCI
4.2%	115	U. of Illinois-Chicago	IL	RESI
10.4%	114	U. of Missouri-Kansas City	MO	DOCII
6.4%	114	U. of Vermont	VT	DOCII
4.7%	113	U. of Pennsylvania	PA	RESI
15.0%	112	Inter American U. of PR-San German	PR	COMPI PM
5.4%	109	Baylor University	TX	DOCII
5.6%	108	U. of New Hampshire	NH	DOCII

TABLE 31 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY MEN AND WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
2.6%	107	Iowa State U. of Science & Tech	IA	RESII
4.3%	107	U. of Oregon	OR	RESII
14.8%	107	U. of Chicago	IL	RESI
3.3%	105	Boston University	MA	RESI
9.1%	103	Catholic University of Puerto Rico	PR	COMPI PM
4.6%	103	Boston College	MA	DOCI
3.2%	103	U. of Tennessee-Knoxville	TN	RESI
6.2%	101	C. of William and Mary	VA	DOCI
3.3%	101	San Francisco State University	CA	COMPI
11.7%	101	U. of Scranton	PA	COMPI
7.7%	101	Yale University	CT	RESI
8.3%	100	CUNY-City College	NY	COMPI PM
3.0%	100	San Jose State University	CA	COMPI
7.5%	99	Washington University	MO	RESI
8.8%	98	Princeton University	NJ	RESI
3.6%	98	U. of Utah	UT	RESI
7.9%	97	Emory University	GA	RESII
3.6%	97	New York University	NY	RESI
8.9%	96	Inter American U. of PR-Metropolitan	PR	COMPI PM
3.3%	96	Oklahoma State University	OK	RESII
3.3%	95	U. of Southern California	CA	RESI
1.7%	93	Arizona State University	AZ	RESII
6.5%	91	U. of Texas-San Antonio	TX	COMPI PM
5.0%	91	Long Island University-All Campuses	NY	COMPI
3.6%	90	U. of Hawaii-Manoa	HI	RESI
7.1%	90	U. of Wisconsin-Stevens Point	WI	COMPI

TABLE 32
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.4%	7,381	All Academic Institutions		
4.6%	116	U of California-Los Angeles	CA	RESI
2.8%	101	Pennsylvania State U.-All Campuses	PA	RESI
2.5%	73	U. of Illinois-Urbana	IL	RESI
5.8%	64	SUNY-Stony Brook	NY	RESI
2.5%	64	U. of California-Berkeley	CA	RESI
4.0%	61	Central Michigan University	MI	COMPI
2.0%	59	U. of Wisconsin-Madison	WI	RESI
2.0%	53	U. of Washington	WA	RESI
1.6%	52	U. of Michigan-All Campuses	MI	RESI
1.5%	52	Rutgers State U.-All Campuses	NJ	RESI
2.0%	49	U. of Colorado-All Campuses	CO	RESI
2.0%	49	Purdue University-All Campuses	IN	RESI
12.3%	47	SUNY-College at Potsdam	NY	COMPI
2.0%	44	Brigham Young U.-All Campuses	UT	DOCI
7.3%	44	Vanderbilt University	TN	RESI
4.1%	43	U. of California-San Diego	CA	RESI
2.1%	42	U. of North Carolina-Chapel Hill	NC	RESI
1.3%	41	U. of Minnesota-All Campuses	MN	RESI
0.9%	41	Indiana University-All Campuses	IN	RESI
3.1%	40	SUNY-Albany	NY	RESII
3.7%	40	U. of New Hampshire	NH	DOCII
2.2%	39	San Jose State University	CA	COMPI
2.0%	37	Miami University-All Campuses	OH	DOCI
2.2%	36	Virginia Polytechnic Institute	VA	RESI
2.7%	[illegible]	Boston College	MA	DOCI

TABLE 32 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
1.9%	35	U. of Pittsburgh-All Campuses	PA	RESI	
2.8%	35	U. of Texas-Arlington	TX	DOCII	
3.7%	34	Clemson University	SC	DOCI	
2.1%	34	U. of California-Davis	CA	RESI	
2.1%	33	U. of Connecticut	CT	RESI	
4.7%	33	Smith College	MA	LAI	W
2.4%	33	U. of Illinois-Chicago	IL	RESI	
1.3%	33	U. of Florida	FL	RESI	
2.8%	31	U. of California-Irvine	CA	RESI	
1.3%	30	San Diego State University	CA	COMPI	
0.9%	29	U. of Texas-Austin	TX	RESI	
0.8%	29	Michigan State University	MI	RESI	
7.7%	29	Saint Olaf College	MN	LAI	
1.5%	28	Illinois State University	IL	DOCII	
1.5%	28	U. of South Carolina-All Campuses	SC	RESII	
1.9%	27	Colorado State University	CO	RESI	
0.8%	27	Ohio State University-All Campuses	OH	RESI	
2.5%	27	SUNY-Binghamton	NY	DOCI	
1.3%	26	Northern Illinois University	IL	DOCI	
1.6%	26	U. of Virginia	VA	RESI	
1.2%	25	U. of Iowa	IA	RESI	
1.7%	25	Saint John's University	NY	DOCI	
7.9%	24	Carnegie-Mellon University	PA	RESI	
7.0%	24	C. of the Holy Cross	MA	LAI	
1.3%	24	Auburn University-All Campuses	AL	RESII	

TABLE 32 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
2.0%	24	U. of Southern Mississippi	MS	DOCI
1.9%	22	North Carolina State U.-Raleigh	NC	RESI
1.3%	22	U. of California-Santa Barbara	CA	RESII
3.1%	22	Brown University	RI	RESII
2.4%	22	C. of William and Mary	VA	DOCI
1.9%	22	James Madison University	VA	COMPI
1.8%	22	Georgia State University	GA	DOCI
3.1%	22	SUNY-College at Oneonta	NY	COMPI
3.1%	21	SUNY-College at Geneseo	NY	COMPI
3.7%	21	Shippensburg University	PA	COMPI
3.3%	21	Millersville University	PA	COMPI
2.0%	21	U. of Vermont	VT	DOCII
5.3%	20	Bucknell University	PA	LAI
1.7%	20	California Poly St U, San Luis Obispo	CA	COMPI
1.0%	20	California State U., Northridge	CA	COMPI
1.7%	20	SUNY-Buffalo	NY	RESII
1.5%	20	U. of Houston	TX	DOCI
1.7%	20	U. of Utah	UT	RESI
1.4%	20	Ball State University	IN	DOCI
1.3%	20	Cornell University	NY	RESI
2.3%	19	Appalachian State University	NC	COMPI
2.2%	19	Metropolitan State College	CO	COMPI
1.3%	19	New York University	NY	RESI
0.7%	19	U. of Maryland-College Park	MD	RESI
1.3%	19	U. of Tennessee-Knoxville	TN	RESI

TABLE 32 (CONTINUED)
BACCALAUREATE DEGREES IN MATHEMATICS
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
1.1%	19	Iowa State U. of Science & Tech	IA	RESII	
1.7%	19	Kansas State U. of Ag & Appl Sci.	KS	RESII	
3.7%	19	Mount Holyoke College	MA	LAI	W
0.9%	19	U. of Massachusetts-Amherst	MA	RESII	
1.7%	19	U. of Pennsylvania	PA	RESI	
1.3%	19	Eastern Michigan University	MI	COMPI	
1.2%	19	Syracuse University-All Campuses	NY	RESII	
3.1%	18	Jacksonville State University	AL	COMPI	
1.4%	18	U. of Nebraska-Lincoln	NE	RESII	
2.0%	18	U. of Wisconsin-Eau Claire	WI	COMPI	
1.1%	18	Boston University	MA	RESI	
2.3%	18	Duke University	NC	RESI	
6.0%	18	Spelman College	GA	LAII PM	HBW
4.0%	18	Fairfield University	CT	COMPI	
1.3%	18	Towson State University	MD	COMPI	
0.9%	17	California State U., Sacramento	CA	COMPI	
0.8%	17	California State U., Long Beach	CA	COMPI	
3.5%	17	South Dakota State University	SD	COMPI	
0.7%	17	Texas A & M U.-All Campuses	TX	RESI	
1.0%	16	Temple University	PA	RESII	
1.3%	16	U. of Cincinnati	OH	RESI	
2.0%	16	U. of Wisconsin-Whitewater	WI	COMPI	
3.2%	16	Providence College	RI	COMPI	
1.5%	16	U. of Northern Iowa	IA	COMPI	
1.2%	16	California State U., Chico	CA	COMPI	
2.3%	16	Montana State University	MT	DOCII	

TABLE 33
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
0.7%	3,586	All Academic Institutions		
1.0%	44	Indiana University-All Campuses	IN	RESI
2.7%	32	North Carolina State U.-Raleigh	NC	RESI
2.0%	32	U. of Virginia	VA	RESI
0.9%	30	Rutgers State U.-All Campuses	NJ	RESI
1.6%	28	U. of Pittsburgh-All Campuses	PA	RESI
1.3%	27	U. of North Carolina-Chapel Hill	NC	RESI
0.9%	26	U. of Illinois-Urbana	IL	RESI
13.7%	23	Xavier University of Louisiana	LA	COMPII PM HB
0.7%	23	U. of Michigan-All Campuses	MI	RESI
2.0%	23	U. of California-Irvine	CA	RESI
0.9%	22	Purdue University-All Campuses	IN	RESI
0.7%	22	U. of Minnesota-All Campuses	MN	RESI
0.8%	21	U. of Colorado-All Campuses	CO	RESI
1.3%	21	U. of Puerto Rico-Rio Piedras C.	PR	COMPI PM
2.5%	19	Duke University	NC	RESI
1.2%	19	U. of Delaware	DE	RESII
0.7%	19	U. of Washington	WA	RESI
0.7%	18	U. of California-Berkeley	CA	RESI
1.5%	18	West Virginia University	WV	RESII
1.1%	17	Cornell University	NY	RESI
5.1%	16	Houston Baptist University	TX	COMPI
0.4%	16	Pennsylvania State U.-All Campuses	PA	RESI
5.9%	16	Bryn Mawr College	PA	LAI W
0.8%	15	Miami University-All Campuses	OH	DOCI
1.2%	15	Wayne State University	MI	RESII

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TABLE 33 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
1.4%	15	U. of California-San Diego	CA	RESI
1.1%	14	U. of Akron	OH	DOCI
1.2%	14	U. of Southern Mississippi	MS	DOCI
7.7%	14	Case Western Reserve University	OH	RESI
0.5%	14	U. of Wisconsin-Madison	WI	RESI
0.9%	13	New York University	NY	RESI
0.8%	13	U. of California-Davis	CA	RESI
0.5%	13	U. of Florida	FL	RESI
1.6%	13	Catholic University of Puerto Rico	PR	COMPI PM
0.7%	13	Illinois State University	IL	DOCII
0.9%	13	Kent State University-All Campuses	OH	DOCI
4.2%	13	Spelman College	GA	LAII PM HBW
0.4%	13	U. of Maryland-College Park	MD	RESI
1.8%	12	Emory University	GA	RESII
3.3%	12	Saint Olaf College	MN	LAI
1.7%	12	Howard University	DC	RESI PM HB
0.9%	12	U. of Illinois-Chicago	IL	RESI
1.2%	11	C. of William and Mary	VA	DOCI
6.0%	11	C. of Wooster	OH	LAI
3.2%	11	C. of the Holy Cross	MA	LAI
3.8%	11	Massachusetts Institute of Tech.	MA	RESI
0.6%	11	San Jose State University	CA	COMPI
2.0%	11	Wellesley College	MA	LAI W
1.2%	11	Florida Atlantic University	FL	DOCII
0.9%	11	SUNY-Buffalo	NY	RESII

TABLE 33 (CONTINUED)
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
0.5%	11	U. of South Florida	FL	DOCI		
0.3%	11	Michigan State University	MI	RESI		
0.3%	11	Ohio State U.-All Campuses	OH	RESI		
0.4%	11	Texas A & M U.-All Campuses	TX	RESI		
0.8%	11	U. of Cincinnati	OH	RESI		
1.2%	11	U. of Miami	FL	RESI		
0.5%	10	Auburn University-All Campuses	AL	RESII		
0.5%	10	Northern Illinois University	IL	DOCI		
0.6%	10	U. of Arizona	AZ	RESI		
2.5%	10	U. of Scranton	PA	COMPI		
1.1%	10	U. of Wisconsin-Eau Claire	WI	COMPI		
4.2%	10	Gannon University	PA	COMPI		
3.4%	10	U. of Puerto Rico-Cayey U. C.	PR	COMPI	PM	
4.4%	10	Williams College	MA	LAI		
4.4%	10	Carleton College	MN	LAI		
0.9%	10	U. of Northern Iowa	IA	COMPI		
0.8%	10	U. of Oklahoma	OK	RESII		
2.4%	10	Valparaiso University	IN	COMPI		
1.0%	9	Metropolitan State College	CO	COMPI		
0.4%	9	San Diego State University	CA	COMPI		
0.6%	9	Virginia Polytechnic Inst. & St U.	VA	RESI		
0.3%	9	Arizona State University	AZ	RESII		
1.0%	9	Loyola University of Chicago	IL	DOCI	PM	
1.8%	9	Mount Holyoke College	MA	LAI		W
1.6%	9	Rochester Institute of Technology	NY	COMPI		

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TABLE 33
BACCALAUREATE DEGREES IN CHEMISTRY
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
2.2%	9	Saint Mary's College (IN)	IN	COMPII	W
2.2%	9	Bucknell University	PA	LAI	
0.6%	9	Colorado State University	CO	RESI	
0.8%	9	SUNY-Binghamton	NY	DOCI	
0.8%	8	SUNY-Stony Brook	NY	RESI	
0.5%	8	U. of Connecticut	CT	RESI	
3.9%	8	Allegheny College	PA	LAI	
0.4%	8	California State U., Long Beach	CA	COMPI	
0.4%	8	California State U., Northridge	CA	COMPI	
1.0%	8	Northern Arizona University	AZ	DOCII PM	
0.9%	8	U. of Louisville	KY	DOCI	
1.2%	8	U. of Missouri-Kansas City	MO	DOCII	
3.6%	8	U. of Puerto Rico-Humacao U. C.	PR	COMPI PM	
2.2%	8	Wake Forest University	NC	COMPI	
0.5%	8	Boston University	MA	RESI	
0.7%	8	California State U., Hayward	CA	COMPI	
1.8%	8	C. of Saint Catherine	MN	COMPII	W
1.0%	8	Harvard University	MA	RESI	
6.5%	8	Kalamazoo College	MI	LAI	
1.8%	8	Princeton University	NJ	RESI	
0.6%	8	SUNY-Albany	NY	RESII	
2.1%	8	Saint Joseph's University	PA	COMPI	
1.2%	8	Saint Louis University	MO	DOCI	
0.5%	8	U. of Kansas	KS	RESII	

TABLE 34
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE[2]
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989
LEADING INSTITUTIONS IN ORDER BY ABSOLUTE NUMBER

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
3.8%	19,852	All Academic Institutions		
19.1%	314	U. of California-Davis	CA	RESI
9.9%	255	U. of California-Berkeley	CA	RESI
6.7%	232	Rutgers State U.-All Campuses	NJ	RESI
7.1%	206	U. of Illinois-Urbana	IL	RESI
18.2%	204	U. of California-Irvine	CA	RESI
7.3%	184	Texas A & M U.-All Campuses	TX	RESI
11.0%	178	U. of Puerto Rico-Rio Piedras C.	PR	COMPI PM
6.7%	170	U of California-Los Angeles	CA	RESI
4.7%	168	Pennsylvania State U.-All Campuses	PA	RESI
16.2%	168	U. of California-San Diego	CA	RESI
10.3%	155	Cornell University	NY	RESI
5.5%	155	U. of Maryland-College Park	MD	RESI
4.4%	148	U. of Michigan-All Campuses	MI	RESI
4.8%	144	U. of Wisconsin-Madison	WI	RESI
4.1%	136	U. of Minnesota-All Campuses	MN	RESI
2.8%	128	Indiana University-All Campuses	IN	RESI
3.6%	128	Michigan State University	MI	RESI
4.9%	121	U. of Colorado-All Campuses	CO	RESI
4.6%	120	U. of Washington	WA	RESI
7.3%	118	Virginia Polytechnic Institute	VA	RESI

[2]These data do not include specialized optometric, chiropractic or podiatric institutions.

TABLE 34 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION
5.2%	113	U. of Massachusetts-Amherst	MA	RESII
3.3%	112	U. of Texas-Austin	TX	RESI
8.3%	99	North Carolina State U.-Raleigh	NC	RESI
9.0%	99	SUNY-Stony Brook	NY	RESI
6.6%	94	Colorado State University	CO	RESI
4.6%	92	U. of North Carolina-Chapel Hill	NC	RESI
2.8%	90	Ohio State University-All Campuses	OH	RESI
5.0%	84	U. of California-Santa Barbara	CA	RESII
7.3%	84	Oregon State University	OR	RESI
11.5%	84	U. of California-Santa Cruz	CA	DOCI
4.6%	83	U. of Arizona	AZ	RESI
28.0%	81	U. of Puerto Rico-Cayey U. C.	PR	COMPI PM
3.7%	81	U. of South Florida	FL	DOCI
3.4%	81	Purdue University-All Campuses	IN	RESI
3.2%	78	U. of Florida	FL	RESI
4.3%	78	U. of Pittsburgh-All Campuses	PA	RESI
4.2%	77	Miami University-All Campuses	OH	DOCI
6.9%	74	U. of New Hampshire	NH	DOCII
4.5%	73	U. of Connecticut	CT	RESI
3.5%	73	U. of Georgia	GA	RESI
10.2%	73	Brown University	RI	RESII
9.1%	72	Duke University	NC	RESI
9.3%	72	Harvard University	MA	RESI
3.1%	70	California State U., Long Beach	CA	COMPI
6.4%	70	SUNY-Binghamton	NY	DOCI

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TABLE 34 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION		
5.4%	68	SUNY-Albany	NY	RESII		
16.0%	67	U. of California-Riverside	CA	DOCI		
9.1%	67	Stanford University	CA	RESI		
14.5%	67	Inter American U. of PR-San German	PR	COMPI	PM	
2.8%	65	San Diego State University	CA	COMPI		
5.5%	64	Washington State University	WA	RESII		
5.5%	64	California Poly St U, San Luis Obispo	CA	COMPI		
3.3%	64	U. of South Carolina-All Campuses	SC	RESII		
5.5%	63	Kansas State U.	KS	RESII		
9.4%	63	Inter American U. of PR-Metropolitan	PR	COMPI	PM	
6.2%	63	U. of Vermont	VT	DOCII		
7.5%	60	Catholic University of Puerto Rico	PR	COMPI	PM	
3.7%	60	U. of Delaware	DE	RESII		
3.2%	58	San Francisco State University	CA	COMPI		
4.6%	57	Wayne State University	MI	RESII		
20.1%	56	Johns Hopkins University	MD	RESI		
10.5%	56	U. of Puerto Rico-Mayaguez	PR	COMPI	PM	
4.1%	56	U. of Illinois-Chicago	IL	RESI		
11.7%	56	U. of Rochester	NY	RESI		
10.7%	55	Mount Holyoke College	MA	LAI		W
3.1%	54	San Jose State University	CA	COMPI		
3.9%	54	U. of Hawaii-Manoa	HI	RESI		
6.1%	54	Loyola University of Chicago	IL	DOCI	PM	
5.7%	53	C. of William and Mary	VA	DOCI		
4.1%	53	U. of Akron	OH	DOCI		

TABLE 34 (CONTINUED)
BACCALAUREATE DEGREES IN BIOLOGICAL SCIENCE
EARNED BY WOMEN GRADUATES
AVERAGE 1987-1989

% OF ALL FIELDS	NUMBER	ACADEMIC INSTITUTION	STATE	CLASSIFICATION	
3.2%	53	U. of Kansas	KS	RESII	
2.5%	52	U. of Iowa	IA	RESI	
7.3%	52	Howard University	DC	RESI	PM HB
2.6%	52	Louisiana State U.-All Campuses	LA	RESI	
17.8%	52	U. of Chicago	IL	RESI	
2.9%	51	Iowa State U. of Science & Tech	IA	RESII	
3.6%	50	Southern Illinois U.-Carbondale	IL	RESII	
7.0%	49	Smith College	MA	LAI	W
7.6%	49	U. of Missouri-Kansas City	MO	DOCII	
4.4%	48	Long Island U.-All Campuses	NY	COMPI	
4.3%	48	U. of Pennsylvania	PA	RESI	
2.8%	48	Boston University	MA	RESI	
3.7%	48	U. of Southern California	CA	RESI	
2.2%	47	Brigham Young U.-All Campuses	UT	DOCI	
8.4%	47	Yale University	CT	RESI	
1.7%	47	Arizona State University	AZ	RESII	
8.7%	47	Sonoma State University	CA	COMPI	
8.5%	46	Barnard College	NY	LAI	W
2.4%	46	California State U., Northridge	CA	COMPI	
3.5%	46	Boston College	MA	DOCI	
2.4%	46	California State U., Sacramento	CA	COMPI	
3.6%	46	U. of Oregon	OR	RESII	
2.9%	45	New York University	NY	RESI	
2.9%	45	U. of Tennessee-Knoxville	TN	RESI	
6.6%	44	Emory University	GA	RESII	
11.9%	44	Saint Olaf College	MN	LAI	
10.4%	44	Princeton University	NJ	RESI	

