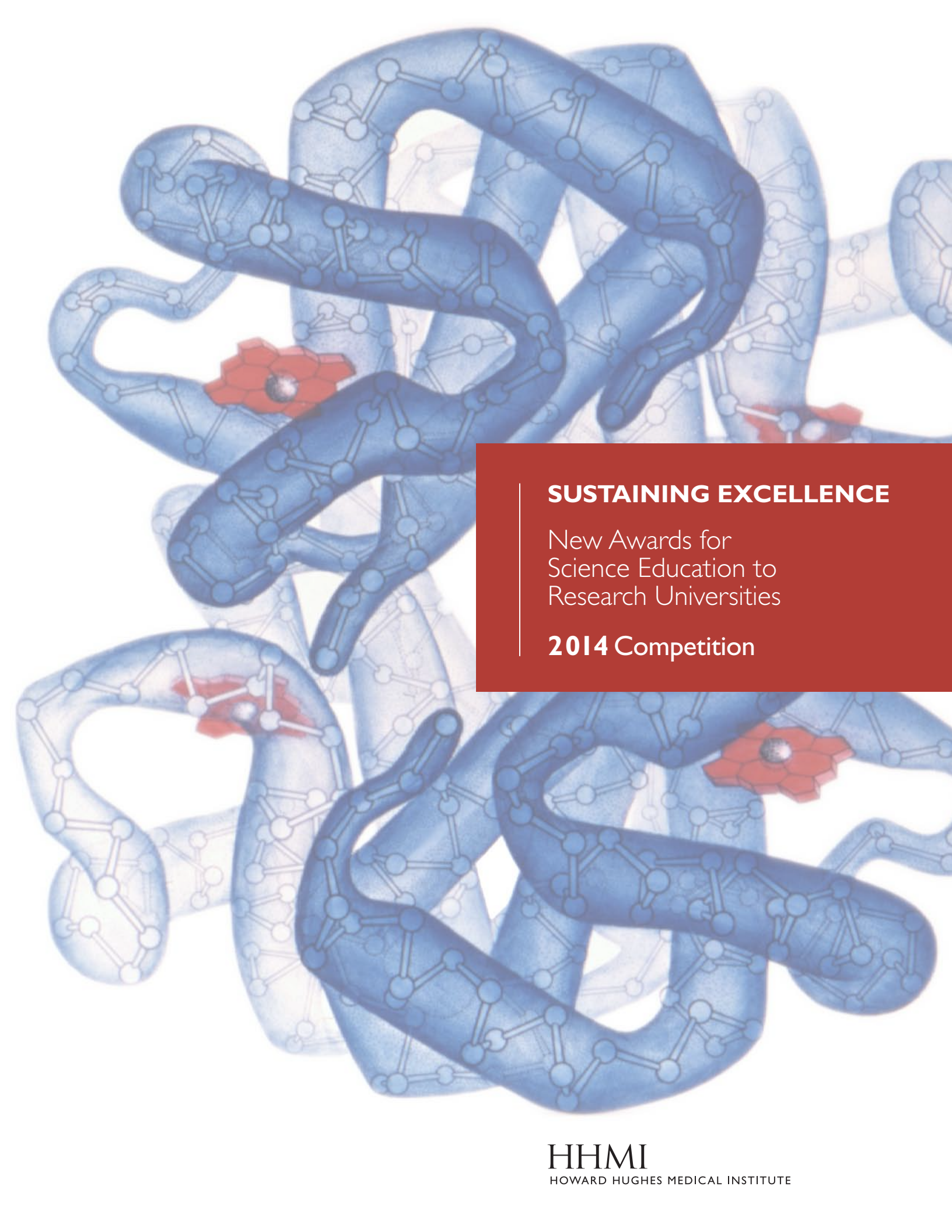

SUSTAINING EXCELLENCE

New Awards for Science Education to Research Universities

2014 Competition

HHMI
HOWARD HUGHES MEDICAL INSTITUTE

SUSTAINING EXCELLENCE
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2014 COMPETITION

The Howard Hughes Medical Institute announces a new competition for science education grants to research universities. We expect to make up to 35 awards of up to $2.5 million each over five years. The goal of the initiative is to enable universities to develop and implement strategies that will significantly increase the persistence in science of undergraduate students from all backgrounds.