TABLE 35
BACCALAUREATE DEGREES GRANTED TO BLACK AND HISPANIC GRADUATES
IN MATHEMATICS, PHYSICAL OR BIOLOGICAL SCIENCE IN 1988-89

	BLACK			HISPANIC			ALL GRADUATES
	MATH & SCIENCE		ALL FIELDS	MATH & SCIENCE		ALL FIELDS	ALL FIELDS
	NUMBER	% OF ALL FIELDS		NUMBER	% OF ALL FIELDS		
COMPREHENSIVE COLLEGES & UNIVERSITIES (910)	1,871	5%	34,153	1,820	8%	25,207	454,885
PREDOMINANTLY MINORITY* (117)	1,187	7%	16,372	1,442	9%	14,969	
MAJORITY	684	4%	17,781	378	6%	10,238	
RESEARCH UNIVERSITIES (104)	869	7%	11,897	746	9%	8,546	293,340
PREDOMINANTLY MINORITY*(Howard)	108	11%	997	0		3	
MAJORITY	761	7%	10,900	746	9%	8,543	
OTHER DOCTORATE-GRANTING UNIVERSITIES(109)	320	5%	6,576	256	8%	3,263	154,954
PREDOMINANTLY MINORITY*(3)	17	7%	230	17	8%	210	
MAJORITY	303	5%	6,346	239	8%	3,053	
LIBERAL ARTS COLLEGES (300)	312	12%	2,584	96	11%	871	58,340
PREDOMINANTLY MINORITY*(8)	156	18%	847	0		0	
MAJORITY	156	9%	1,737	96	11%	871	
ALL INSTITUTIONS	3,405		58,016	3,012		40,150	

*Source: Quality Education for Minorities Project

TABLE 36
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO NATIVE AMERICAN GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Pembroke State University	NC	COMPII	4	3	2
Northeastern State University	OK	COMPI	2	0	2
San Jose State University	CA	COMPI	2	1	1
Southeastern Oklahoma State U.	OK	COMPI	2	2	1
Fort Lewis College	CO	COMPI	2	1	1
U. of Alaska-Fairbanks	AK	COMPI	2	2	0
U. of California-Los Angeles	CA	RESI	2	2	1
U. of Minnesota-All Campuses	MN	RESI	2	1	1
U. of Washington	WA	RESI	2	•1	1
Western Washington U.	WA	COMPI	2	2	0

TABLE 37
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO NATIVE AMERICAN GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Southeastern Oklahoma State U.	OK	COMPI	3	2	1
Northeastern State University	OK	COMPI	3	2	1
Ohio State U.-All Campuses	OH	RESI	2	1	2
Pembroke State University	NC	COMPII	2	1	1
San Jose State University	CA	COMPI	2	2	0
U. of Minnesota-All Campuses	MN	RES I	2	1	1
U. of New Mexico	NM	RESI	2	1	1
US Naval Academy	MD	OTHER	2	2	0
U. of Nevada-Reno	NV	DOCII	2	2	0

TABLE 38
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO NATIVE AMERICAN GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Pembroke State University	NC	COMPII	6	3	3
Northeastern State University	OK	COMPI	4	2	2
U. of North Carolina-Chapel Hill	NC	RESI	4	2	2
San Jose State University	CA	COMPI	3	2	2
U. of California-San Diego	CA	RESI	3	2	2
University of Oklahoma	OK	RESII	3	2	2
Oregon State University	OR	RESI	3	2	1
University of California-Davis	CA	RESI	3	2	1
University of Washington	WA	RESI	3	1	2
California State U., Hayward	CA	COMPI	2	2	0
Northern Arizona University	AZ	DOCII PM	2	1	1
Stanford University	CA	RESI	2	1	2
U. of California-Los Angeles	CA	RESI	2	2	1
U. of California-Santa Barbara	CA	RESII	2	2	1
U. of Minnesota-All Campuses	MN	RESI	2	1	1
University of Wisconsin-Madison	WI	RESI	2	1	1
California State U., Long Beach	CA	COMPI	2	1	1
Colorado State University	CO	RESI	2	1	1
Fort Lewis College	CO	COMPI	2	2	0
Indiana University-All Campuses	IN	RESI	2	2	0
Montclair State College	NJ	COMPI	2	1	1
University of California-Berkeley	CA	RESI	2	1	1
University of New Mexico	NM	RESI	2	1	1

TABLE 39
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
All Academic Institutions				347	210	137
U. of Puerto Rico-Rio Piedras C.	PR	COMPI	PM	17	8	10
Inter American U. of PR-San German	PR	COMPI	PM	10	8	3
U. of Puerto Rico-Mayaguez	PR	COMPI	PM	10	5	5
U. of Puerto Rico-Humacao U. C.	PR	COMPI	PM	9	5	4
Laredo State University	TX	LAII*	PM	8	2	7
U. of Illinois-Chicago	IL	RESI		7	6	1
Inter American U. of PR-Metropolitan	PR	COMPI	PM	7	5	2
U of California-Los Angeles	CA	RESI		7	4	3
Catholic University of Puerto Rico	PR	COMPI	PM	6	3	3
Pan American University	TX	COMPI	PM	6	5	1
U. of California-Berkeley	CA	RESI		6	3	3
Northeastern University	MA	DOCII		5	5	1
U. of California-Santa Barbara	CA	RESII		5	4	1
U. of Florida	FL	RESI		5	4	2
U. of New Mexico	NM	RESI		5	4	2
U. of Texas-San Antonio	TX	COMPI	PM	5	3	2
U. of Texas-Austin	TX	RESI		5	4	1
California State Univ, Los Angeles	CA	COMPI	PM	4	4	0
U. of California-San Diego	CA	RESI		4	3	2
California State Univ, Long Beach	CA	COMPI		4	2	2
San Jose State University	CA	COMPI		4	4	0
U. of Colorado-All Campuses	CO	RESI		4	3	1
Jersey City State College	NJ	COMPI		3	2	1
Massachusetts Institute of Technology	MA	RESI		3	2	1
San Diego State University	CA	COMPI		3	2	2

TABLE 39 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
U. of Illinois-Urbana	IL	RESI		3	2	1
U. of Southern California	CA	RESI		3	1	2
Arizona State University	AZ	RESII		3	2	1
California Poly St U, San Luis Obispo	CA	COMPI		3	2	1
California State Polytech Univ, Pomona	CA	COMPI		3	2	1
Florida International University	FL	COMPI	PM	3	2	1
Mercy College	NY	COMPI	PM	3	2	1
Purdue University-All Campuses	IN	RESI		3	2	1
U. of California-Riverside	CA	DOCI		3	2	1
U. of the Sacred Heart	PR	COMPI	PM	3	1	2

TABLE 40
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
All Academic Institutions				574	370	205
U. of Puerto Rico-Rio Piedras C.	PR	COMPI	PM	44	20	24
Catholic University of Puerto Rico	PR	COMPI	PM	26	12	14
U. of Puerto Rico-Mayaguez	PR	COMPI	PM	26	16	10
Inter American U. of PR-San German	PR	COMPI	PM	22	14	8
U. of Puerto Rico-Cayey J. C.	PR	COMPI	PM	19	9	11
U. of Puerto Rico-Humacao U. C.	PR	COMPI	PM	16	7	9
US Naval Academy	MD	OTHER		15	15	1
U. of Miami	FL	RESI		13	9	4
Inter American U. of PR-Metropolitan	PR	COMPI	PM	10	7	3
Pan American University	TX	COMPI	PM	9	6	3
Florida International University	FL	COMPI	PM	9	5	4
U. of Texas-El Paso	TX	COMPI	PM	8	6	2
New Mexico State U.-All Campuses	NM	RESI		8	6	2
Rutgers State U.-All Campuses	NJ	RESI		8	4	4
Texas A & M University-All Campuses	TX	RESI		7	5	2
Bayamon Central University	PR	COMPII	PM	6	4	3
Texas A & I University	TX	COMPI	PM	6	4	2
U. of Texas-Austin	TX	RESI		6	5	1
U. of the Sacred Heart	PR	COMPI	PM	6	4	2
U. of New Mexico	NM	RESI		6	5	1

TABLE 40 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
U. of California-San Diego	CA	RESI		5	4	1
U. of Texas-San Antonio	TX	COMPI	PM	5	3	2
California State U., Fullerton	CA	COMPI		4	3	1
Florida State University	FL	RESII		4	4	1
Metropolitan State College	CO	COMPI		4	4	1
New York Institute of Technology	NY	COMPI		4	3	1
U. of South Florida	FL	DOCI		4	3	1
Cornell University	NY	RESI		4	3	1
New Mexico Highlands University	NM	COMPII	PM	4	3	1
San Jose State University	CA	COMPI		4	4	0
US Air Force Academy	CO	OTHER		4	4	0
U. of California-Berkeley	CA	RESI		4	3	1
U. of California-Irvine	CA	RESI		4	3	1
U. of Florida	FL	RESI		4	3	1
California State Univ, Hayward	CA	COMPI		3	2	1
California State Univ, Long Beach	CA	COMPI		3	3	1
Florida Atlantic University	FL	DOCII		3	1	2
Southwest Texas State University	TX	COMPI		3	3	0
Stanford University	CA	RESI		3	2	1
California State Polytech Univ, Pomona	CA	COMPI		3	2	1
California State U., Los Angeles	CA	COMPI	PM	3	2	1
California State U., Northridge	CA	COMPI		3	3	0
California State U., Sacramento	CA	COMPI		3	2	1
Corpus Christi State University	TX	COMPI	PM	3	1	2
Fordham University	NY	DOCI		3	3	0

TABLE 40 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
Kean College of New Jersey	NJ	COMPI		3	2	1
Massachusetts Institute of Technology	MA	RESI		3	3	0
Saint Mary's University of San Antonio	TX	COMPI	PM	3	3	0
Saint Thomas University	FL	COMPI	PM	3	1	2
San Diego State University	CA	COMPI		3	2	1
San Francisco State University	CA	COMPI		3	2	1
Santa Clara University	CA	COMPI		3	2	1
U. of California-Santa Cruz	CA	DOCI		3	1	2
U. of Southern California	CA	RESI		3	2	1
U. of Texas-Arlington	TX	DOCII		3	2	1

TABLE 41
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
All Academic Institutions				2,118	992	1,127
U. of Puerto Rico-Rio Piedras C.	PR	COMPI	PM	190	77	114
Inter American U. of PR-San German	PR	COMPI	PM	111	48	63
U. of Puerto Rico-Cayey U. C.	PR	COMPI	PM	108	32	77
Catholic University of Puerto Rico	PR	COMPI	PM	104	44	60
Inter American U. of PR-Metropolitan	PR	COMPI	PM	97	36	61
U. of Puerto Rico-Mayaguez	PR	COMPI	PM	89	33	57
Inter American U. of PR-System	PR	COMPI	PM	64	24	40
U. of the Sacred Heart	PR	COMPI	PM	45	26	20
Saint Mary's University of San Antonio	TX	COMPI	PM	37	17	20
U. of Texas-Austin	TX	RESI		35	23	12
U. of Miami	FL	RESI		33	17	17
Pan American University	TX	COMPI	PM	32	16	16
U. of Texas-San Antonio	TX	COMPI	PM	31	20	12
Rutgers State University of New Jersey	NJ	RESI		28	15	13
U. of California-Davis	CA	RESI		28	15	13
U of California-Los Angeles	CA	RESI		26	14	12
U. of California-Irvine	CA	RESI		24	16	8
Inter American U. of Pr-Bayamon	PR	PM		21	5	16
Universidad Del Turabo	PR	COMPI	PM	21	10	11
U. of California-Berkeley	CA	RESI		21	10	11
U. of South Florida	FL	DOCI		21	14	8
U. of Texas-El Paso	TX	COMPI	PM	21	13	8
U. of California-San Diego	CA	RESI		17	11	7
U. of Florida	FL	RESI		16	11	5
Texas A & M University-All Campuses	TX	RESI		15	10	5

TABLE 41 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
Cornell University	NY	RESI		13	6	7
Florida International University	FL	COMPI	PM	13	6	7
U. of New Mexico	NM	RESI		13	7	6
Stanford University	CA	RESI		12	8	4
U. of California-Riverside	CA	DOCI		12	8	4
U. of California-Santa Barbara	CA	RESII		12	8	5
U. of Puerto Rico-Arecibo Tech U.	PR	ENGR		12	3	9
California State Univ, Long Beach	CA	COMPI		12	6	6
Universidad Metropolitana	PR	COMPI	PM	12	8	4
Loyola University of Chicago	IL	DOCI	PM	11	6	5
U. of California-Santa Cruz	CA	DOCI		11	6	5
U. of Illinois-Urbana	IL	RESI		11	7	4
California State Polytech Univ, Pomona	CA	COMPI		10	6	5
California State Univ, Northridge	CA	COMPI		10	8	2
U. of Arizona	AZ	RESI		10	7	4
San Diego State University	CA	COMPI		10	5	5
California State Univ, Fullerton	CA	COMPI		9	5	4
U. of Massachusetts-Amherst	MA	RESII		8	4	4
Harvard University	MA	RESI		8	4	4
Loyola Marymount University	CA	COMPI		8	3	5
New Mexico State U.-All Campuses	NM	RESI		8	3	5
SUNY-Stony Brook	NY	RESI		8	4	4
California State Univ, Sacramento	CA	COMPI		7	5	3
Saint John's University	NY	DOCI		7	3	5
U. of Houston	TX	DOCI		7	5	3

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TABLE 41 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
U. of Southern California	CA	RESI		7	3	5
U. of Wisconsin-Madison	WI	RESI		7	3	4
California State Univ, Fresno	CA	COMPI		7	2	5
Cleveland Chiropractic College	CA	HLTH		7	5	2
George Washington University	DC	RESII		7	3	4
Purdue University-All Campuses	IN	RESI		7	4	3
Tulane University of Louisiana	LA	RESII		7	4	3
U. of Colorado-All Campuses	CO	RESI		7	4	3
U. of Maryland-College Park	MD	RESI		7	4	3
Barry University	FL	COMPI	PM	6	3	3
Bayamon Central University	PR	COMPII	PM	6	3	3
Long Island University-All Campuses	NY	COMPI		6	2	4
New Mexico Highlands University	NM	COMPII	PM	6	3	4
U. of Michigan-All Campuses	MI	RESI		6	3	3
U. of Puerto Rico-Humacao U. C.	PR	COMPI	PM	6	3	4
Colorado State University	CO	RESI		6	3	3
Fairleigh-Dickinson University	NJ	COMPI		6	4	2
Florida State University	FL	RESII		6	4	2
U. of Illinois-Chicago	IL	RESI		6	4	2
Kean College of New Jersey	NJ	COMPI		5	2	4
Seton Hall University	NJ	COMPI		5	3	3
U. of Central Florida	FL	COMPI		5	2	3
U. of Southern Colorado	CO	COMPI		5	2	4
Yale University	CT	RESI		5	3	3
Baylor University	TX	DOCII		5	2	3

TABLE 41 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION		ALL	MEN	WOMEN
California State Univ, Los Angeles	CA	COMPI	PM	5	2	3
Emory University	GA	RESII		5	2	3
Manhattan College	NY	COMPI		5	2	3
Saint Thomas University	FL	COMPI	PM	5	2	3
Texas Tech University	TX	DOCI		5	2	3
Boston College	MA	DOCI		4	3	2
California State Univ, San Bernardino	CA	COMPI		4	3	2
Columbia University	NY	RESI		4	2	2
Corpus Christi State University	TX	COMPI	PM	4	2	2
Fordham University	NY	DOCI		4	1	3
Iowa State U. of Science & Tech	IA	RESII		4	3	1
Kansas State U. of Ag & Appl Science	KS	RESII		4	3	2
Michigan State University	MI	RESI		4	2	2
Southwest Texas State University	TX	COMPI		4	4	1
U. of Rochester	NY	RESI		4	2	2
U. of Texas-Arlington	TX	DOCII		4	2	2
Adelphi University	NY	DOCII		4	2	2
Eastern New Mexico U.-All Campuses	NM	COMPI		4	2	2
Los Angeles College of Chiropractic	CA	HLTH		4	2	2
Loyola University in New Orleans	LA	COMPI		4	3	1
Montclair State College	NJ	COMPI		4	1	3
SUNY-Binghamton	NY	DOCI		4	2	2
San Jose State University	CA	COMPI		4	2	2
Texas A & I University	TX	COMPI	PM	4	3	1
Trinity University	TX	COMPI		4	1	3

TABLE 41 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
U. of Chicago	IL	RESI	4	2	2
U. of Missouri-Columbia	MO	RESI	4	3	1
U. of Missouri-Kansas City	MO	DOCII	4	2	2
U. of Pennsylvania	PA	RESI	4	3	1
Austin College	TX	LAI	3	2	2
Boston University	MA	RESI	3	2	2
Georgetown University	DC	RESII	3	2	1
Hofstra University	NY	DOCII	3	2	2
Humboldt State University	CA	COMPI	3	2	1
Indiana University-All Campuses	IN	RESI	3	1	2
Louisiana State University-All Campuses	LA	RESI	3	1	2
Saint Louis University	MO	DOCI	3	3	1
U. of the Pacific	CA	COMPI	3	3	1
Whittier College	CA	COMPII	3	3	0
Antillian College	PR	LAII* PM	3	2	1
Barnard College	NY	LAI W	3	0	3
Brown University	RI	RESII	3	1	2
California Poly St U, San Luis Obispo	CA	COMPI	3	2	1
California State Univ, Hayward	CA	COMPI	3	1	2
California State Univ, Stanislaus	CA	COMPI	3	2	1
Clark University	MA	DOCII	3	2	1
Florida Atlantic University	FL	DOCII	3	1	2
Houston Baptist University	TX	COMPI	3	2	1
Jersey City State College	NJ	COMPI	3	1	2
Johns Hopkins University	MD	RESI	3	1	2

TABLE 41 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO HISPANIC GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
North Texas State University	TX	DOCI	3	1	2
Northeastern Illinois University	IL	COMPI	3	1	2
Northwestern University	IL	RESI	3	1	2
Occidental College	CA	LAI	3	0	3
Ohio State University-All Campuses	OH	RESI	3	2	1
Pace University-All Campuses	NY	COMPI	3	1	2
Pennsylvania State U.-All Campuses	PA	RESI	3	2	1
SUNY-Buffalo	NY	RESII	3	1	2
SUNY-College at Old Westbury	NY	COMPI	3	1	2
San Francisco State University	CA	COMPI	3	1	2
Santa Clara University	CA	COMPI	3	0	3
Syracuse University-All Campuses	NY	RESII	3	1	2
U. of Dallas	TX	LAI	3	1	2
U. of Minnesota-All Campuses	MN	RESI	3	1	2
U. of St. Thomas	TX	COMPII	3	1	2
U. of Tampa	FL	COMPII	3	1	2

TABLE 42
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
All Academic Institutions			760	399	361
Xavier University of Louisiana	LA	COMPII PM HB	43	14	30
Howard University	DC	RESI PM HB	22	11	12
Lincoln University	PA	LAII* PM HB	18	11	7
US Naval Academy	MD	OTHER	16	14	2
Spelman College	GA	LAII PM HB W	15	0	15
Morehouse College	GA	LAII PM HB	13	13	0
Southern University and A & M College	LA	COMPI PM HB	13	6	7
Talladega College	AL	LAII* PM HB	11	6	6
US Air Force Academy	CO	OTHER	10	9	1
Tougaloo College	MS	LAII PM HB	10	2	8
U. of the District of Columbia	DC	COMPI PM HB	10	6	4
Tennessee State University	TN	COMPI PM HB	9	6	4
Jackson State University	MS	COMPI PM HB	9	3	6
Dillard University	LA	LAII* PM HB	8	5	4
Fisk University	TN	LAII PM HB	8	2	6
Norfolk State University	VA	COMPI PM HB	8	6	2
Rutgers State U.-All Campuses	NJ	RESI	8	6	2
Alcorn State University	MS	COMPII PM HB	7	3	5
Hampton University	VA	COMPI PM HB	7	3	5
Morgan State University	MD	COMPI PM HB	7	5	3
North Carolina Central University	NC	COMPI PM HB	7	3	5
U. of Pittsburgh-All Campuses	PA	RESI	7	5	2
Clark College	GA	COMPII PM HB	6	3	3
North Carolina A & T State U.	NC	COMPI PM HB	6	2	5
Oakwood College	AL	LAII* PM HB	6	4	3

TABLE 42 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Virginia State University	VA	COMPI PM HB	6	4	2
Wayne State University	MI	RESII	6	4	2
Chicago State University	IL	COMPI PM	6	2	4
Savannah State College	GA	COMPII PM HB	6	3	3
U. of Southern Mississippi	MS	DOCI	6	3	3
Alabama Agricultural & Mechanical U.	AL	COMPI PM HB	5	3	3
Benedict College	SC	LAII* PM HB	5	3	2
SUNY-Stony Brook	NY	RESI	5	3	2
Youngstown State University	OH	COMPI	5	2	3
Emory University	GA	RESII	5	2	3
North Carolina State U.-Raleigh	NC	RESI	5	3	2
Rust College	MS	LAII* PM HB	5	2	3
Stillman College	AL	LAII* PM HB	5	3	2
U. of Arkansas-Pine Bluff	AR	COMPI PM HB	5	2	3
U. of Maryland-College Park	MD	RESI	5	2	3
U. of North Carolina-Chapel Hill	NC	RESI	5	3	2
Texas Southern University	TX	COMPI PM HB	4	3	1
U. of Michigan-All Campuses	MI	RESI	4	3	2
U. of Pennsylvania	PA	RESI	4	2	2
U. of South Carolina-All Campuses	SC	RESII	4	3	1
U. of Virginia	VA	RESI	4	2	2
Ohio State University-All Campuses	OH	RESI	4	3	1
Prairie View Agric & Mech Univ	TX	COMPI PM HB	4	2	2
U of California-Los Angeles	CA	RESI	4	3	1
Bethune Cookman College	FL	COMPII PM HB	3	2	2

TABLE 42 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN PHYSICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
C. of Charleston	SC	COMPI	3	0	3
Michigan State University	MI	RESI	3	2	2
SUNY-Buffalo	NY	RESII	3	3	0
Tuskegee University	AL	COMPI PM HB	3	3	1
U. of Detroit	MI	COMPI	3	1	3
Alabama State University	AL	COMPI PM HB	3	2	1
Auburn University-All Campuses	AL	RESII	3	2	1
Austin Peay State University	TN	COMPI	3	2	1
California State U., Hayward	CA	COMPI	3	2	1
Coppin State College	MD	COMPII PM HB	3	1	2
Eastern Michigan University	MI	COMPI	3	2	1
Elizabeth City State University	NC	COMPII PM HB	3	2	1
Florida Agricultural and Mechanical U.	FL	COMPI PM HB	3	2	1
Georgia State University	GA	DOCI	3	2	1
Jarvis Christian College	TX	LAII* PM HB	3	1	2
Memphis State University	TN	DOCI	3	2	1
SUNY-College at Old Westbury	NY	COMPI	3	2	1
Saint Augustine's College	NC	COMPII PM HB	3	1	2
San Jose State University	CA	COMPI	3	2	1
U. of Illinois-Chicago	IL	RESI	3	2	1
U. of Missouri-Kansas City	MO	DOCII	3	1	2

TABLE 43
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
All Academic Institutions			813	387	427
Hampton University	VA	COMPI PM HB	19	7	12
Prairie View A & M U.	TX	COMPI PM HB	16	6	11
South Carolina State College	SC	COMPI PM HB	16	5	11
Spelman College	GA	LAII PM HB W	16	0	16
Morehouse College	GA	LAII PM HB	15	15	0
Delaware State College	DE	COMPII PM HB	14	10	4
Fayetteville State University	NC	COMPI PM HB	12	6	6
Florida Agricultural and Mechanical U.	FL	COMPI PM HB	11	5	7
Virginia Union University	VA	LAII* PM HB	11	7	4
Morris College	SC	LAII PM HB	10	8	2
Benedict College	SC	LAII* PM HB	9	4	5
Bethune Cookman College	FL	COMPII PM HB	9	5	5
Claflin College	SC	LAII* PM HB	9	2	7
Saint Augustine's College	NC	COMPII PM HB	9	7	3
Southern University and A & M College	LA	COMPI PM HB	9	4	5
Alabama Agricultural & Mechanical U.	AL	COMPI PM HB	8	4	4
Clark College	GA	COMPII PM HB	8	2	6
Coppin State College	MD	COMPII PM HB	8	5	3
Dillard University	LA	LAII* PM HB	8	1	7
Norfolk State University	VA	COMPI PM HB	8	3	6
U of California-Los Angeles	CA	RESI	8	5	4
Tougaloo College	MS	LAII PM HB	8	5	3
Bowie State College	MD	COMPII PM HB	7	5	2
Rutgers State U.All Campuses	NJ	RESI	7	5	3
SUNY-Stony Brook	NY	RESI	7	4	4

TABLE 43 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
U. of Georgia	GA	RESI	7	4	4
U. of South Carolina-All Campuses	SC	RESII	7	3	4
Voorhees College	SC	LAII PM HB	7	6	1
Alabama State University	AL	COMPI PM HB	7	5	2
Central State University	OH	COMPII PM HB	7	4	3
Howard University	DC	RESI PM HB	7	3	4
Savannah State College	GA	COMPII PM HB	7	2	5
Albany State College	GA	COMPII PM HB	6	3	3
Citadel Military College of S Carolina	SC	COMPI	6	6	0
North Carolina Central University	NC	COMPI PM HB	6	3	3
US Naval Academy	MD	OTHER	6	6	1
U. of Cincinnati	OH	RESI	6	2	4
Jackson State University	MS	COMPI PM HB	6	3	3
U. of Texas-Austin	TX	RESI	6	3	3
Alcorn State University	MS	COMPII PM HB	5	3	3
Barber-Scotia College	NC	LAII* PM HB	5	4	2
Saint Paul's College	VA	LAII* PM HB	5	3	2
Tuskegee University	AL	COMPI PM HB	5	3	3
U. of Illinois-Chicago	IL	RESI	5	3	3
Georgia State University	GA	DOCI	5	0	5
Ohio State University-All Campuses	OH	RESI	5	3	2
U. of Maryland-College Park	MD	RESI	5	3	2
U. of Pittsburgh-All Campuses	PA	RESI	5	3	2
U. of the Virgin Islands	VI	COMPI PM	5	4	1
Fisk University	TN	LAII PM HB	4	1	3

TABLE 43 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Jarvis Christian College	TX	LAII* PM HB	4	2	2
Kentucky State University	KY	COMPII PM HB	4	2	2
Miles College	AL	LAII* PM HB	4	2	2
Syracuse University-All Campuses	NY	RESII	4	2	3
Talladega College	AL	LAII* PM HB	4	1	3
Tennessee State University	TN	COMPI PM HB	4	0	4
Texas Southern University	TX	COMPI PM HB	4	2	3
U. of Florida	FL	RESI	4	3	2
U. of Southern Mississippi	MS	DOCI	4	2	3
U. of Texas-Arlington	TX	DOCII	4	2	2
U. of the District of Columbia	DC	COMPI PM HB	4	2	2
Fort Valley State College	GA	COMPII PM HB	4	3	1
Le Moyne-Owen College	TN	LAII* PM HB	4	3	1
Livingstone College	NC	LAII* PM HB	4	3	1
North Carolina State U.-Raleigh	NC	RESI	4	1	3
Oakwood College	AL	LAII* PM HB	4	1	3
Pembroke State University	NC	COMPII	4	3	1
Purdue University-All Campuses	IN	RESI	4	2	2
U. of Alabama	AL	DOCI	4	2	2
U. of Illinois-Urbana	IL	RESI	4	3	1
Virginia State University	VA	COMPI PM HB	4	1	3
Xavier University of Louisiana	LA	COMPII PM HB	4	1	3
Chicago State University	IL	COMPI PM	3	2	2
Clemson University	SC	DOCI	3	1	2
Columbus College	GA	COMPI	3	2	2

TABLE 43 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN MATHEMATICS TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Francis Marion College	SC	COMPI	3	1	2
Paine College	GA	LAII* PM HB	3	1	3
Pennsylvania State U.-All Campuses	PA	RESI	3	1	2
SUNY-College at Old Westbury	NY	COMPI	3	2	1
Texas College	TX	LAII* PM HB	3	2	1
U. of Virginia	VA	RESI	3	2	2
Virginia Commonwealth University	VA	RESII	3	1	2
Wilberforce University	OH	LAII* PM HB	3	1	2
C. of William and Mary	VA	DOCI	3	1	2
Columbia University	NY	RESI	3	2	1
Duke University	NC	RESI	3	2	1
East Carolina University	NC	COMPI	3	1	2
Elizabeth City State University	NC	COMPII PM HB	3	1	2
Goucher College	MD	LAI W	3	0	3
Lane College	TN	LAII* PM HB	3	2	1
Mississippi Valley State University	MS	COMPII PM HB	3	1	2
North Carolina A & T State U.	NC	COMPI PM HB	3	1	2
SUNY-College at Brockport	NY	COMPI	3	1	2
Saint John's University	NY	DOCI	3	1	2
U. of California-Davis	CA	RESI	3	1	2
U. of Houston	TX	DOCI	3	1	2
U. of Michigan-All Campuses	MI	RESI	3	1	2
U. of Tennessee-Knoxville	TN	RESI	3	2	1
U. of Washington	WA	RESI	3	2	1

TABLE 44
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
All Academic Institutions			1,903	712	1,192
Howard University	DC	RESI PM HB	68	26	42
Hampton University	VA	COMPI PM HB	40	15	26
Jackson State University	MS	COMPI PM HB	33	9	25
Tuskegee University	AL	COMPI PM HB	28	10	18
Rutgers State U.-All Campuses	NJ	RESI	26	11	16
Xavier University of Louisiana	LA	COMPII PM HB	26	10	16
Spelman College	GA	LAII PM HB W	24	0	24
Tennessee State University	TN	COMPI PM HB	24	9	16
Mississippi Valley State University	MS	COMPII PM HB	20	1	19
Morehouse College	GA	LAII PM HB	20	20	0
U. of the District of Columbia	DC	COMPI PM HB	19	10	9
Prairie View Agric & Mech Univ	TX	COMPI PM HB	19	5	14
Oakwood College	AL	LAII* PM HB	18	6	12
Benedict College	SC	LAII* PM HB	17	6	11
Morgan State University	MD	COMPI PM HB	17	7	11
U. of North Carolina-Chapel Hill	NC	RESI	17	6	11
U. of California-Berkeley	CA	RESI	16	7	9
North Carolina Central University	NC	COMPI PM HB	15	5	11
U. of Maryland-College Park	MD	RESI	15	7	8
U. of South Carolina-All Campuses	SC	RESII	15	9	6
Tougaloo College	MS	LAII PM HB	15	3	12
Harvard University	MA	RESI	14	8	7
North Carolina State U.-Raleigh	NC	RESI	14	4	10
Talladega College	AL	LAII* PM HB	14	5	9
Brown University	RI	RESII	13	5	9

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
SUNY-Stony Brook	NY	RESI	13	6	7
Rust College	MS	LAII* PM HB	13	7	6
Grambling State University	LA	COMPI PM HB	12	8	5
Southern University and A & M College	LA	COMPI PM HB	12	5	8
Stanford University	CA	RESI	12	7	6
Dillard University	LA	LAII* PM HB	12	2	10
Long Island University-All Campuses	NY	COMPI	12	4	8
SUNY-College at Old Westbury	NY	COMPI	12	3	9
Wayne State University	MI	RESII	12	6	6
North Carolina Agri & Tech State Univ	NC	COMPI PM HB	11	3	9
Cornell University	NY	RESI	11	5	6
Lincoln University	PA	LAII* PM HB	11	3	8
U. of Illinois-Chicago	IL	RESI	10	3	8
Virginia Commonwealth University	VA	RESII	10	4	6
Alcorn State University	MS	COMPII PM HB	10	4	6
Fisk University	TN	LAII PM HB	10	3	7
Fort Valley State College	GA	COMPII PM HB	10	4	6
U. of Michigan-All Campuses	MI	RESI	10	5	5
U. of Pittsburgh-All Campuses	PA	RESI	10	7	3
Alabama Agricultural & Mechanical U.	AL	COMPI PM HB	9	4	6
Delta State University	MS	COMPI	9	1	8
Loyola University of Chicago	IL	DOCI PM	9	4	5
Savannah State College	GA	COMPII PM HB	9	4	6
Southern Illinois University-Carbondale	IL	RESII	9	6	4
U. of Texas-Austin	TX	RESI	9	4	6

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
U. of California-Davis	CA	RESI	9	2	7
Clark College	GA	COMPII PM HB	8	1	7
Stillman College	AL	LAII* PM HB	8	2	7
Temple University	PA	RESII	8	2	6
U of California-Los Angeles	CA	RESI	8	5	3
U. of California-San Diego	CA	RESI	8	2	7
U. of Illinois-Urbana	IL	RESI	8	3	5
Winston-Salem State University	NC	COMPII PM HB	8	3	6
Georgia State University	GA	DOCI	8	3	5
Paine College	GA	LAII* PM HB	8	3	5
U. of Maryland-Eastern Shore	MD	LAII* PM HB	8	3	5
Virginia Polytechnic Inst. & State U	VA	RESI	8	4	4
Chicago State University	IL	COMPI PM	7	3	4
Claflin College	SC	LAII* PM HB	7	1	6
Clemson University	SC	DOCI	7	2	5
Eastern Michigan University	MI	COMPI	7	3	4
Indiana University-All Campuses	IN	RESI	7	3	5
Michigan State University	MI	RESI	7	3	4
U. of Florida	FL	RESI	7	4	3
U. of Georgia	GA	RESI	7	3	4
Winthrop College	SC	COMPI	7	3	4
Alabama State University	AL	COMPI PM HB	7	4	3
Oberlin College	OH	LAI	7	2	5
U. of Southern California	CA	RESI	7	3	4
U. of Southern Mississippi	MS	DOCI	7	3	4

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Florida Agricultural and Mechanical U.	FL	COMPI PM HB	6	2	4
Princeton University	NJ	RESI	6	3	3
Seton Hall University	NJ	COMPI	6	2	4
U. of Alabama-Birmingham	AL	DOCII	6	2	4
U. of Arkansas-Fayetteville	AR	DOCI	6	3	3
U. of Arkansas-Pine Bluff	AR	COMPI PM HB	6	2	4
U. of Delaware	DE	RESII	6	2	4
Albany State College	GA	COMPII PM HB	6	3	3
Cheyney University of Pennsylvania	PA	COMPII PM HB	6	2	4
Elizabeth City State University	NC	COMPII PM HB	6	2	4
Jarvis Christian College	TX	LAII* PM HB	6	3	3
Johnson C. Smith University	NC	LAII* PM HB	6	1	5
Lane College	TN	LAII* PM HB	6	2	4
Old Dominion University	VA	DOCII	6	3	3
Saint John's University	NY	DOCI	6	2	4
Shaw University	NC	COMPII PM HB	6	2	4
U. of Virginia	VA	RESI	6	3	3
Auburn University-All Campuses	AL	RESII	5	2	3
Coppin State College	MD	COMPII PM HB	5	2	4
Emory University	GA	RESII	5	2	4
Georgetown University	DC	RESII	5	2	3
Hofstra University	NY	DOCII	5	1	5
Northwestern University	IL	RESI	5	3	3
Ohio State University-All Campuses	OH	RESI	5	2	4
Philander Smith College	AR	LAII* PM HB	5	2	3

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
SUNY-Albany	NY	RESII	5	1	4
Texas A & M University-All Campuses	TX	RESI	5	2	4
U. of California-Irvine	CA	RESI	5	3	3
U. of California-Riverside	CA	DOCI	5	3	3
U. of Cincinnati	OH	RESI	5	3	2
U. of Miami	FL	RESI	5	3	2
U. of North Carolina-Greensboro	NC	DOCII	5	1	4
U. of South Florida	FL	DOCI	5	2	3
Andrews University	MI	DOCII	5	2	3
Bowie State College	MD	COMPII PM HB	5	2	3
California State Univ, Dominguez Hills	CA	COMPI PM	5	2	3
Le Moyne-Owen College	TN	LAII* PM HB	5	1	4
Louisiana State University-All Campuses	LA	RESI	5	1	4
Memphis State University	TN	DOCI	5	3	2
Norfolk State University	VA	COMPI PM HB	5	3	2
SUNY-Binghamton	NY	DOCI	5	2	3
Saint Augustine's College	NC	COMPII PM HB	5	2	3
San Francisco State University	CA	COMPI	5	2	3
Towson State University	MD	COMPI	5	1	4
U. of Louisville	KY	DOCI	5	1	4
U. of Missouri-Kansas City	MO	DOCII	5	3	2
U. of Rochester	NY	RESI	5	3	2
Washington University	MO	RESI	5	3	2
Yale University	CT	RESI	5	2	3
Central State University	OH	COMPII PM HB	4	2	2

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Furman University	SC	LAI	4	2	2
Morris College	SC	LAII PM HB	4	2	2
Mount Holyoke College	MA	LAI W	4	0	4
North Texas State University	TX	DOCI	4	3	1
Pennsylvania State U.-All Campuses	PA	RESI	4	3	2
Saint Louis University	MO	DOCI	4	1	3
Syracuse University-All Campuses	NY	RESII	4	3	1
Tulane University of Louisiana	LA	RESII	4	2	3
U. of Houston	TX	DOCI	4	2	2
U. of Oklahoma	OK	RESII	4	3	1
U. of Washington	WA	RESI	4	2	2
Upsala College	NJ	COMPII	4	2	2
Voorhees College	SC	LAII PM HB	4	2	2
Augusta College	GA	COMPI	4	0	4
Bennett College	NC	LAII* PM HB W	4	0	4
California State Univ, Hayward	CA	COMPI	4	1	3
C. of William and Mary	VA	DOCI	4	2	2
East Carolina University	NC	COMPI	4	2	2
Florida State University	FL	RESII	4	2	2
Fordham University	NY	DOCI	4	1	3
Langston University	OK	COMPII PM HB	4	3	1
Miami University-All Campuses	OH	DOCI	4	2	2
Northern Illinois University	IL	DOCI	4	1	3
Roosevelt University	IL	COMPI	4	1	3
Saint Mary's University of San Antonio	TX	COMPI PM	4	1	3

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Texas Southern University	TX	COMPI PM HB	4	2	2
Troy State University-Troy	AL	COMPI	4	1	3
U. of Maryland-Baltimore County	MD	DOCII	4	1	3
Virginia State University	VA	COMPI PM HB	4	3	1
Virginia Union University	VA	LAII* PM HB	4	1	3
Bethune Cookman College	FL	COMPII PM HB	3	1	3
Bloomfield College	NJ	COMPII	3	1	2
California State Univ, Long Beach	CA	COMPI	3	1	3
California State Univ, Northridge	CA	COMPI	3	3	0
C. of Charleston	SC	COMPI	3	1	2
Duke University	NC	RESI	3	0	3
Fairleigh-Dickinson University	NJ	COMPI	3	2	2
Francis Marion College	SC	COMPI	3	1	2
Jacksonville State University	AL	COMPI	3	1	2
Kean College of New Jersey	NJ	COMPI	3	1	3
Kentucky State University	KY	COMPII PM HB	3	1	3
Mississippi Uni ersity for Women	MS	COMPII W	3	1	3
Montclair State College	NJ	COMPI	3	2	2
Notre Dame College (OH)	OH	LAII* W	3	0	3
Pace University-All Campuses	NY	COMPI	3	2	2
Park College	MO	COMPI	3	2	1
US Air Force Academy	CO	OTHER	3	2	2
U. of Akron	OH	DOCI	3	1	2
U. of California-Santa Cruz	CA	DOCI	3	2	2
U. of Minnesota-All Campuses	MN	RESI	3	2	1

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
U. of Tennessee-Martin	TN	COMPI	3	1	2
U. of Texas-Arlington	TX	DOCII	3	2	2
U. of the Virgin Islands	VI	COMPI PM	3	2	2
Washington State University	WA	RESII	3	1	2
Wofford College	SC	LAII	3	3	0
Adelphi University	NY	DOCII	3	1	2
American University	DC	DOCI	3	1	2
Baylor University	TX	DOCII	3	2	1
Boston University	MA	RESI	3	0	3
California State Univ, Los Angeles	CA	COMPI PM	3	2	1
Clark University	MA	DOCII	3	2	1
Columbia University	NY	RESI	3	2	1
Georgia Southern College	GA	COMPI	3	1	2
Indiana University of Pennsylvania	PA	COMPI	3	2	1
Johns Hopkins University	MD	RESI	3	1	2
Loyola Marymount University	CA	COMPI	3	2	1
Mercy College	NY	COMPI PM	3	2	1
Middle Tennessee State University	TN	DOCII	3	1	2
Oakland University	MI	COMPI	3	1	2
Radford University	VA	COMPI	3	1	2
Rensselaer Polytechnic Institute	NY	RESII	3	2	1
Saint Joseph's University	PA	COMPI	3	3	0
Saint Paul's College	VA	LAII* PM HB	3	1	2
Salisbury State College	MD	COMPI	3	0	3
Smith College	MA	LAI W	3	0	3

TABLE 44 (CONTINUED)
INSTITUTIONS GRANTING BACCALAUREATE DEGREES
IN BIOLOGICAL SCIENCE TO BLACK GRADUATES
AVERAGE 1987 AND 1989

ACADEMIC INSTITUTION	STATE	CLASSIFICATION	ALL	MEN	WOMEN
Texas Woman's University	TX	DOCI W	3	0	3
U. of Alabama	AL	DOCI	3	1	2
U. of California-Santa Barbara	CA	RESII	3	2	1
U. of Chicago	IL	RESI	3	1	2
U. of Connecticut	CT	RESI	3	1	2
U. of Tennessee-Knoxville	TN	RESI	3	1	2
U. of Texas-San Antonio	TX	COMPI PM	3	2	1
Wagner College	NY	COMPII	3	1	2
Wake Forest University	NC	COMPI	3	0	3
Wesleyan University	CT	LAI	3	2	1
Western Kentucky University	KY	COMPI	3	2	1