The Howard Hughes Medical Institute plays a powerful role in advancing biomedical research and science education in the United States. HHMI's program in biomedical research rests on the conviction that scientists of exceptional talent, commitment, and imagination will make fundamental discoveries for the betterment of human health if they receive the resources, time, and freedom to pursue challenging questions. The Institute's science education program supports initiatives with the power to transform education in the life sciences for all students. Our objectives are to recruit and develop talented students who will become the future leaders of science and science education and to promote scientific literacy among all students. Just as today's researchers solve complex questions by working across scientific disciplines and integrating tools from these disciplines, HHMI seeks to support undergraduate science education by integrating a variety of tools and approaches that will engage students in science.

The current system of STEM education has effectively trained many STEM workers, including most of the current STEM workforce. However, its longevity is not evidence that it cannot be improved or that this system will be successful with today's student body. Indeed, extensive evidence points to a need to do better. STEM disciplines have substantially lower rates of retention than do the social sciences and humanities. Furthermore, many of those who leave STEM majors express dissatisfaction with the teaching of STEM classes. This should be seen as a national crisis of STEM teaching, yet many STEM faculty members believe that this "weeding out" process is in the best interest of their disciplines and the larger national interest. If many of those who leave performed well in introductory STEM courses, and many others could be helped to succeed, then it is unreasonable to conclude that this attrition represents an effective selection process that is maximally beneficial to STEM fields. The first two years of college are the most critical to retention and recruitment of STEM majors.
PCAST 2012: Engage to Excel

The United States stands again at the crossroads: A national effort to sustain and strengthen S&E must also include a strategy for ensuring that we draw on the minds and talents of all Americans, including minorities who are underrepresented in S&E and currently embody a vastly underused resource and a lost opportunity for meeting our nation's technology needs.
The National Academies 2011: Talent at the Crossroads

Background

Much of the responsibility for sustaining excellence in science in the United States falls on research universities, home to some of the world's best scientists. They recruit the nation's most talented students, who reflect the dynamic demographics of the country. The opportunities are great: The 203 research universities invited to this competition annually award about 75,000 baccalaureate degrees in the natural sciences and mathematics, and their undergraduate alumni go on to receive one-third of all the science and mathematics Ph.D.s awarded in the United States. At these institutions, underrepresented racial minorities (black, non-white Hispanic, Native American) comprise 18 percent of the total undergraduate enrollment and approximately 12 percent of the science and mathematics baccalaureates.

The undergraduate stage of student development is a critical time to influence the quality of science, because it is the transition period between the precollege years and the postbaccalaureate professional preparation of scientists, physicians, and educators. For this reason the core focus of HHMI science education is on undergraduate science education. Since 1988, HHMI has awarded more than $870 million in grants to 274 public and private colleges and universities in the United States. These grants are distinctive because they represent the commitment of an entire institution, not an individual faculty member or department, and because they encourage institutions to achieve educational objectives through combinations of strategies. HHMI grants have enabled research universities to engage large numbers of undergraduates in authentic research, create new courses and curricula, and reach out to local K-12 students and teachers.

The objective of this competition

The 2014 competition will encourage research universities to develop effective strategies that lead to significant and sustained improvement in the persistence in science by all students, including those students who belong to groups underrepresented in science. Successful proposals will effectively present the rationale for each of the proposed activities, so that it is clear how the activity will contribute to the objective of student persistence at the institution. We seek bold ideas grounded in evidence-based strategies.