TABLE 45
BACCALAUREATE DEGREES EARNED IN MATHEMATICS AND NATURAL SCIENCE
AVERAGE BACCALAUREATES EARNED BY ALL GRADUATES 1987-89
BY INSTITUTIONAL TYPE

	LIBERAL ARTS COLLEGES	COMPREHENSIVE COLLEGES & UNIVERSITIES	DOCTORATE GRANTING UNIVERSITIES	RESEARCH UNIVERSITIES	ALL INSTITUTIONS
# OF INSTITUTIONS	221	867	103	102	
ALL FIELDS	54,680	446,363	153,204	300,255	1,013,245
CHEMISTRY	1,218	3,910	1,213	2,859	9,270
PHYSICS	630	1,394	539	1,606	4,258
EARTH SCIENCE	273	1,244	640	1,140	3,319
PHYSICAL SCIENCE	2,197	7,121	2,506	6,115	18,434
MATHEMATICS	1,574	6,872	2,068	5,237	15,937
BIOLOGICAL SCIENCE	4,091	14,755	5,467	15,008	40,045
SUBTOTAL[1]	7,862	28,748	10,041	26,360	74,416
COMPUTER SCIENCE	800	19,027	5,505	7,228	35,262
ENGINEERING	621	15,974	13,859	36,800	70,775
TOTAL NS&E BACC. DEGREES	9,283	63,749	29,405	70,388	180,453
BACCALAUREATE ORIGIN OF PH.D.'S EARNED BY 1970-82 BACCALAUREATES					
BACCALAUREATES	676,067	5,416,136	1,851,799	3,544,338	11,816,174
NATURAL SCIENCE PH.D.'S	7,975	14,475	9,154	34,771	67,148

[1] Calculations for natural science and mathematics exclude institutions reported as granting no baccalaureate degrees in these fields (See Appendix B)

TABLE 46
BACCALAUREATE DEGREES EARNED IN MATHEMATICS AND NATURAL SCIENCE
AVERAGE BACCALAUREATES EARNED BY WOMEN GRADUATES 1987-89
BY INSTITUTIONAL TYPE

	LIBERAL ARTS COLLEGES	COMPREHENSIVE COLLEGES & UNIVERSITIES	DOCTORATE GRANTING UNIVERSITIES	RESEARCH UNIVERSITIES	ALL INSTITUTIONS
ALL-FIELDS	31,653	248,989	77,756	145,097	528,644
CHEMISTRY	514	1,615	452	985	3,586
PHYSICS	122	226	81	214	649
GEOLOGY	93	288	148	282	815
PHYSICAL SCIENCE	765	2,319	711	1,582	5,446
MATHEMATICS	814	3,413	1,001	2,124	7,381
BIOLOGICAL SCIENCE	2,244	7,744	2,554	7,079	19,852
SUBTOTAL[2]	3,823	13,476	4,266	10,785	32,679
COMPUTER SCI.	298	6,557	1,742	2,102	11,596
ENGINEERING	115	2,252	1,982	6,121	10,852
TOTAL NS&E BACC. DEGREES	4,236	22,285	7,990	19,008	55,127
BACCALAUREATE ORIGIN OF PH.D.'S EARNED BY 1970-82 WOMEN BACCALAUREATES					
BACCALAUREATES	355,379	2,688,543	829,871	1,501,996	5,456,246
NATURAL SCIENCE PH.D.'S	2,249	3,033	1,743	6,793	13,949

[2] Calculations for natural science and mathematics exclude institutions reported as granting no baccalaureate degrees in these fields (See Appendix B).

TABLE 47
BACCALAUREATE DEGREES EARNED IN MATHEMATICS AND NATURAL SCIENCE
AVERAGE BACCALAUREATES EARNED BY WOMEN GRADUATES 1987-89
BY INSTITUTIONAL TYPE

	LIBERAL ARTS COLLEGES	LIBERAL ARTS WOMEN'S	LIBERAL ARTS COED	COMPREHENSIVE COLLEGES & UNIVERSITIES	COMPREHENSIVE WOMEN'S	COMPREHENSIVE COED
ALL-FIELDS	31,653	7,309	24,344	248,989	8,586	240,403
CHEMISTRY	514	120	394	1,615	78	1,537
PHYSICS	122	27	95	226	4	222
GEOLOGY	93	15	78	288	1	287
PHYSICAL SCIENCE TOTAL	765	165	600	2,319	87	2,232
MATHEMATICS	814	199	615	3,413	138	3,275
BIOLOGICAL SCIENCE	2,244	443	1,801	7,744	322	7,422
TOTAL[3]	3,823	807	3,016	13,476	547	12,929
BACCALAUREATE ORIGIN OF PH.D.'S EARNED BY 1970-82 WOMEN BACCALAUREATES						
BACCALAUREATES	355,406	93,985	261,421	2,688,060	107,501	2,580,559
NATURAL SCIENCE PH.D.'S	2,249	703	1,546	3,033	218	2,815

[3] Calculations for natural science and mathematics exclude institutions reported as granting no baccalaureate degrees in these fields (See Appendix B).

TABLE 48
NATURAL SCIENCE PH.D.'S AWARDED TO
1970-1982 BACCALAUREATE DEGREE RECIPIENTS
PH.D. PRODUCTIVITY ADJUSTED FOR INSTITUTIONAL SIZE

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	% TOTAL BACH.	MATH & PHYS. SCIENCE PH.D.'S	% TOTAL BACH.	BIOL. SCIENCE PH.D.'S	% TOTAL BACH.
LIBERAL ARTS I							
Public	5276	34	--	15	--	19	--
Private	511,734	7,281	1.42	3,466	0.68	3,815	0.75
LIBERAL ARTS II							
Public	16,984	42	0.25	9	0.05	33	0.19
Private	142,073	618	0.43	257	0.18	361	0.25
RESEARCH I							
Public	2,085,984	18,846	0.90	7,047	0.34	11,799	0.57
Private	429,227	8,884	2.07	4,712	1.10	4,172	0.97
RESEARCH II							
Public	866,729	5,382	0.62	1,830	0.21	3,552	0.41
Private	162,398	1,659	1.02	853	0.53	806	0.50
DOCTORATE I							
Public	794,065	3,401	0.43	1,410	0.18	1,991	0.25
Private	277,962	2,104	0.76	1,028	0.37	1,076	0.39
DOCTORATE II							
Public	525,202	2,224	0.42	942	0.18	1,282	0.24
Private	254,570	1,425	0.56	809	0.32	616	0.24
COMP. I							
Public	3,374,031	8,096	0.24	3,571	0.11	4,525	0.13
Private	930,917	3,376	0.36	1,647	0.18	1,729	0.19
COMP. II							
Public	156,717	249	0.16	102	0.07	147	0.09
Private	401,418	1,367	0.34	583	0.15	784	0.20
LIBERAL ARTS II*							
Public	34.356	51	0.15	25	0.07	26	0.08
Private	518,697	1,336	0.26	631	0.12	705	0.14

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	% TOTAL BACH.	MATH & PHYS. SCIENCE PH.D.'S	% TOTAL BACH.	BIOL. SCIENCE PH.D.'S	% TOTAL BACH.
ENGINEERING							
Public	18,395	85	0.46	62	0.34	23	0.13
Private	30,172	304	1.01	268	0.89	36	0.12
MILITARY- MARITIME							
Public	46,927	66	0.14	49	0.10	17	0.04

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	MATH & PHYSICAL SCIENCE PH.D.'S	LIFE SCIENCE PH.D.'S
TOTAL PUBLIC	7,900,000	38,666	15,100	23,566
TOTAL PRIVATE	3,900,000	28,482	14,296	14,186
TOTAL	11,800,000	67,148	29,396	37,752

1987 CARNEGIE CLASSIFICATION
NUMBER OF INSTITUTIONS

	PUBLIC	PRIVATE
Liberal Arts I	2	140
Liberal Arts II	9	106
Research I	45	25
Research II	26	8
Doctorate-Granting I	30	21
Doctorate-Granting II	33	25
Comprehensive I	284	140
Comprehensive II	47	124
Liberal Arts II*[1]	21	294
Engineering	7	22
Maritime/Military	11	0

[1] The Liberal Arts II* institutions are those that otherwise meet the criteria for Comprehensive (fewer than half their baccalaureate degrees in liberal arts fields) but that enroll fewer than 1,500 students.

TABLE 49
NATURAL SCIENCE PH.D.'S AWARDED TO WOMEN
1970-1982 BACCALAUREATE DEGREE RECIPIENTS
PH.D. PRODUCTIVITY ADJUSTED FOR INSTITUTIONAL SIZE

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	% TOTAL BACH.	MATH & PHYS. SCIENCE PH.D.'S	% TOTAL BACH.	BIOL. SCIENCE PH.D.'S	% TOTAL BACH.
LIBERAL ARTS I							
Public	1,300	5	--	2	--	3	--
Private	265,343	2,074	0.78	658	0.25	1,416	0.53
LIBERAL ARTS II							
Public	8,600	11	0.13	0	0	11	0.13
Private	80,136	159	0.20	39	0.05	120	0.15
RESEARCH I							
Public	886,853	3,736	0.42	799	0.09	2937	0.33
Private	169,195	1,648	0.97	486	0.29	1,162	0.69
RESEARCH II							
Public	376,546	1,046	0.28	237	0.06	809	0.21
Private	69,402	363	0.52	129	0.19	234	0.34
DOCTORATE I							
Public	381,112	726	0.19	191	0.05	535	0.14
Private	111,117	371	0.33	101	0.09	270	0.24
DOCTORATE II							
Public	235,211	401	0.17	98	0.04	303	0.13
Private	102,431	245	0.24	77	0.08	168	0.16
COMP. I							
Public	1,695,841	1,638	0.10	505	0.03	1,133	0.07
Private	387,637	663	0.17	200	0.05	463	0.12
COMP.II							
Public	83,274	50	0.06	15	0.02	35	0.04
Private	214,003	361	0.17	94	0.04	267	0.12
LIBERAL ARTS II*							
Public	16,374	6	--	2	--	4	--
Private	291,414	315	0.11	92	0.03	223	0.08

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	% TOTAL BACH.	MATH & PHYS. SCIENCE PH.D.'S	% TOTAL BACH.	BIOL. SCIENCE PH.D.'S	% TOTAL BACH.
ENGINEER-ING							
Public	1,287	10	0.78	2	--	8	0.62
Private	1,940	15	0.77	15	0.77	0	0
MILITARY- MARITIME							
Public	817	0	0	0	0	0	0

	TOTAL BACHELOR'S DEGREES	NATURAL SCIENCE PH.D.'S	MATH & PHYSICAL SCIENCE PH.D.'S	LIFE SCIENCE PH.D.'S
TOTAL PUBLIC	3,700,000	7,703	1,855	5,848
TOTAL PRIVATE	1,760,000	6,246	1,895	4,351
TOTAL	5,460,000	13,949	3,750	10,199

TABLE 50
INSTITUTIONS IN TOP 15% BOTH FOR PROPORTION AND
ABSOLUTE NUMBER OF BACCALAUREATES EARNING NATURAL SCIENCE DOCTORATE
DOCTORATES EARNED BY ALL GRADUATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER	INSTITUTION	CLASSIFICATION
22.7	514	CALIFORNIA INSTITUTE OF TECHNOLOGY	RES1
15.7	174	HARVEY MUDD C. CA	ENGR
8.3	1143	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	RES1
6.0	393	U. OF CHICAGO IL	RES1
5.8	157	REED C. OR	LA1
4.8	217	CARLETON C. MN	LA1
4.6	184	POMONA C. CA	LA1
4.4	106	HAVERFORD C. PA	LA1
4.0	545	U. OF CALIFORNIA-SAN DIEGO	RES1
4.0	212	RICE U. TX	DOC1
3.7	138	SWARTHMORE C. PA	LA1
3.6	739	HARVARD-RADCLIFFE MA	RES1
3.5	315	JOHNS HOPKINS U. MD	RES1
3.4	432	PRINCETON U. NJ	RES1
3.4	116	KALAMAZOO C. MI	LA1
3.3	376	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII
2.9	1968	CORNELL U. NY	RES1
2.9	232	OBERLIN C. OH	LA1
2.9	304	CASE WESTERN RESERVE U. OH	RES1
2.8	99	GRINNELL C. IA	LA1
2.8	324	U. OF CALIFORNIA-RIVERSIDE	DOC1
2.7	405	BROWN U. RI	RESII
2.7	377	U. OF ROCHESTER NY	RES1
2.7	93	STEVENS INSTITUTE OF TECHNOLOGY NJ	DOCII
2.6	113	AMHERST C. MA	LA1
2.5	397	YALE U. CT	RES1
2.4	526	STANFORD U. CA	RES1
2.4	91	BOWDOIN C. ME	LA1
2.3	137	WESLEYAN U. CT	LA1
2.3	103	MUHLENBERG C. PA	LA1
2.3	114	C. OF WOOSTER OH	LA1
2.2	765	U. OF CALIFORNIA-DAVIS	RES1
2.1	374	U. OF CALIFORNIA-IRVINE	RES1
2.1	171	BRANDEIS U. MA	RESII
2.1	247	DARTMOUTH C. NH	DOCII
2.1	284	U. OF CALIFORNIA-SANTA CRUZ	DOC1
2.1	487	SUNY U. AT STONY BROOK	RES1
2.1	110	WILLIAMS C. MA	LA1
2.1	105	SUNY C. OF ENVIRONMENTAL SCI.& FORESTRY	DOCII
2.0	121	FRANKLIN & MARSHALL C. PA	LA1
2.0	98	POLYTECHNIC INSTITUTE OF NEW YORK	DOCII
2.0	182	CARNEGIE-MELLON U. PA	RES1
1.9	97	OCCIDENTAL C. CA	LA1
1.9	167	BUCKNELL U. PA	LA1
1.9	302	COLUMBIA U. NY [ALL DIV. EXCEPT BARNARD]	RES1
1.9	331	DUKE U. NC	RES1
1.9	99	WORCESTER POLYTECHNIC INSTITUTE MA	COMP1
1.8	129	UNION C. & U. NY	LA1
1.8	1254	U. OF CALIFORNIA-BERKELEY	RES1
1.7	93	HOPE C. MI	LA1

TABLE 50 (CONTINUED)
INSTITUTIONS IN TOP 15% BOTH FOR PROPORTION AND
ABSOLUTE NUMBER OF BACCALAUREATES EARNING NATURAL SCIENCE DOCTORATE
DOCTORATES EARNED BY ALL GRADUATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER	INSTITUTION	CLASSIFICATION	
1.7	211	C. OF WILLIAM & MARY VA	DOC1	
1.7	102	MOUNT HOLYOKE C. MA	LA1	W
1.6	121	COLGATE U. NY	LA1	
1.6	125	SAINT OLAF C. MN	LA1	
1.6	124	SMITH C. MA	LA1	W
1.5	100	ILLINOIS INSTITUTE OF TECHNOLOGY	DOC1	
1.4	90	WELLESLEY C. MA	LA1	W
1.4	211	WASHINGTON U. MO	RES1	
1.4	88	LAFAYETTE C. PA	LA1	
1.4	382	U. OF PENNSYLVANIA	RES1	
1.3	845	U. OF WISCONSIN-MADISON	RES1	
1.3	809	U. OF MICHIGAN-ANN ARBOR	RES1	
1.3	144	LEHIGH U. PA	DOC1	
1.3	643	RUTGERS U.-NEW BRUNSWICK NJ	RES1	
1.3	123	MANHATTAN C. NY	COMP1	
1.2	206	SUNY U. AT BINGHAMTON	DOC1	
1.2	425	U. OF CALIFORNIA-SANTA BARBARA	RESII	
1.2	105	CALVIN C. MI	COMP1	
1.2	702	U. OF CALIFORNIA-LOS ANGELES	RES1	
1.2	254	U. OF NOTRE DAME IN	DOC1	
1.2	252	NORTHWESTERN U. IL	RES1	
1.1	836	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RES1	
1.1	119	EMORY U. GA	RESII	
1.1	93	WAKE FOREST U. NC	COMP1	
1.1	322	NORTH CAROLINA STATE U.-RALEIGH	RES1	
1.1	635	PURDUE U. IN	RES1	
1.1	382	SUNY U. AT BUFFALO	RESII	
1.1	158	DREXEL U. PA	DOCII	
1.1	87	ANTIOCH C. OH	LA1	
1.1	288	SUNY U. AT ALBANY	RESII	
1.0	304	U. OF DELAWARE	RESII	
1.0	147	HUMBOLDT STATE U. CA	COMP1	
1.0	348	COLORADO STATE U.	RES1	
1.0	128	TUFTS U. MA	DOC1	
1.0	433	IOWA STATE U. OF SCIENCE & TECHNOLOGY	RESII	
1.0	154	VANDERBILT U. TN	RES1	
1.0	254	U. OF VIRGINIA	RES1	
0.9	362	U. OF CONNECTICUT	RES1	
0.9	165	GEORGIA INSTITUTE OF TECHNOLOGY	RES1	
0.9	809	PENNSYLVANIA STATE U.	RES1	
0.9	114	TULANE U. OF LOUISIANA	RESII	
0.9	336	U. OF NORTH CAROLINA AT CHAPEL HILL	RES1	
0.8	245	CUNY CITY C. NY	COMP1	PM
0.8	91	SAINT JOSEPH'S U. PA	COMP1	
0.8	159	U. OF VERMONT	DOCII	
0.8	769	MICHIGAN STATE U.	RES1	
0.8	130	NEW MEXICO STATE U.	RES1	
0.8	146	UTAH STATE U.	RESII	

TABLE 51
INSTITUTIONS IN TOP 15% **BOTH** FOR PROPORTION AND
ABSOLUTE NUMBER OF BACCALAUREATES EARNING NATURAL SCIENCE DOCTORATE
DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER	INSTITUTION	CLASSIFICATION	
14.8	29	CALIFORNIA INSTITUTE OF TECHNOLOGY	RES1	
7.2	119	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	RES1	
4.1	47	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII	
3.6	89	U. OF CHICAGO IL	RES1	
2.7	30	REED C. OR	LA1	
2.6	59	RICE U. TX	DOC1	
2.4	41	SWARTHMORE C. PA	LA1	
2.4	51	CARLETON C. MN	LA1	
2.2	41	POMONA C. CA	LA1	
2.1	123	HARVARD-RADCLIFFE MA	RES1	
2.1	58	BRYN MAWR C. PA	LA1	W
2.0	273	CORNELL U. NY	RES1	
2.0	32	GRINNELL C. IA	LA1	
1.9	106	U. OF CALIFORNIA-SAN DIEGO	RES1	
1.8	28	KALAMAZOO C. MI	LA1	
1.8	34	JOHNS HOPKINS U. MD	RES1	
1.7	141	STANFORD U. CA	RES1	
1.7	102	MOUNT HOLYOKE C. MA	LA1	W
1.6	63	OBERLIN C. OH	LA1	
1.6	67	YALE U. CT	RES1	
1.6	124	SMITH C. MA	LA1	W
1.5	89	BROWN U. RI	RESII	
1.5	59	BRANDEIS U. MA	RESII	
1.5	33	OCCIDENTAL C. CA	LA1	
1.5	46	PRINCETON U. NJ	RES1	
1.4	90	WELLESLEY C. MA	LA1	W
1.4	84	U. OF ROCHESTER NY	RES1	
1.3	62	VASSAR C. NY	LA1	
1.3	24	MUHLENBERG C. PA	LA1	
1.3	24	DARTMOUTH C. NH	DOCII	
1.2	78	BARNARD C. NY	LA1	W
1.2	42	BUCKNELL U. PA	LA1	
1.2	31	MIDDLEBURY C. VT	LA1	
1.1	32	GOUCHER C. MD	LA1	W
1.1	23	RANDOLPH-MACON WOMAN'S C. VA	LA1	W
1.1	85	DUKE U. NC	RES1	
1.1	74	U. OF CALIFORNIA-SANTA CRUZ	DOC1	
1.1	59	U. OF CALIFORNIA-RIVERSIDE	DOC1	
1.1	45	CASE WESTERN RESERVE U. OH	RES1	
1.1	24	COLBY C. ME	LA1	
1.0	171	U OF CALIFORNIA-DAVIS	RES1	
1.0	22	WESLEYAN U. CT	LA1	
0.9	103	U. OF PENNSYLVANIA	RES1	
0.9	276	U. OF CALIFORNIA-BERKELEY	RES1	
0.9	58	C. OF WILLIAM & MARY VA	DOC1	
0.9	24	HOPE C. MI	LA1	
0.9	22	COLORADO C.	LA1	
0.8	55	NORTH CAROLINA STATE U.-RALEIGH	RES1	
0.8	67	U. OF CALIFORNIA-IRVINE	RES1	
0.8	86	SUNY U. AT STONY BROOK	RES1	

TABLE 51 (CONTINUED)
INSTITUTIONS IN TOP 15% **BOTH** FOR PROPORTION AND
ABSOLUTE NUMBER OF BACCALAUREATES EARNING NATURAL SCIENCE DOCTORATE
DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER	INSTITUTION	CLASSIFICATION
0.8	25	ST. LAWRENCE U. NY	LA1
0.8	47	WASHINGTON U. MO	RES1
0.8	48	TUFTS U. MA	DOC1
0.8	31	SAINT OLAF C. MN	LA1
0.7	94	SUNY U. AT BUFFALO	RESII
0.7	71	NORTHWESTERN U. IL	RES1
0.7	35	EMORY U. GA	RESII
0.7	24	DREXEL U. PA	DOCII
0.7	183	U. OF MICHIGAN-ANN ARBOR	RES1
0.6	143	RUTGERS U.-NEW BRUNSWICK NJ	RES1
0.6	49	SUNY U. AT BINGHAMTON	DOC1
0.6	48	VANDERBILT U. TN	RES1
0.6	29	SIMMONS C. MA	COMP1
0.6	120	PURDUE U. IN	RES1
0.5	162	U. OF WISCONSIN-MADISON	RES1
0.5	41	FORDHAM U. NY	DOC1
0.5	25	ANTIOCH C. OH	LA1
0.5	88	U. OF CALIFORNIA-SANTA BARBARA	RESII
0.5	56	CUNY CITY C. NY	COMP1 PM
0.5	27	SKIDMORE C. NY	LA1
0.5	148	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RES1
0.5	77	U. OF DELAWARE	RESII
0.5	94	U. OF CONNECTICUT	RES1

TABLE 52
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES
IN ORDER BY PROPORTION OF BACCALAUREATES

PH.D.'S AS % OF BACC DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
22.7	514	CALIFORNIA INSTITUTE OF TECHNOLOGY	RESI	
15.7	174	HARVEY MUDD C. CA	ENGR	
8.3	1143	MASSACHUSETTS INSTITUTE OF TECH.	RESI	
6.0	393	U. OF CHICAGO IL	RESI	
5.8	157	REED C. OR	LAI	
4.8	217	CARLETON C. MN	LAI	
4.6	184	POMONA C. CA	LAI	
4.4	108	HAVERFORD C. PA	LAI	
4.0	545	U. OF CALIFORNIA-SAN DIEGO	RESI	
4.0	312	RICE U. TX	DOCI	
3.7	138	SWARTHMORE C. PA	LAI	
3.6	739	HARVARD-RADCLIFFE MA	RESI	
3.6	55	NEW MEXICO INSTITUTE OF MINING & TECH.	ENGR	
3.5	315	JOHNS HOPKINS U. MD	RESI	
3.4	432	PRINCETON U. NJ	RESI	
3.4	116	KALAMAZOO C. MI	LAI	
3.3	376	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII	
2.9	1068	CORNELL U. NY	RESI	
2.9	233	OBERLIN C. OH	LAI	
2.9	304	CASE WESTERN RESERVE U. OH	RESI	
2.8	99	GRINNELL C. IA	LAI	
2.8	324	U. OF CALIFORNIA-RIVERSIDE	DOCI	
2.7	75	COOPER UNION NY	ENGR	
2.7	405	BROWN U. RI	RESII	
2.7	377	U. OF ROCHESTER NY	RESI	
2.7	93	STEVENS INSTITUTE OF TECHNOLOGY NJ	DOCII	
2.7	59	WABASH C. IN	LAI	
2.6	113	AMHERST C. MA	LAI	
2.5	397	YALE U. CT	RESI	
2.5	526	STANFORD U. CA	RESI	
2.4	70	EARLHAM C. IN	LAI	
2.4	91	BOWDOIN C. ME	LAI	
2.4	80	KNOX C. IL	LAI	
2.3	137	WESLEYAN U. CT	LAI	
2.3	103	MUHLENBERG C. PA	LAI	
2.3	61	BRYN MAWR C. PA	LAI	W
2.3	114	C. OF WOOSTER OH	LAI	
2.2	765	U. OF CALIFORNIA-DAVIS	RESI	
2.2	72	JUNIATA C. PA	LAI	
2.2	83	BATES C. ME	LAI	
2.1	374	U. OF CALIFORNIA-IRVINE	RESI	
2.1	171	BRANDEIS U. MA	RESII	
2.1	284	U. OF CALIFORNIA-SANTA CRUZ	DOCI	
2.1	247	DARTMOUTH C. NH	DOCII	
2.1	75	DAVIDSON C. NC	LAI	
2.1	110	WILLIAMS C. MA	LAI	
2.1	487	SUNY U. AT STONY BROOK	RESI	
2.0	105	SUNY C. OF ENVIR. SCI. & FORESTRY	DOCII	
2.0	73	LAWRENCE U. WI	LAI	
2.0	98	POLYTECHNIC INSTITUTE OF NEW YORK	DOCII	

TABLE 52 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
2.0	121	FRANKLIN & MARSHALL C. PA	LAI	
2.0	44	PHILADELPHIA C. OF PHARMACY & SCI.	HLTH	
2.0	182	CARNEGIE-MELLON U. PA	RESI	
2.0	57	LEBANON VALLEY C. PA	LAI	
1.9	97	OCCIDENTAL C. CA	LAI	
1.9	167	BUCKNELL U. PA	LAI	
1.9	53	WHITMAN C. WA	LAI	
1.9	42	HAMPSHIRE C. MA	LAI	
1.9	302	COLUMBIA U. NY (ALL DIV. EXCEPT BARNARD)	RESI	
1.9	331	DUKE U. NC	RESI	
1.9	99	WORCESTER POLYTECHNIC INSTITUTE MA	COMPI	
1.8	129	UNION C. & U. NY	LAI	
1.8	1254	U. OF CALIFORNIA-BERKELEY	RESI	
1.8	61	URSINUS C. PA	LAI	
1.8	46	ILLINOIS BENEDICTINE C.	COMPII	
1.7	9	MARLBORO C. VT	LAI	
1.7	63	BELOIT C. WI	LAI	
1.7	40	ECKERD C. FL	LAI	
1.7	93	HOPE C. MI	LAI	
1.7	48	WASHINGTON & JEFFERSON C. PA	LAI	
1.7	211	C. OF WILLIAM & MARY VA	DOCI	
1.7	102	MOUNT HOLYOKE C. MA	LAI	W
1.6	32	CENTRE C. OF KENTUCKY	LAI	
1.6	121	COLGATE U. NY	LAI	
1.6	125	SAINT OLAF C. MN	LAI	
1.6	68	ST. JOHN'S U. MN	LAI	
1.6	124	SMITH C. MA	LAI	W
1.5	85	GETTYSBURG C. PA	LAI	
1.5	48	DELAWARE VALLEY C. OF SCI.& AG. PA	COMPII	
1.5	54	COLORADO SCHOOL OF MINES	DOCII	
1.5	65	MACALESTER C. MN	LAI	
1.5	51	WESTERN MARYLAND C.	LAI	
1.5	100	ILLINOIS INSTITUTE OF TECHNOLOGY	DOCI	
1.4	90	WELLESLEY C. MA	LAI	W
1.4	55	DREW U. NJ	LAI	
1.4	54	KENYON C. OH	LAI	
1.4	71	ALLEGHENY C. PA	LAI	
1.4	211	WASHINGTON U. MO	RESI	
1.4	45	HIRAM C. OH	LAII	
1.4	82	MIDDLEBURY C. VT	LAI	
1.4	79	COLORADO C.	LAI	
1.4	88	LAFAYETTE C. PA	LAI	
1.4	68	COLBY C. ME	LAI	
1.4	27	HAMPDEN-SYDNEY C. VA	LAI	
1.4	40	ROSE-HULMAN INSTITUTE OF TECH. IN	ENGR	
1.4	33	CORNELL C. IA	LAI	
1.4	382	U. OF PENNSYLVANIA	RESI	
1.4	40	THOMAS MORE C. KY	LAI	
1.4	31	MILLSAPS C. MS	LAI	
1.3	50	ALBRIGHT C. PA	LAI	

TABLE 52(CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
1.3	60	HAMILTON C. NY	LAI	
1.3	53	YESHIVA U. NY	RESI	
1.3	35	NEBRASKA WESLEYAN U. NE	LAI	
1.3	845	U. OF WISCONSIN-MADISON	RESI	
1.3	41	LONG ISLAND U. SOUTHAMPTON CENTER	LAII	
1.3	809	U. OF MICHIGAN	RESI	
1.3	66	TRINITY C. CT	LAI	
1.3	85	VASSAR C. NY	LAI	
1.3	144	LEHIGH U. PA	DOCI	
1.3	38	AUSTIN C. TX	LAI	
1.3	77	DEPAUW U. IN	LAI	
1.3	11	ST. JOHN'S C. MD	LAI	
1.3	643	RUTGERS U. NJ	RESI	
1.3	123	MANHATTAN C. NY	COMPI	
1.2	206	SUNY U. AT BINGHAMTON	DOCI	
1.2	425	U. OF CALIFORNIA-SANTA BARBARA	RESII	
1.2	105	CALVIN C. MI	COMPI	
1.2	39	THIEL C. PA	LAII	
1.2	25	U. OF DALLAS TX	LAI	
1.2	702	U. OF CALIFORNIA-LOS ANGELES	RESI	
1.2	59	ALBION C. MI	LAI	
1.2	254	U. OF NOTRE DAME IN	DOCI	
1.2	78	BARNARD C. NY	LAI	W
1.2	25	RANDOLPH-MACON WOMAN'S C. VA	LAI	W
1.2	15	KANSAS WESLEYAN	LAII*	
1.2	31	THE U. OF THE SOUTH TN	LAI	
1.2	78	ST. LAWRENCE U. NY	LAI	
1.2	71	DENISON U. OH	LAI	
1.2	8	KING C. TN	LAI	
1.1	252	NORTHWESTERN U. IL	RESI	
1.1	836	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RESI	
1.1	119	EMORY U. GA	RESII	
1.1	33	GOUCHER C. MD	LAI	W
1.1	20	C. OF IDAHO	LAII	
1.1	3	FRIENDS WORLD C. NY	LAII	
1.1	93	WAKE FOREST U. NC	COMPI	
1.1	65	AUGUSTANA C. IL	LAI	
1.1	322	NORTH CAROLINA STATE U.-RALEIGH	RESI	
1.1	635	PURDUE U. IN	RESI	
1.1	18	BARD C. NY	LAI	
1.1	32	HEIDELBERG C. OH	LAII*	
1.1	57	DICKINSON C. PA	LAI	
1.1	31	RHODES C. TN	LAI	
1.1	28	TEXAS LUTHERAN C.	LAII*	
1.1	382	SUNY U. AT BUFFALO	RESII	
1.1	17	WELLS C. NY	LAI	W
1.1	87	ANTIOCH C. OH	LAI	
1.1	158	DREXEL U. PA	DOCII	
1.1	27	RIPON C. WI	LAI	
1.1	81	C. OF THE HOLY CROSS MA	LAI	

TABLE 52 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION
1.1	288	SUNY U. AT ALBANY	RESII
1.1	61	FURMAN U. SC	LAI
1.1	22	SOUTHWESTERN U. TX	LAII*
1.1	304	U. OF DELAWARE	RESII
1.1	33	CENTRAL U. OF IOWA	COMPII
1.1	20	WASHINGTON C. MD	LAI
1.0	5	COVENANT C. GA	LAII
1.0	67	CLARK U. MA	DOCII
1.0	32	HOUGHTON C. NY	LAI
1.0	46	MARIETTA C. OH	LAII*
1.0	63	WHEATON C. IL	LAI
1.0	147	HUMBOLDT STATE U. CA	COMPI
1.0	31	LAKE FOREST C. IL	LAI
1.0	37	FLORIDA INSTITUTE OF TECHNOLOGY	DOCII
1.0	13	BETHEL C. KS	LAII*
1.0	33	HAMLINE U. MN	LAI
1.0	348	COLORADO STATE U.	RESI

TABLE 53
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN
IN ORDER BY % OF WOMEN BACCALAUREATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
14.8	29	CALIFORNIA INSTITUTE OF TECHNOLOGY	RESI	
11.1	12	HARVEY MUDD C. CA	ENGR	
7.2	119	MASSACHUSETTS INSTITUTE OF TECH.	RESI	
4.1	47	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII	
3.6	89	U. OF CHICAGO IL	RESI	
2.7	30	REED C. OR	LAI	
2.6	59	RICE U. TX	DOCI	
2.4	51	CARLETON C. MN	LAI	
2.4	41	SWARTHMORE C. PA	LAI	
2.3	14	ILLINOIS INSTITUTE OF TECHNOLOGY	DOCI	
2.2	41	POMONA C. CA	LAI	
2.2	123	HARVARD-RADCLIFFE MA	RESI	
2.1	58	BRYN MAWR C. PA	LAI	W
2.1	7	NEW MEXICO INSTITUTE OF MINING & TECH.	ENGR	
2.0	273	CORNELL U. NY	RESI	
2.0	32	GRINNELL C. IA	LAI	
1.9	106	U. OF CALIFORNIA-SAN DIEGO	RESI	
1.8	28	KALAMAZOO C. MI	LAI	
1.8	34	JOHNS HOPKINS U. MD	RESI	
1.7	141	STANFORD U. CA	RESI	
1.7	102	MOUNT HOLYOKE C. MA	LAI	W
1.6	67	YALE U. CT	RESI	
1.6	63	OBERLIN C. OH	LAI	
1.6	124	SMITH C. MA	LAI	W
1.6	13	SUNY C. OF ENVIR. SCI. & FOPESTRY	DOCII	
1.5	89	BROWN U. RI	RESII	
1.5	4	POLYTECHNIC INSTITUTE OF NEW YORK	DOCII	
1.5	59	BRANDEIS U. MA	RESII	
1.5	33	OCCIDENTAL C. CA	LAI	
1.5	46	PRINCETON U. NJ	RESI	
1.4	90	WELLESLEY C. MA	LAI	W
1.4	84	U. OF ROCHESTER NY	RESI	
1.3	15	HAMPSHIRE C. MA	LAI	
1.3	5	ST. JOHN'S C. MD	LAI	
1.3	62	VASSAR C. NY	LAI	
1.3	5	WORCESTER POLYTECHNIC INSTITUTE MA	COMPI	
1.3	24	MUHLENBERG C. PA	LAI	
1.3	24	DARTMOUTH C. NH	DOCII	
1.2	12	BOWDOIN C. ME	LAI	
1.2	78	BARNARD C. NY	LAI	W
1.2	42	BUCKNELL U. PA	LAI	
1.2	16	JUNIATA C. PA	LAI	
1.2	31	MIDDLEBURY C. VT	LAI	
1.1	13	ECKERD C. FL	LAI	
1.1	32	GOUCHER C. MD	LAI	W
1.1	23	RANDOLPH-MACON WOMAN'S C. VA	LAI	W
1.1	14	WHITMAN C. WA	LAI	
1.1	59	U. OF CALIFORNIA-RIVERSIDE	DOCI	
1.1	74	U. OF CALIFORNIA-SANTA CRUZ	DOCI	
1.1	85	DUKE U. NC	RESI	

TABLE 53 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
1.1	17	WELLS C. NY	LAI	W
1.1	45	CASE WESTERN RESERVE U. OH	RESI	
1.1	24	COLBY C. ME	LAI	
1.0	171	U. OF CALIFORNIA-DAVIS	RESI	
1.0	9	ILLINOIS BENEDICTINE C.	COMPII	
1.0	22	WESLEYAN U. CT	LAI	
1.0	6	DELAWARE VALLEY C. OF SCI. & AG. PA	COMPII	
1.0	17	FRANKLIN & MARSHALL C. PA	LAI	
1.0	8	CENTRE C. OF KENTUCKY	LAI	
1.0	10	WILSON C. PA	LAII	W
0.9	103	U. OF PENNSYLVANIA	RESI	
0.9	276	U. OF CALIFORNIA-BERKELEY	RESI	
0.9	16	LAWRENCE U. WI	LAI	
0.9	2	SAINT JOHN'S C. NM	LAI	
0.9	20	ALLEGHENY C. PA	LAI	
0.9	58	C. OF WILLIAM & MARY VA	DOCI	
0.9	24	HOPE C. MI	LAI	
0.9	13	KNOX C. IL	LAI	
0.9	22	COLORADO C.	LAI	
0.9	12	LAFAYETTE C. PA	LAI	
0.9	13	WILLIAMS C. MA	LAI	
0.8	67	U. OF CALIFORNIA-IRVINE	RESI	
0.8	55	NORTH CAROLINA STATE U.-RALEIGH	RESI	
0.8	86	SUNY U. AT STONY BROOK	RESI	
0.8	5	WASHINGTON & JEFFERSON C. PA	LAI	
0.8	12	EARLHAM C. IN	LAI	
0.8	12	LAKE FOREST C. IL	LAI	
0.8	20	C. OF WOOSTER OH	LAI	
0.8	2	MARLBORO C. VT	LAI	
0.8	14	WESTERN MARYLAND C.	LAI	
0.8	14	TRINITY C. CT	LAI	
0.8	25	ST. LAWRENCE U. NY	LAI	
0.8	11	URSINUS C. PA	LAI	
0.8	6	MARYVILLE C. TN	LAII	
0.8	17	MACALESTER C. MN	LAI	
0.8	9	HENDRIX C. AR	LAI	
0.8	13	BATES C. ME	LAI	
0.8	48	TUFTS U. MA	DOCI	
0.8	31	SAINT OLAF C. MN	LAI	
0.8	47	WASHINGTON U. MO	RESI	
0.8	10	KENYON C. OH	LAI	
0.8	17	GETTYSBURG C. PA	LAI	
0.8	15	DREW U. NJ	LAI	
0.8	11	LEBANON VALLEY C. PA	LAI	
0.7	13	HOBART & WM SMITH C. NY	LAI	
0.7	6	WHEELING JESUIT C. WV	LAII*	
0.7	10	ALBERTUS MAGNUS C. CT	LAII	W
0.7	71	NORTHWESTERN U. IL	RESI	
0.7	94	SUNY U. AT BUFFALO	RESII	
0.7	8	NOTRE DAME C. OH	LAII*	W

TABLE 53 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.7	8	KING'S C. PA	COMPII	
0.7	13	GEORGIA INSTITUTE OF TECHNOLOGY	RESI	
0.7	35	EMORY U. GA	RESII	
0.7	21	WAKE FOREST U. NC	COMPI	
0.7	13	UNION C. & U. NY	LAI	
0.7	24	DREXEL U. PA	DOCII	
0.7	20	CARNEGIE-MELLON U. PA	RESI	
0.7	3	ALLENTOWN C. OF ST. FRANCIS DE SALES PA	LAII*	
0.7	16	DICKINSON C. PA	LAI	
0.7	2	SOUTH DAKOTA SCHOOL OF MINES & TECH.	ENGR	
0.7	2	KING C. TN	LAI	
0.7	21	DEPAUW U. IN	LAI	
0.7	11	AGNES SCOTT C. GA	LAI	W
0.7	12	C. OF THE HOLY CROSS MA	LAI	
0.7	14	COLGATE U. NY	LAI	
0.7	7	MANHATTAN C. NY	COMPI	
0.7	183	U. OF MICHIGAN	RESI	
0.7	4	DAVIDSON C. NC	LAI	
0.7	5	PHILADELPHIA C. OF PHARMACY & SCI.	HLTH	
0.7	18	FURMAN U. SC	LAI	
0.6	7	CORNELL C. IA	LAI	
0.6	10	HAMILTON C. NY	LAI	
0.6	49	SUNY U. AT BINGHAMTON	DOCI	
0.6	10	MICHIGAN TECHNOLOGICAL U.	COMPI	
0.6	143	RUTGERS U. NJ	RESI	
0.6	6	U. OF MISSOURI-ROLLA	DOCII	
0.6	16	CHESTNUT HILL C. PA	LAI	W
0.6	10	SAINT FRANCIS C. PA	COMPII	
0.6	18	C. OF CHARLESTON SC	COMPI	
0.6	7	TEXAS LUTHERAN C.	LAII*	
0.6	18	DENISON U. OH	LAI	
0.6	5	THE U. OF THE SOUTH TN	LAI	
0.6	48	VANDERBILT U. TN	RESI	
0.6	11	ALBRIGHT C. PA	LAI	
0.6	29	SIMMONS C. MA	COMPI	W
0.6	19	CATHOLIC U. OF AMERICA DC	DOCI	
0.6	120	PURDUE U. IN	RESI	
0.6	7	LONG ISLAND U. SOUTHAMPTON CENTER	LAII	
0.6	16	U. OF NOTRE DAME IN	DOCI	
0.6	18	OHIO WESLEYAN U.	LAII	
0.6	6	PFEIFFER C. NC	LAII*	
0.6	10	BELOIT C. WI	LAI	
0.6	162	U. OF WISCONSIN-MADISON	RESI	
0.5	14	FAIRFIELD U. CT	COMPI	
0.5	4	C. OF IDAHO	LAII	
0.5	19	WHEATON C. MA	LAI	W
0.5	12	ALBION C. MI	LAI	
0.5	8	THIEL C. PA	LAII	
0.5	88	U. OF CALIFORNIA-SANTA BARBARA	RESII	
0.5	16	CLARK U. MA	DOCII	