Persistence of all students

The 2012 PCAST report, *Engage to Excel,* concludes that the United States, in order to meet growing workforce needs, should produce in the next decade 1 million additional college graduates with degrees in science, technology, engineering, and mathematics. Of the students who enter postsecondary education intending to major in STEM, only 40 percent persist and graduate with baccalaureate degrees in STEM. Most of the switching out of STEM disciplines occurs in the first two years of the undergraduate experience, and the large majority of students who leave STEM remain in college and graduate with non-STEM majors. The report points out that if the persistence rate were to increase to 50 percent, most of the goal of 1 million additional STEM graduates would be achieved.

Of particular concern is the extremely poor persistence rate of undergraduate students from underrepresented racial groups. Minority student persistence in science is only about 20 percent. This low persistence cannot be explained by relatively weak preparation. In studies that compared students with similar precollege preparation and family financial and educational backgrounds, underrepresented minority students were still much more likely to switch from science to a non-STEM major than were whites and Asians. As is the case for majority students, most of the minority students who switch out of STEM graduate from college in non-STEM majors. The nation's inability to retain minority students in science is alarming when viewed in the context of the rapidly changing demographics of the nation's talent pool: In seven years, the majority of children 18 years and younger will be persons of color, and in less than 30 years, the entire U.S. population will be "majority minority."

The PCAST report proposes three strategies to increase the retention of students in STEM:

1. Adopt teaching strategies that emphasize student engagement. This includes the adoption of empirically validated teaching practices and the replacement of traditional lab courses with discovery-based research courses.

2. Provide all students with the tools to excel. This includes recognizing that self-efficacy might be attained differently by students from different backgrounds; improving the preparation of incoming students, especially in mathematics; and providing enrichment programs and cohort events to build community among students.

3. Diversify pathways to STEM degrees. This includes acknowledging the fact that talented students come from diverse backgrounds and have widely divergent levels of preparation and experiences.

As grantee institutions develop strategies to improve the development and persistence of undergraduates in science, it is particularly important to give thoughtful consideration to how to reach all of the available talent pool, including students from groups underrepresented in science. Science will benefit from a diverse workforce. The best solutions often depend on a group of problem solvers who bring different perspectives to the challenge, apply different tools to the problem, and interpret the data through different lenses. The harder the problem, the greater the advantage of a diverse group of problem solvers.

Evidence-based strategies

The way we teach

Careful consideration of the way science is being taught is central to improving persistence in science of all students. We challenge grantees to explore ways to accomplish the first recommendation of the PCAST *Engage to Excel* report: "(to) adopt empirically validated teaching practices." Curricular changes should consider evidence-based approaches to course content and classroom pedagogy. The introductory science experience includes courses in several science and mathematics disciplines, and it is important to develop a curriculum that emphasizes cross-disciplinary competencies.

The way students learn

One of the achievements of the HHMI undergraduate science education program is the widespread involvement of undergraduates in authentic research experiences. In many cases, the research experience matches a student with a scientist mentor for an extended period—e.g., a 10-week summer research experience. When it is effective, this apprentice-based research model requires significant mentor attention and financial resources for stipends and supplies. And because it is expensive, the research experience is often restricted to relatively few students.

In the 2014 competition, we encourage strategies that introduce larger numbers of students to authentic research at an early stage of their undergraduate career. We challenge grantees to explore ways to accomplish the second recommendation of the PCAST *Engage to Excel* report: "(to) replace standard laboratory courses with discovery-based research courses." In this competition, traditional apprentice-based student research will not be funded without an accompanying approach designed to engage larger numbers of students as part of their introductory science experience.

Measuring progress

This competition focuses on student persistence in science. In order to articulate its specific goals and to measure its progress toward achieving the goals, it is important that the grantee institution first have a clear understanding of how well its students progress through the science curriculum. Thus, applicants are asked to evaluate their current programs and provide baseline data in the tables that are part of the proposal. Grantees will be expected to develop effective ways to regularly assess their progress and to show how the assessment informs their programs.

Sustainable strategies

A goal of this competition is to catalyze the implementation of strategies that are found to be effective and that will be sustained beyond the lifetime of the HHMI grant. In the proposal, the institution should include a plan for sustaining successful strategies after the lifetime of the HHMI grant. Grantee institutions will be asked to provide an updated plan for sustainability in the fourth year of the grant. The fifth and final year of funding will depend on approval of the sustainability plan.