TABLE 53 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.5	41	FORDHAM U. NY	DOCI	
0.5	25	ANTIOCH C. OH	LAI	
0.5	148	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RESI	
0.5	56	CUNY CITY C. NY	COMPI	PM
0.5	27	SKIDMORE C. NY	LAI	
0.5	7	RHODES C. TN	LAI	
0.5	3	NORTHLAND C. WI	LAII	
0.5	19	CONNECTICUT C.	LAI	
0.5	94	U. OF CONNECTICUT	RESI	
0.5	77	U. OF DELAWARE	RESII	
0.5	2	TRINITY CHRISTIAN C. IL	LAII	
0.5	14	HOLLINS C. VA	LAI	W
0.5	12	U. OF RICHMOND VA	COMPI	
0.5	7	PITZER C. CA	LAI	
0.5	5	MILLSAPS C. MS	LAI	

TABLE 54
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES
IN ORDER BY ABSOLUTE NUMBER OF DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION
1.8	1254	U. OF CALIFORNIA-BERKELEY	RESI
8.3	1143	MASSACHUSETTS INSTITUTE OF TECH.	RESI
2.9	1068	CORNELL U. NY	RESI
1.3	845	U. OF WISCONSIN-MADISON	RESI
1.1	836	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RESI
1.3	809	U. OF MICHIGAN	RESI
0.9	809	PENNSYLVANIA STATE U.	RESI
0.8	769	MICHIGAN STATE U.	RESI
2.2	765	U. OF CALIFORNIA-DAVIS	RESI
3.6	739	HARVARD-RADCLIFFE MA	RESI
1.2	702	U. OF CALIFORNIA-LOS ANGELES	RESI
1.3	643	RUTGERS U. NJ	RESI
1.1	635	PURDUE U. IN	RESI
0.7	616	OHIO STATE U.	RESI
0.8	571	U. OF MINNESOTA-TWIN CITIES	RESI
4.0	545	U. OF CALIFORNIA-SAN DIEGO	RESI
2.5	526	STANFORD U. CA	RESI
22.7	514	CALIFORNIA INSTITUTE OF TECHNOLOGY	RESI
0.7	509	U. OF MARYLAND COLLEGE PARK	RESI
0.7	503	U. OF WASHINGTON	RESI
0.6	492	U. OF TEXAS AT AUSTIN	RESI
2.1	487	SUNY U. AT STONY BROOK	RESI
1.0	433	IOWA STATE U. OF SCIENCE & TECH.	RESII
3.4	432	PRINCETON U. NJ	RESI
1.2	425	U. OF CALIFORNIA-SANTA BARBARA	RESII
2.7	405	BROWN U. RI	RESII
2.5	397	YALE U. CT	RESI
6.0	393	U. OF CHICAGO IL	RESI
0.8	391	U. OF MASSACHUSETTS AT AMHERST	RESII
1.1	382	SUNY U. AT BUFFALO	RESII
1.4	382	U. OF PENNSYLVANIA	RESI
0.7	382	BRIGHAM YOUNG U. UT	DOCI
2.7	377	U. OF ROCHESTER NY	RESI
3.3	376	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII
2.1	374	U. OF CALIFORNIA-IRVINE	RESI
0.8	366	TEXAS A. & M. U.	RESI
0.9	362	U. OF CONNECTICUT	RESI
0.6	358	U. OF FLORIDA	RESI
1.0	348	COLORADO STATE U.	RESI
0.7	340	U. OF COLORADO AT BOULDER	RESI
0.6	339	INDIANA U.-BLOOMINGTON	RESI
0.9	336	U. OF NORTH CAROLINA AT CHAPEL HILL	RESI
1.9	331	DUKE U. NC	RESI
2.8	324	U. OF CALIFORNIA-RIVERSIDE	DOCI
1.1	322	NORTH CAROLINA STATE U.-RALEIGH	RESI
3.5	315	JOHNS HOPKINS U. MD	RESI
4.0	312	RICE U. TX	DOCI
1.1	304	U. OF DELAWARE	RESII
2.9	304	CASE WESTERN RESERVE U. OH	RESI
1.9	302	COLUMBIA U. NY (ALL DIV. EXCEPT BARNARD)	RESI

TABLE 54 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.7	295	U. OF MISSOURI-COLUMBIA	RESI	
0.8	290	VIRGINIA POLYTECHNIC INSTITUTE	RESI	
1.1	288	SUNY U. AT ALBANY	RESII	
2.1	284	U. OF CALIFORNIA-SANTA CRUZ	DOCII	
0.7	276	U. OF ARIZONA	RESII	
0.7	263	U. OF KANSAS	RESII	
0.7	262	LOUISIANA STATE U. & A & M	RESI	
0.7	259	CUNY BROOKLYN C. NY	COMPI	
1.2	254	U. OF NOTRE DAME IN	DOCI	
0.7	254	OREGON STATE U.	RESI	
0.9	254	U. OF VIRGINIA	RESI	
0.6	253	U. OF PITTSBURGH PA	RESI	
1.1	252	NORTHWESTERN U. IL	RESI	
2.1	247	DARTMOUTH C. NH	DOCII	
0.8	245	CUNY CITY C. NY	COMPI	PM
0.6	234	MIAMI U. OH	DOCI	
2.9	233	OBERLIN C. OH	LAI	
0.6	233	U. OF NEBRASKA-LINCOLN	RESII	
0.6	227	U. OF IOWA	RESI	
0.8	226	NEW YORK U.	RESI	
0.5	225	U. OF GEORGIA	RESI	
0.6	222	BOSTON U. MA	RESI	
0.7	222	KANSAS STATE U.	RESII	
0.5	219	FLORIDA STATE U.	RESII	
0.5	219	U. OF CINCINNATI OH	RESI	
4.8	217	CARLETON C. MN	LAI	
0.6	212	OKLAHOMA STATE U.	RESII	
1.4	211	WASHINGTON U. MO	RESI	
1.7	211	C. OF WILLIAM & MARY VA	DOCI	
0.6	208	WASHINGTON STATE U.	RESII	
1.2	206	SUNY U. AT BINGHAMTON	DOCI	
0.4	206	U. OF TENNESSEE	RESI	
0.6	200	U. OF ILLINOIS AT CHICAGO	RESI	
0.6	199	U. OF UTAH	RESI	
0.4	198	U. OF SOUTH FLORIDA	DOCI	
0.8	190	U. OF RHODE ISLAND	RESII	
4.6	184	POMONA C. CA	LAI	
2.0	182	CARNEGIE-MELLON U. PA	RESI	
15.7	174	HARVEY MUDD C. CA	ENGR	
0.6	173	U. OF OREGON	RESII	
0.3	172	SOUTHERN ILLINOIS U. AT CARBONDALE	RESII	
2.1	171	BRANDEIS U. MA	RESII	
0.7	171	U. OF NEW MEXICO	RESI	
0.4	170	TEMPLE U. PA	RESII	
0.7	169	U. OF NEW HAMPSHIRE	DOCII	
0.3	167	ARIZONA STATE U.	RESII	
1.9	167	BUCKNELL U. PA	LAI	
0.9	165	GEORGIA INSTITUTE OF TECHNOLOGY	RESI	
0.4	164	CUNY QUEENS C. NY	COMPI	
0.8	159	U. OF VERMONT	DOCII	

TABLE 54 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
1.1	158	DREXEL U. PA	DOCII	
5.8	157	REED C. OR	LAI	
0.3	156	SAN DIEGO STATE U. CA	COMPI	
0.4	154	WAYNE STATE U. MI	RESII	
1.0	154	VANDERBILT U. TN	RESI	
0.3	152	NORTHERN ILLINOIS U.	DOCI	
0.6	152	BOSTON C. MA	DOCI	
0.4	152	TEXAS TECH U.	DOCI	
0.6	148	U. OF MIAMI FL	RESI	
0.8	148	U. OF MAINE AT ORONO	DOCII	
1.0	147	HUMBOLDT STATE U. CA	COMPI	
0.5	146	SYRACUSE U. NY	RESII	
0.8	146	UTAH STATE U.	RESII	
0.4	145	U. OF HAWAII AT MANOA	RESI	
0.6	144	MISSISSIPPI STATE U.	RESII	
1.3	144	LEHIGH U. PA	DOCI	
0.4	142	NORTHEASTERN U. MA	DOCII	
0.8	140	VILLANOVA U. PA	COMPI	
3.7	138	SWARTHMORE C. PA	LAI	
2.3	137	WESLEYAN U. CT	LAI	
0.5	137	U. OF SOUTHERN CALIFORNIA	RESI	
0.5	137	U. OF OKLAHOMA	RESII	
0.3	136	AUBURN U.-AUBURN AL	RESII	
0.4	136	U. OF KENTUCKY	RESI	
0.4	134	U. OF WISCONSIN-MILWAUKEE	DOCI	
0.4	134	WEST VIRGINIA U.	RESII	
0.3	131	KENT STATE U. OH	DOCI	
0.7	131	CLEMSON U. SC	DOCI	
0.3	131	U. OF HOUSTON TX	DOCI	
0.8	130	NEW MEXICO STATE U.	RESI	
1.8	129	UNION C. & U. NY	LAI	
1.0	128	TUFTS U. MA	DOCI	
0.6	125	FORDHAM U. NY	DOCI	
1.6	125	SAINT OLAF C. MN	LAI	
1.6	124	SMITH C. MA	LAI	W
0.3	124	BOWLING GREEN STATE U. OH	DOCI	
1.3	123	MANHATTAN C. NY	COMPI	
0.7	122	MONTANA STATE U.	DOCII	
1.6	121	COLGATE U. NY	LAI	
2.0	121	FRANKLIN & MARSHALL C. PA	LAI	
1.1	119	EMORY U. GA	RESII	
0.6	118	U. OF ARKANSAS	DOCI	
3.4	116	KALAMAZOO C. MI	LAI	
0.9	114	TULANE U. OF LOUISIANA	RESII	
2.3	114	C. OF WOOSTER OH	LAI	
2.6	113	AMHERST C. MA	LAI	
0.4	112	CALIFORNIA POLYTECHNIC STATE U.	COMPI	
0.6	112	LOYOLA U. OF CHICAGO IL	DOCI	PM
0.6	112	U. OF WYOMING	RESII	
3.1	110	WILLIAMS C. MA	LAI	

TABLE 54 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.3	110	OHIO U.	DOCI	
0.3	109	CALIFORNIA STATE U.-NORTHRIDGE	COMPI	
4.4	108	HAVERFORD C. PA	LAI	
0.2	107	CALIFORNIA STATE U.-LONG BEACH	COMPI	
0.2	106	WESTERN MICHIGAN U.	DOCI	
2.0	105	SUNY C. OF ENVIRONMENTAL SCIENCE & FORESTRY	DOCII	
1.2	105	CALVIN C. MI	COMPII	
0.6	104	MARQUETTE U. WI	DOCI	
0.7	103	U. OF LOWELL MA	COMPI	
2.3	103	MUHLENBERG C. PA	LAI	
1.7	102	MOUNT HOLYOKE C. MA	LAI	W
0.3	101	CALIFORNIA STATE U.-FRESNO	COMPI	
0.3	101	U. OF SOUTH CAROLINA	RESII	
1.5	100	ILLINOIS INSTITUTE OF TECHNOLOGY	DOCI	
0.2	100	U. OF PUERTO RICO	COMPI	PM

TABLE 55
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN
IN ORDER BY ABSOLUTE NUMBER OF DOCTORATES

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.92	276	U. OF CALIFORNIA-BERKELEY	RESI	
1.98	273	CORNELL U. NY	RESI	
0.66	183	U. OF MICHIGAN	RESI	
1.04	171	U. OF CALIFORNIA-DAVIS	RESI	
0.46	165	PENNSYLVANIA STATE U.	RESI	
0.55	162	U. OF WISCONSIN-MADISON	RESI	
0.36	161	MICHIGAN STATE U.	RESI	
0.52	148	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RESI	
0.64	143	RUTGERS U. NJ	RESI	
1.68	141	STANFORD U. CA	RESI	
0.49	136	U. OF CALIFORNIA-LOS ANGELES	RESI	
0.41	130	U. OF MARYLAND COLLEGE PARK	RESI	
0.32	130	U. OF TEXAS AT AUSTIN	RESI	
1.55	124	SMITH C. MA	LAI	W
2.15	123	HARVARD-RADCLIFFE MA	RESI	
0.32	121	OHIO STATE U.	RESI	
0.57	120	PURDUE U. IN	RESI	
7.23	119	MASSACHUSETTS INSTITUTE OF TECH.	RESI	
1.92	106	U. OF CALIFORNIA-SAN DIEGO	RESI	
0.93	103	U. OF PENNSYLVANIA	RESI	
1.66	102	MOUNT HOLYOKE C. MA	LAI	W
0.31	99	U. OF MINNESOTA-TWIN CITIES	RESI	
0.51	94	U. OF CONNECTICUT	RESI	
0.73	94	SUNY U. AT BUFFALO	RESII	
0.30	92	U. OF WASHINGTON	RESI	
1.44	90	WELLESLEY C. MA	LAI	W
3.61	89	U. OF CHICAGO IL	RESI	
1.54	89	BROWN U. RI	RESII	
0.53	88	U. OF CALIFORNIA-SANTA BARBARA	RESII	
0.83	86	SUNY U. AT STONY BROOK	RESI	
1.10	85	DUKE U. NC	RESI	
1.38	84	U. OF ROCHESTER NY	RESI	
0.34	79	U. OF MASSACHUSETTS AT AMHERST	RESII	
1.21	78	BARNARD C. NY	LAI	W
0.51	77	U. OF DELAWARE	RESII	
0.36	75	CUNY BROOKLYN C. NY	COMPI	
1.10	74	U. OF CALIFORNIA-SANTA CRUZ	DOCI	
0.30	74	U. OF FLORIDA	RESI	
0.35	71	U. OF COLORADO AT BOULDER	RESI	
0.28	71	INDIANA U.-BLOOMINGTON	RESI	
0.73	71	NORTHWESTERN U. IL	RESI	
0.48	69	NEW YORK U.	RESI	
1.57	67	YALE U. CT	RESI	
0.84	67	U. OF CALIFORNIA-IRVINE	RESI	
0.39	67	IOWA STATE U. OF SCIENCE & TECH.	RESII	
0.49	67	SUNY U. AT ALBANY	RESII	
0.34	64	U. OF PITTSBURGH PA	RESI	
1.57	63	OBERLIN C. OH	LAI	
0.41	62	COLORADO STATE U.	RESI	
0.27	62	BOSTON U. MA	RESI	

TABLE 55
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
1.29	62	VASSAR C. NY	LAI	
0.35	62	U. OF NORTH CAROLINA AT CHAPEL HILL	RESI	
0.36	60	U. OF KANSAS	RESII	
1.10	59	U. OF CALIFORNIA-RIVERSIDE	DOCI	
1.48	59	BRANDEIS U. MA	RESII	
0.24	59	CUNY QUEENS C. NY	COMPI	
0.32	59	MIAMI U. OH	DOCI	
2.56	59	RICE U. TX	DOCI	
2.14	58	BRYN MAWR C. PA	LAI	W
0.90	58	C. OF WILLIAM & MARY VA	DOCI	
0.23	56	FLORIDA STATE U.	RESII	
0.52	56	CUNY CITY C. NY	COMPI	PM
0.34	56	CUNY HUNTER C.	COMPI	
0.84	55	NORTH CAROLINA STATE U.-RALEIGH	RESI	
2.43	51	CARLETON C. MN	LAI	
0.42	50	VIRGINIA POLYTECHNIC INSTITUTE	RESI	
0.64	49	SUNY U. AT BINGHAMTON	DOCI	
0.25	49	U. OF MISSOURI-COLUMBIA	RESI	
0.42	49	TEXAS A. & M. U.	RESI	
0.77	48	TUFTS U. MA	DOCI	
0.62	48	VANDERBILT U. TN	RESI	
0.27	47	U. OF IOWA	RESI	
4.06	47	RENSSELAER POLYTECHNIC INSTITUTE NY	RESII	
0.77	47	WASHINGTON U. MO	RESI	
0.24	47	U. OF TENNESSEE	RESII	
0.35	46	U. OF ILLINOIS AT CHICAGO	RESII	
1.46	46	PRINCETON U. NJ	RESI	
0.23	45	U. OF ARIZONA	RESI	
1.08	45	CASE WESTERN RESERVE U. OH	RESI	
0.44	44	U. OF VERMONT	DOCII	
0.27	43	U. OF CINCINNATI OH	RESI	
0.37	43	U. OF RHODE ISLAND	RESII	
0.16	43	U. OF PUERTO RICO	COMPI	PM
0.28	42	LOUISIANA STATE U. & A & M	RESI	
1.20	42	BUCKNELL U. PA	LAI	
0.16	41	ARIZONA STATE U.	RESII	
2.18	41	POMONA C. CA	LAI	
0.53	41	FORDHAM U. NY	DOCI	
2.43	41	SWARTHMORE C. PA	LAI	
0.21	40	U. OF HAWAII AT MANOA	RESI	
0.26	38	SYRACUSE U. NY	RESII	
0.31	38	U. OF NEW HAMPSHIRE	DOCII	
0.29	38	OREGON STATE U.	RESI	
0.38	38	U. OF VIRGINIA	RESI	
0.17	37	U. OF GEORGIA	RESI	
0.18	37	U. OF SOUTH FLORIDA	DOCI	
0.26	36	U. OF OREGON	RESII	
0.71	35	EMORY U. GA	RESII	
0.29	35	BOSTON C. MA	DOCI	
1.80	34	JOHNS HOPKINS U. MD	RESI	

TABLE 55
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.'S	ACADEMIC INSTITUTION	CLASSIFICATION	
0.23	34	U. OF NEBRASKA-LINCOLN	RESII	
0.19	34	U. OF HOUSTON TX	DOCI	
1.47	33	OCCIDENTAL C. CA	LAI	
0.29	33	NORTHEASTERN U. MA	DOCII	
0.17	33	TEMPLE U. PA	RESII	
1.97	32	GRINNELL C. IA	LAI	
0.24	32	KANSAS STATE U.	RESII	
1.12	32	GOUCHER C. MD	LAI	W
0.19	32	TEXAS TECH U.	DOCI	
0.23	32	WASHINGTON STATE U.	RESII	
0.77	31	SAINT OLAF C. MN	LAI	
0.26	31	U. OF OKLAHOMA	RESII	
1.17	31	MIDDLEBURY C. VT	LAI	
0.12	30	NORTHERN ILLINOIS U.	DOCI	
0.26	30	U. OF NEW MEXICO	RESI	
2.74	30	REED C. OR	LAI	
14.80	29	CALIFORNIA INSTITUTE OF TECHNOLOGY	RESI	
0.59	29	SIMMONS C. MA	COMPI	W
0.14	29	KENT STATE U. OH	DOCI	
0.19	29	U. OF WISCONSIN-MILWAUKEE	DOCI	
0.34	28	LOYOLA U. OF CHICAGO IL	DOCI	PM
1.83	28	KALAMAZOO C. MI	LAI	
0.14	28	WAYNE STATE U. MI	RESII	
0.36	28	MARQUETTE U. WI	DOCI	
0.11	27	CALIFORNIA STATE U.-LONG BEACH	COMPI	
0.15	27	SOUTHERN ILLINOIS U. AT CARBONDALE	RESII	
0.52	27	SKIDMORE C. NY	LAI	
0.20	27	WEST VIRGINIA U.	RESII	
0.19	26	THE U. OF ALABAMA	DOCI	
0.23	26	U. OF SOUTHERN CALIFORNIA	RESI	
0.24	26	U. OF MIAMI FL	RESI	
0.13	26	BOWLING GREEN STATE U. OH	DOCI	
0.79	25	ST. LAWRENCE U. NY	LAI	
0.53	25	ANTIOCH C. OH	LAI	
0.20	25	U. OF UTAH	RESI	
1.06	24	COLBY C. ME	LAI	
0.89	24	HOPE C. MI	LAI	
1.25	24	DARTMOUTH C. NH	DOCII	
0.19	24	MONTCLAIR STATE C. NJ	COMPI	
0.33	24	U. OF DAYTON OH	COMPI	
0.17	24	OKLAHOMA STATE U.	RESII	
0.70	24	DREXEL U. PA	DOCII	
1.28	24	MUHLENBERG C. PA	LAI	
0.33	23	HOWARD U. DC	RESI	PM HB
0.15	23	U. OF KENTUCKY	RESI	
0.48	23	TULANE U. OF LOUISIANA	RESII	
0.15	23	U. OF SOUTH CAROLINA	RESII	
1.11	23	RANDOLPH-MACON WOMAN'S C. VA	LAI	W
1.03	22	WESLEYAN U. CT	LAI	
0.87	22	COLORADO C.	LAI	

TABLE 55
LEADING BACCALAUREATE SOURCES OF
NATURAL SCIENCE DOCTORATES EARNED BY WOMEN

PH.D.'S AS % OF BACC. DEGREES	NUMBER OF PH.D.	ACADEMIC INSTITUTION	CLASSIFICATION	
0.11	22	CALIFORNIA STATE U.-NORTHRIDGE	COMPI	
0.08	22	SAN DIEGO STATE U. CA	COMPI	
0.26	22	U. OF MAINE AT ORONO	DOCII	
0.35	22	CLEMSON U. SC	DOCI	
0.10	21	SAN FRANCISCO STATE U. CA	COMPI	
0.67	21	DEPAUW U. IN	LAI	
0.32	21	U. OF NEW ORLEANS LA	DOCII	
0.23	21	SAINT JOHN'S U. NY	DOCI	
0.42	21	RUTGERS U. NEWARK CAMPUS NJ	DOCII	
0.71	21	WAKE FOREST U. NC	COMPI	
0.35	21	NEW MEXICO STATE U.	RESI	
0.27	21	SOUTHERN METHODIST U. TX	DOCII	
0.43	21	MARY WASHINGTON C. VA	COMPI	
0.31	20	GEORGETOWN U. DC	RESII	
0.13	20	AUBURN U.-AUBURN AL	RESII	
0.20	20	ADELPHI U. NY	DOCII	
0.81	20	C. OF WOOSTER OH	LAI	
0.90	20	ALLEGHENY C. PA.	LAI	
0.69	20	CARNEGIE-MELLON U. PA	RESI	
0.40	20	VILLANOVA U. PA	COMPI	
0.17	20	TEXAS WOMAN'S U.	DOCI	W

TABLE 56
LEADING BACCALAUREATE SOURCES OF NATURAL SCIENCE DOCTORATES EARNED BY HISPANIC 1975-82 BACCALAUREATES

ALL	MEN	WOMEN	ACADEMIC INSTITUTION	CLASSIFICATION	
44	20	24	U. OF PUERTO RICO-RIO PIEDRAS	COMP1	PM
12	8	4	U. OF PUERTO RICO-MAYAGUEZ	COMP1	PM
10	8	2	MASSACHUSETTS INSTITUTE OF TECH.	RES1	
9	7	2	U. OF MIAMI FL	RES1	
8	6	2	U. OF CALIFORNIA-BERKELEY	RES1	
8	5	3	U. OF TEXAS AT AUSTIN	RES1	
7	6	1	U. OF CALIFORNIA-LOS ANGELES	RES1	
7	6	1	NEW MEXICO STATE U.	RES1	
6	3	3	U. OF CALIFORNIA-RIVERSIDE	DOC1	
6	6	0	U. OF WISCONSIN-MADISON	RES1	
5	3	2	U. OF ARIZONA	RES1	
5	2	3	U. OF CALIFORNIA-SAN DIEGO	RES1	
5	3	2	U. OF CALIFORNIA-SANTA CRUZ	DOC1	
5	3	2	U. OF NEW MEXICO	RES1	
5	3	2	RICE U. TX	DOC1	
5	2	3	U. OF TEXAS AT EL PASO	COMP1	PM
4	2	2	U. OF CALIFORNIA-DAVIS	RES1	
4	3	1	U. OF CHICAGO IL	RES1	
4	3	1	CORNELL U. NY	RES1	
4	4	0	NEW MEXICO INSTITUTE OF MINING & TECH.	ENGR	
4	2	2	RUTGERS U. NEW BRUNSWICK NJ	RES1	
4	2	2	U. OF SOUTHERN CALIFORNIA	RES1	
3	0	3	BARNARD C. NY	LA1	W
3	3	0	CALIFORNIA STATE U.-FRESNO	COMP1	
3	1	2	CUNY QUEENS C. NY	COMP1	
3	0	3	COLORADO STATE U.	RES1	
3	3	0	COLUMBIA U. NY [ALL DIV.EXCEPT BARNARD]	RES1	
3	3	0	EMORY U. GA	RESII	
3	3	0	U. OF FLORIDA	RES1	
3	1	2	FORDHAM U. NY	DOC1	
3	2	1	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RES1	
3	3	0	U. OF SOUTH FLORIDA	DOC1	
3	2	1	YALE U. CT	RES1	
2	2	0	U. OF CALIFORNIA-IRVINE	RES1	
2	2	0	CALIFORNIA INSTITUTE OF TECHNOLOGY	RES1	
2	2	0	CALIFORNIA STATE U.-CHICO	COMP1	
2	1	1	CUNY CITY C. NY	COMP1	PM
2	2	0	CUNY HUNTER C.	COMP1	
2	2	0	DUKE U. NC	RES1	
2	2	0	GEORGIA INSTITUTE OF TECH.	RES1	
2	1	1	HARVEY MUDD C. CA	ENGR	
2	2	0	HAVERFORD C. PA	LA1	
2	2	0	HUMBOLDT STATE U. CA	COMP1	
2	2	0	U. OF ILLINOIS AT CHICAGO	RES1	
2	2	0	KALAMAZOO C. MI	LA1	
2	2	0	KANSAS STATE U.	RESII	
2	2	0	MANHATTAN C. NY	COMP1	
2	1	1	U. OF MASSACHUSETTS AT AMHERST	RESII	
2	1	1	U. OF MICHIGAN-ANN ARBOR	RES1	
2	0	2	U. OF NEBRASKA-LINCOLN	RESII	

TABLE 56 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF NATURAL SCIENCE
DOCTORATES EARNED BY HISPANIC 1975-82 BACCALAUREATES

ALL	MEN	WOMEN	ACADEMIC INSTITUTION	CLASSIFICATION	
2	1	1	NEW YORK U.	RES1	
2	1	1	U. OF OKLAHOMA	RESII	
2	2	0	PRINCETON U. NJ	RES1	
2	2	0	U. OF PUERTO RICO-CAYEY U.	COMP1	PM
2	2	0	U. OF ROCHESTER NY	RES1	
2	2	0	U. OF SOUTH CAROLINA	RESII	
2	2	0	SOUTHWESTERN U. TX	LAII	
2	2	0	STANFORD U. CA	RES1	
2	1	1	SUNY U. AT STONY BROOK	RES1	

TABLE 57
LEADING BACCALAUREATE SOURCES OF NATURAL SCIENCE
DOCTORATES EARNED BY BLACK GRADUATES

ALL	MEN	WOMEN	ACADEMIC INSTITUTION	CLASSIFICATION
17	15	2	TUSKEGEE INSTITUTE AL	COMP1 PM H
12	8	4	HOWARD U. DC	RES1 PM H
6	3	3	NORTH CAROLINA A & T STATE U.	COMP1 PM H
6	6	0	SOUTHERN U. & A & M LA	COMP1 PM H
5	4	1	U. OF CALIFORNIA-BERKELEY	RES1
5	4	1	MASSACHUSETTS INSTITUTE OF TECH.	RES1
4	4	0	CUNY CITY C. NY	COMP1 PM
4	4	0	COLUMBIA U. NY [ALL DIV. EXCEPT BARNARD] EXCEPT BARNARD]	RES1
4	3	1	FISK U. TN	LAII PM H
4	3	1	FORT VALLEY STATE C. GA	COMPII PM H
4	2	2	MORGAN STATE U. MD	COMP1 PM H
4	2	2	NEW YORK U.	RES1
4	2	2	TEXAS SOUTHERN U.	COMP1 PM H
4	3	1	VOORHEES C. SC	LAII PM H
3	1	2	COPPIN STATE C. MD	COMPII PM H
3	1	2	GRAMBLING STATE U. LA	COMP1 PM H
3	2	1	JACKSON STATE U. MS	COMP1 PM H
3	1	2	MICHIGAN STATE U.	RES1
3	3	0	MOREHOUSE C. GA	LAII PM H M
3	2	1	NORTH CAROLINA CENTRAL U.	COMP1 PM H
3	2	1	NORTH CAROLINA STATE U.-RALEIGH	RES1
3	3	0	SOUTHERN ILLINOIS U.-CARBONDALE	RESII
3	3	0	U. OF WISCONSIN-MADISON	RES1
2	1	1	U. OF ALABAMA AT BIRMINGHAM	DOCII
2	2	0	ALBANY STATE C. GA	COMPII PM H
2	2	0	AMERICAN U. DC	DOC1
2	1	1	BLUFFTON C. OH	LAII
2	1	1	BOSTON U. MA	RES1
2	2	0	CALIFORNIA INSTITUTE OF TECHNOLOGY	RES1
2	2	0	CATHOLIC U. OF AMERICA DC	DOC1
2	2	0	CENTRE C. OF KENTUCKY	LA1
2	0	2	CHESTNUT HILL C. PA	LA1 W
2	2	0	CUNY HERBERT H. LEHMAN C. NY	COMP1 PM
2	2	0	CORNELL U. NY	RES1
2	2	0	U. OF FLORIDA	RES1
2	2	0	GEORGE MASON U. VA	COMP1
2	2	0	U. OF GEORGIA	RES1
2	1	1	U. OF HOUSTON TX	DOC1
2	1	1	U. OF ILLINOIS AT URBANA-CHAMPAIGN	RES1
2	0	2	JOHNSON C. SMITH U. NC	LAII PM H
2	2	0	LEHIGH U. PA	DOC1
2	1	1	LOCK HAVEN U. OF PENNSYLVANIA	COMP1
2	2	0	LOMA LINDA U. CA	DOCII
2	1	1	U. OF LOWELL MA	COMP1
2	2	0	MERCER U. GA	COMP1
2	2	0	U. OF MICHIGAN-ANN ARBOR	RES1
2	0	2	U. OF MISSISSIPPI	DOC1
2	0	2	U. OF NORTH CAROLINA AT CHAPEL HILL	RES1
2	1	1	NORTHEAST LOUISIANA U.	COMP1

TABLE 57 (CONTINUED)
LEADING BACCALAUREATE SOURCES OF NATURAL SCIENCE
DOCTORATES EARNED BY BLACK GRADUATES

ALL	MEN	WOMEN	ACADEMIC INSTITUTION	CLASSIFICATION
2	1	1	NORTHWESTERN U. IL	RES1
2	1	1	OBERLIN C. OH	LA1
2	2	0	OHIO STATE U.	RES1
2	2	0	OKLAHOMA CITY U. OK	COMP1
2	1	1	PACE U. NEW YORK CAMPUS	COMP1
2	2	0	PRINCETON U. NJ	RES1
2	2	0	PURDUE U. IN	RES1
2	2	0	RICE U. TX	DOC1
2	1	1	SAINT LOUIS U. MO	DOC1
2	1	1	SAVANNAH STATE C. GA	COMPII PM H
2	2	0	SOUTH CAROLINA STATE C.	COMP1 PM H
2	2	0	U. OF SOUTHWESTERN LOUISIANA	COMP1
2	0	2	SPELMAN C. GA	LAII PM H W
2	0	2	VASSAR C. NY	LA1
2	2	0	WILEY C. TX	LAII PM H
2	1	1	C. OF WILLIAM & MARY VA	DOC1

APPENDIX D

HISPANIC ASSOCIATION OF COLLEGES AND UNIVERSITIES (HACU)

1990/1991 Members

ARIZONA
South Mountain Community College

CALIFORNIA
California State U., Los Angeles
Cerritos College
Don Bosco Technical Institute
East Los Angeles College
Gavilan College
Imperial Valley College
Kings River Community College
Los Angeles City College
Los Angeles Mission College
Mt. San Antonio College
Mount St. Mary's College
Rio Hondo College
Saint John's Seminary College
San Diego State U., Imperial Valley
Southwestern College

COLORADO
Pueblo Community College
Trinidad State Junior College

FLORIDA
Barry U.
Florida International U.
Miami-Dade Community College
St. Thomas U.
Saint Vincent de Paul Regional Seminary

ILLINOIS
MacCormac Junior College
St. Augustine College
Harry S. Truman College

NEW JERSEY
Hudson Co. Community College
Passaic County Community College

NEW MEXICO
Albuquerque Technical-Vocational Institute
College of Santa Fe
Doña Ana Branch Community College
Eastern New Mexico U.-Roswell
New Mexico Highlands U.
New Mexico State U.
New Mexico State U., Grants Branch
Northern New Mexico Community College
Sante Fe Community College
U. of New Mexico, Valencia
Western New Mexico U.

NEW YORK
Borough of Manhattan Community College
Bronx Community College
Hostos Community College
John Jay College of Criminal Justice
LaGuardia Community College
Herbert H. Lehman College
Mercy College

TEXAS
Bee County College
Corpus Christi State U.
Del Mar College
El Paso Community College
Incarnate Word College
Laredo Junior College
Laredo State U.
Our Lady of the Lake U.
Palo Alto College
St. Mary's U.
St. Philip's College
San Antonio College
Southwest Texas Junior College
Sul Ross State U.
Texas A&I U.
Texas Southmost College
Texas State Technical College
U. of Texas at Brownsville
U. of Texas at El Paso
U. of Texas at San Antonio
U. of Texas-Pan American

PUERTO RICO
American U. of Puerto Rico
Bayamon Central U.
Caribbean Center for Advanced Studies
Center for Advanced Studies on Puerto Rico and the Caribbean
Inter-American Univ. of Puerto Rico, Metropolitan Campus
Inter-American Univ. of Puerto Rico, Ponce Regional College
Inter-American Univ. of Puerto Rico, San German Campus
Puerto Rico Junior College
Universidad Del Turabo
Universidad Metropolitana
Universidad Politecnica de Puerto Rico
U. of Puerto Rico at Aguadilla
U. of Puerto Rico, Carolina Regional College
U. of Puerto Rico, Humacao U. College
U. of Puerto Rico, Mayaguez Campus
U. of Puerto Rico, Medical Sciences Campus

Source: Hispanic Association of Colleges and Universities.

HISTORICALLY AND PREDOMINANTLY BLACK COLLEGES AND UNIVERSITIES

ALABAMA
Alabama A&M University
Alabama State University
S.D. Bishop State Jr. Community College
Carver State Technical College
Concordia College
Lawson State Community College
Miles College
Oakwood College
Selma University
Stillman College
Talladega College
Trenholm State Technical College
Tuskegee University

ARKANSAS
Arkansas Baptist College
Philander Smith College
Shorter College
University of Arkansas, Pine Bluff

DELAWARE
Delaware State College

DISTRICT OF COLUMBIA
Howard University
University of the District of Columbia

FLORIDA
Bethune-Cookman College
Edward Waters College
Florida A&M University
Florida Memorial College

GEORGIA
Albany State College
Clark Atlanta University
Fort Valley State College
Morehouse College
Morehouse School of Medicine
Morris Brown College
Paine College
Savannah State College
Spelman College

KENTUCKY
Kentucky State University
Simmons University Bible College

LOUISIANA
Dillard University
Grambling State University
Southern University, Baton Rouge
Southern University, New Orleans
Southern University, Shreveport
Xavier University

MARYLAND
Bowie State College
Coppin State College
Morgan State University
University of Maryland, Eastern Shore

MICHIGAN
Lewis College of Business

MISSISSIPPI
Alcorn State University
Coahoma Community College
Jackson State University
Mary Holmes College
Mississippi Valley State University
Natchez Junior College
Prentiss Institute Junior College
Rust College
Tougaloo College
Utica Campus, Hinds Jr. College

MISSOURI
Harris-Stowe State College
Lincoln University

NORTH CAROLINA
Barber-Scotia College
Bennett College
Elizabeth City State University
Fayetteville State University
Johnson C. Smith University
Livingstone College
North Carolina A&T State University
North Carolina Central University
Saint Augustine's College
Shaw University
Winston-Salem State University

OHIO
Central State University
Wilberforce University

OKLAHOMA
Langston University

PENNSYLVANIA
Cheyney University of Pennsylvania
Lincoln University

SOUTH CAROLINA
Allen University
Benedict College
Claflin College
Clinton Junior College
Denmark Technical College
Morris College
South Carolina State College
Voorhees College

TENNESSEE
Fisk University
Knoxville College
Lane College
LeMoyne-Owen College
Meharry Medical College
Tennessee State University

TEXAS
Huston-Tillotson College
Jarvis Christian College
Paul Quinn College
Prairie View A&M College
Southwestern Christian College
Texas College
Texas Southern University
Wiley College

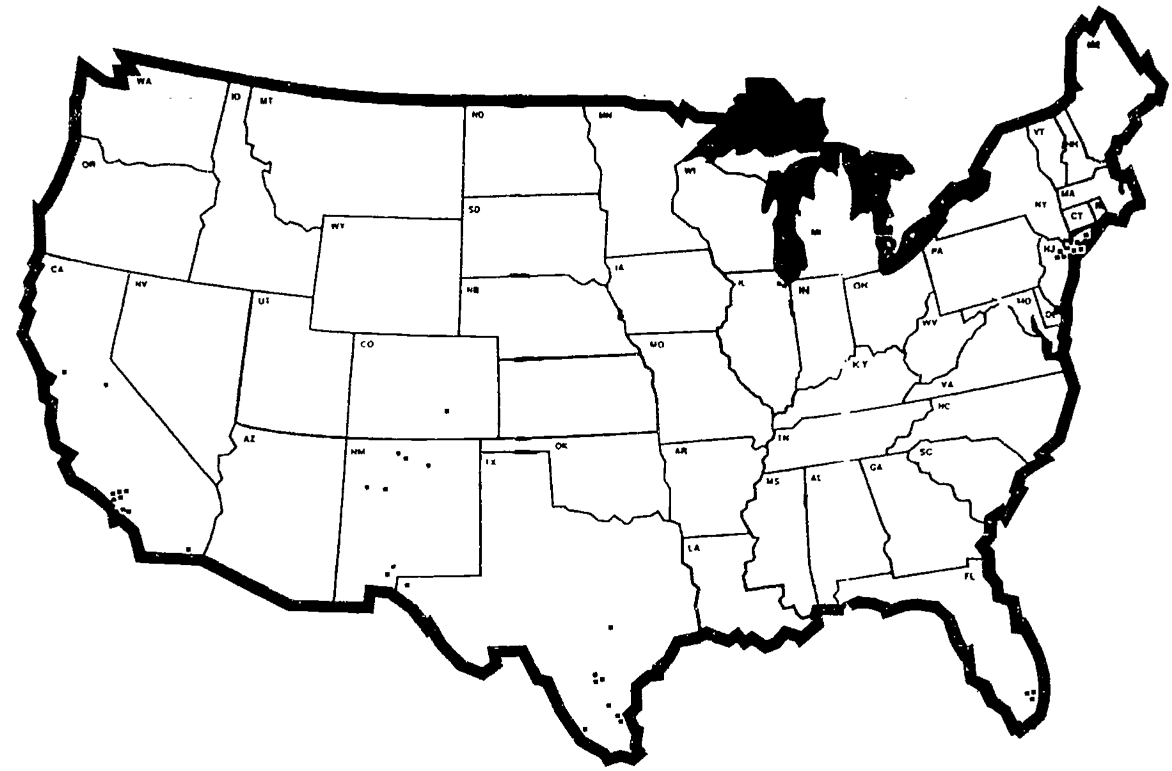
VIRGINIA
Hampton University
Norfolk State University
Saint Paul's College
Virginia Seminary & College
Virginia State University
Virginia Union University

WEST VIRGINIA
West Virginia State University

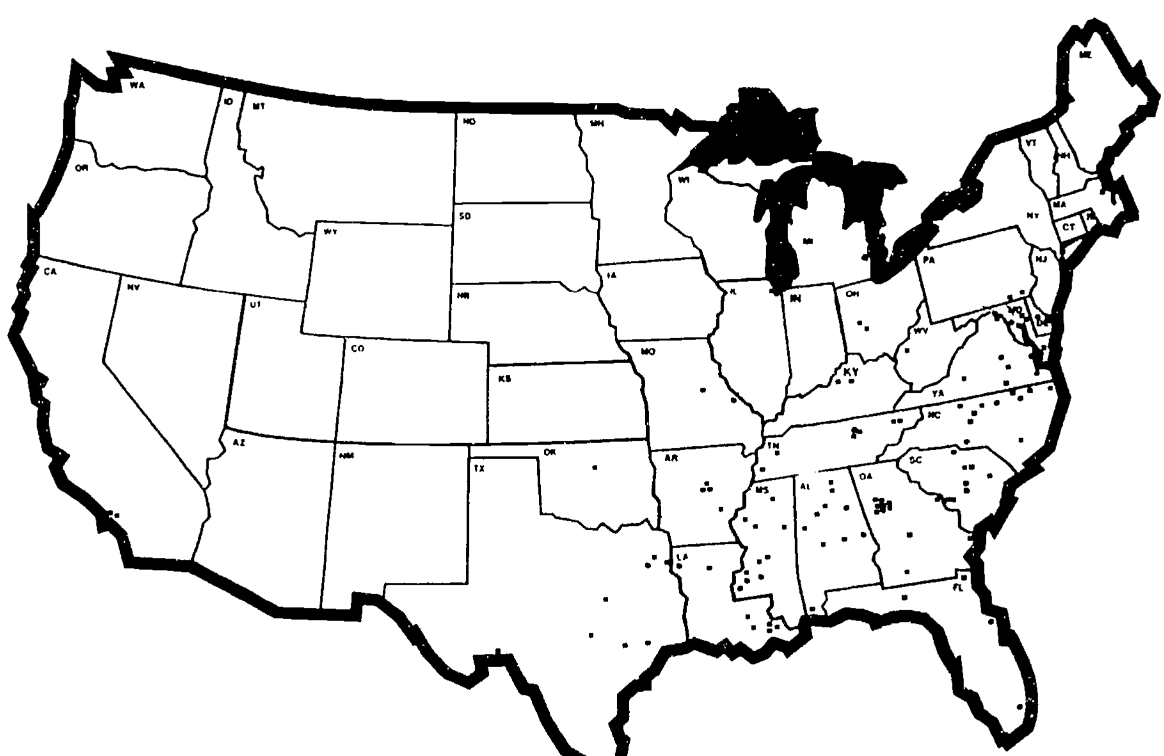
VIRGIN ISLANDS
University of the Virgin Islands

Source: National Association for Equal Opportunity In Higher Education.