This competition

Through this competition, HHMI expects to award five-year grants to up to 35 research universities. Grants will not be renewable.

This competition is open to the 203 institutions, listed in the Appendix to this announcement, that offer baccalaureate degrees in the natural sciences and were classified in 2010 by the Carnegie Foundation for the Advancement of Teaching as "very high" and "high" research activity institutions. Each university is limited to one proposal.

Proposal evaluation

All proposals submitted by the deadline and conforming to the formatting instructions will be reviewed by a panel of distinguished scientists and educators. Reviewers will identify programs that offer effective strategies aimed at the objective of significantly improving the persistence in science of all students, especially during the first two years of their undergraduate experience. Evaluation criteria will include the following:

Proposed Activities

- The potential for the proposed program to make a significant difference at the institution.
- The degree to which the program strategies align with the goal of student persistence.
- The degree to which the proposal builds on documented past activities or new activities described and assessed in the published literature.
- The extent to which faculty members are involved in leadership and implementation of the proposed activities.
- The institution's demonstrated commitment to the objective and to the proposed activities.

Long-Term Impact

- The quality of the institutional data provided in the proposal and the effectiveness of assessment of past and proposed activities in science education.
- Description of an outcomes-based plan to measure progress toward the goals of the program.
- The evidence that the applicant has a successful strategy for disseminating effective practices or products to the larger scientific and educational communities.
- The prospect of effecting long-term institutional change that persists well after the lifetime of the grant, and the institution's record of sustaining successful programs.
- The evidence of involvement of a significant cross-section of faculty and administration in developing the proposal and implementing the proposed activities.

Budget and Administration

- The appropriateness of the budget to the activities specified in the proposal.

• The effectiveness of the plan of management, administration, and oversight of the program, including distribution of grant funds.

• The evidence that the grant will enable new or expanded activities rather than provide budget relief for the institution.

Proposal preparation and submission

Applicants must register and submit proposals using HHMI's online competition system. Each invited institution is provided with instructions for accessing the system. Institutions must register their intent to submit proposals by 2 p.m. ET, Tuesday, June 4, 2013. Thereafter, applicants will have access to the proposal submission module of the system. The proposal system contains the 2014 proposal guidelines and other resources for proposal preparation and submission.

The deadline for submitting completed proposals is 2 p.m. ET, Tuesday, October 1, 2013. Each invited institution may submit one proposal.

For inquiries, please contact **ugradcomp@hhmi.org**.

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Cover image: Illustration of hemoglobin, watercolor, by Irving Geis/HHMI

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Appendix Research universities eligible for the 2014 competition

Alabama
Auburn University
University of Alabama, Birmingham
University of Alabama, Huntsville
University of Alabama, Tuscaloosa
University of South Alabama

Alaska
University of Alaska, Fairbanks

Arizona
Arizona State University, main campus
Northern Arizona University
University of Arizona

Arkansas
University of Arkansas, main campus

California
California Institute of Technology
San Diego State University
Stanford University
University of California, Berkeley
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, Riverside
University of California, San Diego
University of California, Santa Barbara
University of California, Santa Cruz
University of Southern California

Colorado
Colorado School of Mines
Colorado State University
University of Colorado, Boulder
University of Colorado, Denver
University of Denver

Connecticut
University of Connecticut
Yale University

Delaware
University of Delaware

District of Columbia
Catholic University of America
George Washington University
Georgetown University
Howard University

Florida
Florida Atlantic University
Florida International University
Florida State University
Nova Southeastern University
University of Central Florida
University of Florida
University of Miami
University of South Florida

Georgia
Emory University
Georgia Institute of Technology, main campus
Georgia State University
University of Georgia

Hawai'i
University of Hawai'i, Manoa

Idaho
Idaho State University
University of Idaho

Illinois
Illinois Institute of Technology
Loyola University Chicago
Northern Illinois University
Northwestern University
Southern Illinois University, Carbondale
University of Chicago
University of Illinois, Chicago
University of Illinois, Urbana-Champaign

Indiana
Ball State University
Indiana University, Bloomington
Indiana University-Purdue University Indianapolis
Purdue University, main campus
University of Notre Dame

Iowa
Iowa State University
University of Iowa

Kansas
Kansas State University
University of Kansas, main campus
Wichita State University

Kentucky
University of Kentucky
University of Louisville

Louisiana
Louisiana State University
Louisiana Tech University
Tulane University
University of Louisiana, Lafayette
University of New Orleans

Maine
University of Maine

Maryland
Johns Hopkins University
University of Maryland, Baltimore County
University of Maryland, College Park

Massachusetts
Boston College
Boston University
Brandeis University
Clark University
Harvard University
Massachusetts Institute of Technology
Northeastern University
Tufts University
University of Massachusetts, Amherst
University of Massachusetts, Boston
University of Massachusetts, Lowell

Michigan
Michigan State University
Michigan Technological University
University of Michigan, Ann Arbor
Wayne State University
Western Michigan University

Minnesota
University of Minnesota, Twin Cities

Mississippi
Jackson State University
Mississippi State University
University of Mississippi
University of Southern Mississippi

Missouri
Missouri University of Science and Technology
Saint Louis University
University of Missouri, Columbia
University of Missouri, Kansas City
University of Missouri, St. Louis
Washington University

Montana
Montana State University
University of Montana

Nebraska
University of Nebraska, Lincoln

Nevada
University of Nevada, Las Vegas
University of Nevada, Reno

New Hampshire
Dartmouth College
University of New Hampshire

New Jersey
New Jersey Institute of Technology
Princeton University
Rutgers University, New Brunswick
Rutgers University, Newark
Stevens Institute of Technology

New Mexico
New Mexico State University, main campus
University of New Mexico

New York
Clarkson University
Columbia University
Cornell University
Fordham University
New York University
Polytechnic Institute of New York University
Rensselaer Polytechnic Institute
State University of New York, Albany
State University of New York, Binghamton
State University of New York, Buffalo
State University of New York, Stony Brook
Syracuse University
University of Rochester
Yeshiva University

North Carolina
Duke University
North Carolina State University
University of North Carolina, Chapel Hill
University of North Carolina, Greensboro
Wake Forest University

North Dakota
North Dakota State University
University of North Dakota

Ohio
Bowling Green State University
Case Western Reserve University
Cleveland State University
Kent State University, main campus
Miami University
Ohio State University, main campus
Ohio University, main campus
University of Akron, main campus
University of Cincinnati
University of Dayton
University of Toledo
Wright State University, main campus

Oklahoma
Oklahoma State University
University of Oklahoma

Oregon
Oregon State University
Portland State University
University of Oregon

Pennsylvania
Carnegie Mellon University
Drexel University
Duquesne University
Lehigh University
Pennsylvania State University, main campus
Temple University
University of Pennsylvania
University of Pittsburgh, main campus

Puerto Rico
University of Puerto Rico, Rio Piedras

Rhode Island
Brown University
University of Rhode Island

South Carolina
Clemson University
University of South Carolina, Columbia

South Dakota
South Dakota State University
University of South Dakota

Tennessee
University of Memphis
University of Tennessee, Knoxville
Vanderbilt University

Texas
Baylor University
Rice University
Southern Methodist University
Texas A&M University, main campus
Texas Tech University
University of Houston
University of North Texas
University of Texas, Arlington
University of Texas, Austin
University of Texas, Dallas
University of Texas, El Paso
University of Texas, San Antonio

Utah
Brigham Young University
University of Utah
Utah State University

Vermont
University of Vermont

Virginia
College of William and Mary
George Mason University
Old Dominion University
University of Virginia
Virginia Commonwealth University
Virginia Polytechnic Institute and State University

Washington
University of Washington, Seattle
Washington State University

West Virginia
West Virginia University

Wisconsin
University of Wisconsin, Madison
University of Wisconsin, Milwaukee

Wyoming
University of Wyoming