HISPANIC ASSOCIATION OF COLLEGES AND UNIVERSITIES (HACU)



HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCUs)



Source: U.S. Department of Defense

NATIVE AMERICAN INSTITUTIONS ACROSS THE U.S.

ARIZONA
Navajo Community College

CALIFORNIA
D-Q University*

MICHIGAN
Bay Mills Community College

MINNESOTA
Fond du Lac Community College

MONTANA
Blackfeet Community College
Dull Knife Memorial College
Fort Belknap Community College
Fort Peck Community College
Little Big Horn College
Salish Kootenai College
Stone Child Community College

NEBRASKA
Nebraska Indian Community College

NEW MEXICO
Crownpoint Institute of Technology

NORTH DAKOTA
Fort Berthold Community College
Little Hoop Community College
Standing Rock College
Turtle Mountain Community College
United Tribes Technical College**

SOUTH DAKOTA
Cheyenne River Community College
Oglala Lakota College
Sinte Gleska College
Sisseton Wahpeton Community College

WASHINGTON
Northwest Indian College

WISCONSIN
Lac Courte Oreilles Ojibwa Community College

* Not located on a reservation.
** Does not receive funds under the Tribally Controlled Community College Assistance Act; not located on a reservation.
Sources: American Indian Higher Education Consortium and Tribal Colleges: Shaping the Future of America. Princeton: Carnegie Foundation for the Advancement of Teaching, 1989.

WRITINGS FOR REFORM:

SELECTED STUDIES

SECTION III

INTRODUCTION

Access to pertinent information is essential to getting a job done.
-Max DePree

An enlarged "sense of the possible" is an essential ingredient in creating a climate for change.
-Lloyd Averill

The growing concern over the past decade about science and mathematics education in general, and about undergraduate programs in particular, is reflected in the significant increase in the number of books, reports, and studies addressing these concerns from a variety of perspectives. Some outline the general need for reform within the national context; others within the institutional and disciplinary context. Some publications present practices that are proving to be effective in working with students with differing backgrounds and career aspirations; others illustrate specific instances of creative and innovative approaches to making science more investigative and hands-on for all students, regardless of major.

We present here a somewhat idiosyncratic collection of works that have been helpful to members of the Project Kaleidoscope committees as we (individually and collectively) wrestled with issues that are critical to the effective reform of undergraduate science and mathematics. These readings were helpful as we began to develop a common vision for our work.

Our intent in presenting this list is that it will serve as a catalyst for campus-based committees wrestling with similar concerns. Knowing what others are doing elsewhere and learning from their experiences is a beginning point for reform efforts. Reflecting on the insights of respected practitioners of science and mathematics at all educational levels is another essential first step in developing a climate for change and a strategic plan of action for institutional reform.

We hope this reading list provides some of the pertinent information necessary to getting the job of strengthening undergraduate science and mathematics "done right." We also hope, by becoming more familiar with what is going on beyond an individual campus--at other institutions, in the disciplinary associations, in federal agencies, in individual classrooms and laboratories across the country--faculty and administrators will be better able to create an environment for reform that encourages innovation and rewards risk-taking.

Finally, we present an extended discussion about the relationship between the undergraduate and the pre-collegiate sectors of the educational community, and the current efforts to speak of an educational continuum that reaches from K-12. We all have much to learn about reform efforts by looking at the history of such activities in the nation's elementary and secondary schools.

We highlight this continuum also because creative and productive connections between undergraduate institutions and the precollege community are essential if the larger national educational problems are to be addressed. Undergraduate institutions generally, and liberal arts colleges specifically, can serve as a resource for change in K-12 programs at the local, state, and national level: as the site of effective pre- and in-service programs for teachers; as the site for summer programs for young people; and as the source of faculty and staff to be resources in local classrooms and school districts. A mutual benefit in developing working partnerships with colleagues in other educational sectors is that we establish a larger cadre of informed professionals committed to reform.

GENERAL AND INSTITUTIONAL AND CURRICULUM REFORM
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FOCUSING ON THE K-16 CONTINUUM

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Project Kaleidoscope focuses on what works in undergraduate science and mathematics education and what pieces must fit together to create strong programs in science and mathematics. One important part of Project Kaleidoscope's work is examining connections between K-12 and undergraduate education.

It is time to think in terms of K-Ph.D. continuum, rather than treating elementary, middle, and high schools as separate from each other, and all three somehow separate from undergraduate and graduate education. Such a change is already evident in the language used by national agencies and educators--many are turning to a K-16 and even a K-Ph.D. perspective. The current reform in science and mathematics education has a head start in the K-12 levels; it will begin to have a profound impact on undergraduate education during the next five years. Perhaps most important, issues of equity in education can be addressed systemically only by paying careful attention to transitions from kindergarten through graduate school.

A HISTORICAL PERSPECTIVE

The focus on K-12 school reform that began in the 1980's has resulted in a renewed interest in and emphasis on curriculum reform. Calls for such reform are pervasive. Project 2061--Science for All Americans (AAAS, 1989) calls for a shift in both curriculum and instructional delivery. The same is true in numerous reports on mathematics, including Everybody Counts (National Research Council, 1989) and Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989; also see Professional Standards for Teaching Mathematics, NCTM, 1991).

Although reforms efforts differ among the disciplines, they all face the common problem of implementation. This is not a new problem for curriculum reformers.

The impact of the implementation of nationally developed curricula across the country in the 1960's and early 1970's was relatively low. For example, some studies of 1960's reform efforts have shown a relatively high level of adoption of the **materials** produced by reform projects (Science Curriculum Improvement Study [SCIS], Elementary Science Study [ESS], Science as a Process Approach [SAPA]); however, none have indicated a similar level of adoption of the **philosophy** embodied by the projects.

One reason for this might be that the goals of these reform projects were not necessarily consistent with the goals of the schools and teachers who attempted to use the materials. Consequently, although schools adopted these materials, many later abandoned them with the "back to the basics" movement. At that point, the obvious mismatch between what schools wanted to do (and how they wanted to assess it) and the "reformed" curriculum of the national projects became apparent. Schools then opted to pursue local goals and eliminated the "mismatch" by adopting a curriculum more like that of the 1950's. The history of the shift in curriculum in the 1950's-1980's has important lessons for today's curriculum reformers.

First, today, we once again see an emphasis on K-12 reform in science and math curriculum leading the way. Second, like curriculum change in the 1960's, the current movement is driven by the perception of a national deficiency. In the 1960's, we responded to a failure in the space race; today we respond to a failure to maintain economic competitiveness in a global community. A critical attribute of both crises is that they are perceived as national ones, and that thus it is a national, not local or state, curriculum reform movement that is needed.

Third, reform efforts in the 1960's (and today) have been spearheaded by the university and business communities. In both cases, we find forces outside of the school shaping the K-16 curriculum.

Fourth, the calls for reform, then and now, require teachers to teach content they were never taught--in ways they were never taught. In the reform of the 1960's, most in-service programs involved an update of knowledge and some demonstrations or practice using new methods. There was no fundamental examination of why new methodologies were needed or what structure of beliefs and knowledge a teacher might need to successfully use new methods. The necessity of such shifts in teachers' conceptual frameworks was not realized until recently.

Fifth, just as different evaluation strategies were required in the 1960's as educators shifted to more process-oriented curricula, today's reform movement calls for "authentic assessment" that uses improved strategies for measuring the new educational goals. In some cases, the assessment movement has become a driving force to effect curriculum change.

Finally, reform efforts, then and now, are based on a fundamental change in the beliefs about and goals for schools. In the 1960's, schools were expected to produce more scientists. The role of the school was to provide the nation with specialists who could solve our world problems. The adoption of a process approach was driven by a desire to have scientists who could do science. Today, we face a dramatic shift in a different direction. We now have a view of science education in which scientific literacy is seen as a societal problem--"science for all Americans." This reflects a general trend in schooling whereby schools have become agents for social change. As schools have become more inclusive, the goals for schools have become more all-encompassing. The net result has been calls for both greater equity and excellence. We simultaneously expect higher test scores and high graduation rates. While this struggle for the meaning of schools continues, many teachers scramble for safety in past practices.

Essentially, the parallels in these two reform movements suggest ways to approach the current reform effort. We have to insure that teachers--all teachers, from kindergarten through graduate school--"buy-in" to the current movement. That "buy-in" is crucial to the fundamental changes that teachers must make in their understanding of curriculum and pedagogy.

A CHANGE IN PERSPECTIVE

A Nation at Risk (1983), with which some mark the beginning of the current reform effort, was an open letter to the American people from the National Commission on Excellence in Education. This report identifies the American educational system as the major cause of the decline of the United States' worldwide leadership and international competitiveness. The status of the American economy, management of business, and related political decisions are not considered as additional possible causes for the decline. Specifically, A Nation at Risk suggests that our students are not challenged as a result of a compromising, underachieving curriculum in the schools. The report proposes recommendations for improving learning and teaching in all subject areas, although it is important to note that the recommendations for change in the teaching of science and mathematics are focused at the high school level. While the Commission supports commonly accepted goals for student achievement, including understanding major concepts of science, scientific process, and application of scientific knowledge to everyday life, they fail to mention the interdisciplinary nature of science and technology. To implement these goals and encourage more rigorous and measurable standards, the Commission focuses on the revision of textbooks to assure more rigorous content in science and the addition of significantly more time to learning the basics in schools.

A SCIENTIFICALLY LITERATE AND NUMERATE AMERICA

A Nation at Risk sounds the alarm on the status of science and mathematics education. The next group of studies we review addresses scientific literacy from two related questions: (1) What do we need to know to become scientifically literate? and (2) How do we get there? Science for All Americans, Everybody Counts, and Curriculum and Evaluation Standards for School Mathematics suggest curricular changes in science and mathematics at K-12; The Liberal Art of Science and Science Matters address similar issues in postsecondary education.

Science for All Americans (1989) is a major report on literacy goals in science, mathematics, and technology by the American Association for the Advancement of Science. It focuses on societal needs, expectations of functional citizens, scientific literacy, and provides a vision of what Americans want their schools to achieve. A basic assumption of this report is that schools do not need to teach more science content, rather they should focus on scientific literacy that includes teaching critical and independent thinking skills (at the expense of terminology), the relationship of science, mathematics, and technology, the history of science, connections between and among sciences as well as other disciplines, and personal and societal use of science and technology.

In many reports we find a focus on the need for a scientifically literate and numerate American population and the ability to cope confidently with the mathematical demands of adult life. Everybody Counts (1989), a national report on the future of mathematics education by the National Research Council (NRC), argues that quality mathematics education for all students is essential for a healthy economy based on advanced technologies. The NRC suggests that the poor performance of American students in mathematics is a function of underachieving standards and expectations. As with science education, several transitions in mathematics education are necessary to develop a significant common core of mathematics for all students. National standards for school mathematics must be adopted that focus on students' learning through application of mathematics and technology to present and future needs. Appropriate professional development programs for teachers must become available. Ongoing assessment must become responsive to future needs. An excellent follow-up to this report is Curriculum and Evaluation Standards for School Mathematics by the National Council of Teachers of Mathematics (1989). This is accompanied by the recently published Professional Standards for Teaching Mathematics (1991). Standards provides a most comprehensive and broad framework to guide reform in school mathematics during the next decade.

Encompassing the curricular reform recommended by Project 2061 and Everybody Counts is The Liberal Art of Science: Agenda for Action (AAAS, 1990), which reaffirms the value of liberal education for all undergraduates. The document focuses on the need for curricular reform at the college level and defines the goals for natural sciences within a liberal education. All students should understand science and its influence on society and the natural world. The theme is "science should be taught as science is practiced at its best." This report challenges faculty who are actively engaged in scientific research to directly involve undergraduates in the process. Science faculty are urged to develop new instructional strategies at the undergraduate level that promote "doing" science--problem solving, critical thinking, collaborative learning, writing to learn science, and the interdisciplinary nature of science.

Science Matters by Hazen and Trefil (1990) has also received great national attention. The authors use the "great ideas" approach to describe eighteen general scientific principles that form a web to bind all scientific knowledge together. They contend that if American citizens would learn these facts, they would achieve scientific literacy. It is important to recognize that there are a large number of people who subscribe to this conservative approach and believe that knowing about science will lead to scientific literacy. It is our opinion that a body of information about science content is not enough. Rather, science is a way of knowing which not only involves content, but also problem solving, critical thinking, communicating about science, and doing science.

In addition to "what we need to become scientifically literate" and "how do we get there", there is a third important question: how do we know when we get there? Assessment is receiving increasing attention at all academic levels. Many states are revising their assessment strategies as they revise their curricular frameworks. One work, Science Assessment in the Service of Reform (Gerald Kulm and Shirley M. Malcom, 1991) takes a comprehensive look at science assessment, provide guidelines for systems of assessment, examples of current assessment innovations, and policy and research recommendations. We anticipate additional works published on assessment in the next few years.

A K-16 CONTINUUM

Science for All Americans focuses on all students--students of all races, genders, abilities, and socio-economic status and students of all grade levels, beginning in kindergarten. Traditionally, our educational system has allowed discontinuities in all subjects, especially science, between and among grade levels--elementary, middle, secondary and undergraduate. However, a continuum in the K-16 science curriculum is fundamental to the reform. Elementary School Science for the 90's (1990) addresses the science learning needs of children at the elementary level. This book is designed to help educators create opportunities for elementary school children to begin to achieve scientific literacy. In order to accomplish this, science must become a basic part of an elementary curriculum that nurtures conceptual understanding of science, helps children develop scientific attitudes and skills, provides them the opportunity to actively engage in hands-on science, and helps them construct their own scientific knowledge that fits into the way they see the world. To these children, science can become another way of knowing. Importantly, these children will have the kind of foundation that may sustain them through upper grades and into undergraduate and graduate work.

A significant research report of the 1980's is The Science Report Card: Elements of Risk and Recovery (1986). Mullis and Jenkins report the trends and achievement of 9, 13, and 17 year-olds based on the National Assessment of Educational Progress (NAEP) science assessment. Their interpretive overview of the results of the NAEP emphasizes, again, the theme of making connections between the study and the practice of science. Reform in science education includes teaching students to use,the tools of science so that they better understand the world around them. The report describes science proficiency results from 1969-1986, information regarding the current school context for science learning (including the amounts and kind of science instruction students receive, their relative proficiency, and teacher qualifications), and finally, reports key variables associated with learning in science (students' experience with science activities, attitudes toward science, and home environment).

One example of the critical need for enhancing K-16 articulations is found in the training of elementary teachers, addressing the need to focus on the quantity and quality of courses taken in pre-service programs. A survey of teacher preparation programs shows that to be certified for elementary teaching, most teachers need very little science and mathematics coursework. For science, the requirements are most often 8-12 semester hours, usually with some of those hours devoted to a course with a laboratory component. This amounts to two or three one-semester courses in science. The mathematics coursework requirements are similar to those in science.

Most pre-service elementary teachers take only introductory undergraduate level science and mathematics courses. Thus, during the past several decades, we have been in a vicious circle. Our widely-criticized--but immensely important--introductory undergraduate science and mathematics courses provide the only science and mathematics training to pre-service teachers who will be responsible for teaching these subjects to American elementary and middle school children.

Ultimately, our elementary school faculty teach children who go on to high school, to undergraduate education, or into graduate programs. We need to pay attention to both the number of mathematics and science requirements, and to the quality of the undergraduate courses serving pre-service teachers. We need to pay attention also to the scope and content of in-service programs for elementary and secondary teachers.

There are other important and painfully obvious issues. For example, teachers prepare their students for the next higher academic level, and all teachers hope that somewhere down the road these students will be well-equipped for life as productive citizens. Yet there is little communication among faculty at different academic levels. Why are we so often faced with the odd discontinuities in training, professional development activities, and articulation across grade levels that exist between faculty in elementary, middle, and high school? Why are there even greater discontinuities between K-12 and undergraduate faculty?

These writings can serve as a starting point for the dialogue that must occur if we are to achieve the needed reforms in science and mathematics, beginning at kindergarten and continuing through baccalaureate and graduate studies.

SELECTED WORKS
K-12 Education

Driver, Rosalind, Edith Guesne, and Andree Tiberghien. Children's Ideas in Science. Milton Keynes: Open University Press, 1985.

Children arrive in their science classrooms with their own ideas and interpretations of natural phenomenon without necessarily receiving formal instruction. Their ideas are a result of everyday experience and interactions with people. This book documents the ideas of 10-16 year old students about various physical science concepts (e.g. light, heat, force, motion) and examines how students' conceptions change and develop with teaching.

Lawson, A.E., M.R. Abraham, and J.W. Renner. A Theory of Instruction: Using the Learning Cycle to Teach Science Concepts and Thinking Skills. NARST Monograph No. 1, 1989.

The use of deductive and inductive approaches to teaching science is well known; however, this slim volume describes an approach to organizing the curriculum that combines these two approaches to maximize learning. Theory and practice are combined in this book with research reports and examples of learning cycles.

Loucks-Horsley, Susan, Roxanne Kapitan, Maura D. Carlson, Paul J. Kuerbis, Richard C. Clark, G. Marge Melle, Thomas P. Sachse, and Emma Walton. Elementary School Science for the '90s. Alexandria, Virginia: National Center for Improving Science Education. Association for Supervision and Curriculum Development, 1990.

Elementary school science programs in the American educational system are deficient, at best. While teachers lack confidence and training in science, children's interest and enthusiasm for learning about natural phenomena peaks during these years. The book presents 13 recommendations for addressing the science learning needs of children through appropriate development of curricula, instructional strategies, and teacher training.

National Center for Improving Science Education. Building Scientific Literacy: A Blueprint for Science Education in the Middle Years, 1990.

This book summarizes three reports by the center that are concerned with science and technology education for 10-14 year olds, assessment, and developing and supporting teachers. It concludes with recommendations for reforming middle grades science education.

National Center for Improving Science Education. Getting Started in Science: A Blueprint for Elementary School Science Education, 1989.

This summary of reports on reforming elementary science education includes sections that discuss curricular frameworks, instructional strategies, teacher development and support, and assessment. It concludes with recommendations for reforming elementary science education.

National Research Council. Everybody Counts: A Report to the Nation on the Future of Mathematics Education. Mathematical Sciences Education Board and the Board on Mathematical Science, National Research Council. Washington, D.C.: National Academy Press, 1989.

This report addresses the national concern that mathematics teaching and learning in American schools is not adequately preparing our children to gain the mathematical skills required to compete in a technological economy. Everybody Counts is the first major policy study in mathematics education that examines the entire kindergarten through graduate school mathematics curricula, teaching, and assessment components. Strong recommendations that Americans must act now to address the mathematical preparation of American children appear throughout the report.

National Research Council. Fulfilling the Promise: Biology Education in the Nation's Schools. Washington, D.C.: National Academy Press, 1990.

Seventy-five specific recommendations for "fixing" biology education in the country are put forth in this book. The viewpoint tends to be dogmatic and self-righteous but include some excellent ideas about reform from elementary school through teacher preparation. Careful reading is required but productive.

Novak, J. and D.B. Gowin. Learning How to Learn. New York: Cambridge Press, 1984.

This book describes two important techniques for helping learners understand what they know about science and other subjects. Concept mapping and Vee diagrams are explained with numerous examples. These techniques are quickly becoming the most valuable concept learning strategies in science education.

Osborne, Roger and Peter Freyberg. Learning in Science: The Implications of Children's Science. Portsmouth, New Hampshire: Heinemann, 1985.

The ideas that children bring to science lessons reflect their views of the world and meanings for words that a have a major influence on their learning. This book explores the ways children learn science and suggests ways to reduce discrepancies between science teachers' intentions and learning outcomes of the children.

American Association for the Advancement of Science. Science for All Americans. Washington, D.C.: American Association for the Advancement of Science, 1989.

This most influential national policy study of the American Association for the Advancement of Science proposes a new set of goals for science education in this country. Rejecting an emphasis on training new scientists, this report calls for a science curriculum that delivers scientific literacy to all citizens.

U.S. Congress, Office of Technology Assessment. Elementary and Secondary Education for Science and Engineering--A Technical Memorandum. OTA-TM-SET-41. Washington, D.C.: U.S. Government Printing Office, December 1988.

ADDITIONAL WORKS CITED

American Association for the Advancement of Science. The Liberal Art of Science: Agenda for Action. AAAS 90-13S. Washington, D.C.: American Association for the Advancement of Science, 1990.

Hazen, Robert M. and James Trefil. Science Matters: Achieving Scientific Literacy. New York: Doubleday, 1991.

Jenkins, Lynn B. and Ina V.S. Mullis. The Science Report Card: Elements of Risk and Recovery. Trends and Achievement Based on the 1986 National Assessment. Princeton, New Jersey: Educational Testing Service, 1988.

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National Commission on Excellence in Education. A Nation at Risk: The Imperative for Educational Reform. Washington, D.C.: U.S. Government Printing Office, 1983.

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